AMPCO Interrogatory #30

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-1 Page 3, Chart 1 & D2-2-8 Page 7, Chart 3

Preamble: OPG provides a cost breakdown of the total Darlington Refurbishment Program (DRP) Release Quality Estimate (RQE) showing the Program components.

a) Please confirm that the RQE provides the baseline cost estimate for each major program component that OPG will compare all future costs to until 2026.

b) Please add a column to Chart 1 to reflect the component costs approved by OPG's Board of Directors in November 2013.

c) Based on OPG's review of other nuclear refurbishment projects and other megaprojects please compare OPG's Contingency of 16.4% of the RQE (excluding interest & escalation) to the Contingency % of these other projects.

d) Based on OPG's review of other nuclear refurbishment projects megaprojects, please compare OPG's Functional Costs of 21.3% of the RQE (excluding interest & escalation) to the % of Functional Costs of these other projects.

e) Please provide the original and current (revised) Safety Improvement Opportunities and Facilities & Infrastructure Projects budgets and show the % of costs for each that have been reclassified to date.

Response

a) OPG will compare future costs to the baseline established by the RQE on a total program basis. As indicated at Ex. D2-2-8 p. 8, while actual costs may ultimately be different than forecast for individual major program components, OPG's success on refurbishing and returning Unit 2 to service and the Program as a whole, should be measured at the total envelope level.

b) In November 2013, OPG's Board of Directors did not approve any costs equivalent to the costs shown in Ex. D2-2-1 p. 3. The Board of Directors' approval was limited to a release of $680M to continue the Definition Phase of the Darlington Refurbishment Program (DRP) and complete planned 2014 deliverables. The life cycle estimate prepared in

November 2013 in support of the release was a preliminary estimate and is not directly comparable to the RQE, as the scope of work was yet to be finalized. However, an approximation of the comparison is identified below:

Chart 1

	Ex. D-2-2-1 p.3 Chart 1		Nov. 2013 Total Cost Est (Release 4C)		
Program Component	**RQE Total Cost ($2015B)(1)**	**RQE Total Cost (%)**	**Total Cost Estimate Converted to 2015$(1)**	**Total Cost (%)**	**Total Cost Estimate (2013$)(2)**
Major Work Bundles	5.54	43	4.35	38	4.18
Safety Improvement Opportunities	0.20	2	0.11	1	0.11
Facilities & Infrastructure Projects	0.64	5	0.57	5	0.55
OPG Functional Support	2.23	17	2.16	19	2.08
Early Release Funds	0.11	1	0.12	1	0.12
Contingency	1.71	13	2.16	19	2.08
Interest & Escalation($B) (3)	2.37	19	1.97	17	2.20
Total Cost Estimate ($B) (3)	**12.8**	**100**	**11.32**	100	**11.32**

(1) All numbers are in 2015$ except for Interest and Escalation and the Total Cost Estimate
(2) All numbers are in 2013$ except for Interest and Escalation and the Total Cost Estimate
(3) Interest and Escalation and the Total Cost Estimate are in nominal dollars, i.e. a sum of the dollars of the year in which they are expended

c) OPG does not have enough detailed information on the costs estimates developed for such projects and the percentage of contingency in those estimates to do the comparison requested.

d) Please see Ex. L 4.3-1 Staff-45, part c).

e) The requested information for Facilities & Infrastructure Projects is shown in the following chart:

Chart 2

Project Title	Total Project Cost (M$)		% of costs Reclassified
	Original Full Release	EB-2016-0152	
Darlington OSB Refurbishment	53.0	62.7	100
DN Auxiliary Heating System	99.5	99.5	100
D2O Storage Facility	110.0	381.1	0
Water & Sewer Project	40.6	57.7	0
Darlington Energy Complex	105.4	105.4	0
R&FR Island Support Annex	40.7	40.7	0
Refurbishment Project Office	99.9	99.9	0
Electrical Power Distribution System	16.9	20.8	0
GM Office Facility	9.3	9.3	0
Vehicle Screening Facility	3.0	6.6	0

The requested information for the Safety Improvement Opportunities (SIO) projects is shown in the following chart. No SIO projects have been reclassified.

Chart 3

Project Title	Total Project Cost (M$)		% of costs Reclassified
	Original Release	EB-2016-0152	
Third Emergency Power Generator	88.2	120.4	0
Containment Filtered Venting System	80.6	80.3	0
Powerhouse Steam Venting System	5.6	5.6	0
Shield Tank Overpressure Protection	13.5	13.5	0
Emergency Service Water Buried Services	7.9	14.6	0

Note: The original release amounts for the SIO projects are based on the first approved Gate Progression Form or Change Control Form for Execution Phase.

AMPCO Interrogatory #31

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-1 Page 5

a) Please provide the OPG Functional Support % of in-service additions for Units 1, 3 and 4.

Response

a) OPG declines to provide the requested information for Units 1, 3 and 4 on the basis of relevance. The return-to-service of these units is beyond the test period and therefore is not part of OPG's request in this application.

AMPCO Interrogatory #32

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-1 Page 11

a) Please provide a copy of the Integrated Investment Plan (IIP).

Response

a) OPG assumes that the interrogatory is requesting a copy of the Integrated Implementation Plan (IIP) as there is no Integrated Investment Plan. The IIP document is included as Attachment 1.

ONTARIO POWER GENERATION

Report

Document Number:	Usage Classification:
NK38-REP-03680-10185	N/A
Sheet Number:	Revision:
N/A	R002

Title:
DARLINGTON NGS INTEGRATED IMPLEMENTATION PLAN

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Darlington NGS Integrated Implementation Plan (IIP)

NK38-REP-03680-10185-R002

2015-04-30

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Revision Summary

Revision Number	Date	Comments
R000	2013-11-14	Initial Issue
R001	2014-10-31	General - Revised IIP to reflect feedback received following CNSC staff initial review [R-6] Section 1.0 - Added Section 1.1 CNSC Review and Assessment of the GAR and IIP Section 2.0 - Added the IIP Criteria used for the CCA and Code Gap IIP Commitments. Section 3.0 - High-level expectation of schedule has been provided. - Life Extension Model has been removed. Major Activities - Major Activities have been removed as they are identified in the respective IIP Commitment tables located in the Appendices. IIP Change Control Process - The IIP Change Control Process has been limited to a high-level description. Specific details will be described in the IIP Change Control Process document. Tables - Removed Roadmap of Items Considered in the Development of the IIP. Appendices - Appendix A identifies the Open IIP Commitments for EA, CCAs and Code Gaps. - Appendix B identifies the IIP Commitments that have been completed for EA, CCAs and Code Gaps. - Appendix C identifies the IIP Item Number mapping between IIP R000 and IIP R001. - Appendix D describes the Integrated Aging Management Program.
R002	2015-04-30	General Revised IIP to reflect feedback received from CNSC staff of IIP R001 [R-7]. Section 3.0 Clarified TRF work to be managed by TRF lifecycle planning Section 5.0 Removed as managed systems instruction for Change Control and Close-out of actions has been issued Appendix A Removed items completed since R001 issuance Appendix B Inserted items completed since R001 issuance Appendix C Updated table for completed items

1.0 INTRODUCTION

The Darlington Nuclear Generating Station, also referred to here as Darlington, is a four-unit generating station that includes a separately housed Tritium Removal Facility (TRF). The site is located in the Municipality of Clarington, Regional Municipality of Durham, in the Province of Ontario. Darlington has operated successfully since the early 1990s and a program has been implemented to extend the life of the plant for 30 additional years.

The justification for the continued operation of Darlington following Life Extension is documented in a Global Assessment [R-1] carried out in accordance with the Canadian Nuclear Safety Commission (CNSC) Regulatory Document RD-360, “Life Extension of Nuclear Power Plants” [R-2]. The regulatory document, hereafter referred to as RD-360, requires the licensee to demonstrate that continued station operation poses no unreasonable risk to health, safety, security of the public or the environment, and will continue to conform to international obligations.

The results from the Global Assessment [R-1] demonstrated that Darlington is a safe and reliable nuclear power plant today. Implementation of the improvements, as documented here, will result in Darlington being an even safer and more reliable source of clean electrical power to the Province of Ontario for another 30 years.

Three principal activities were undertaken by OPG to systematically identify the environmental and safety enhancements that will assure ongoing safe operation for 30 additional years:

1. Environmental Assessment (EA)

   The EA is a comprehensive assessment of the potential impacts of refurbishment and continued operation on the natural environment including public safety and socio-economic considerations. The EA is focused on the impacts beyond the plant boundary. The EA determined that refurbishment and continued operation of Darlington, given the mitigations described, will not have significant adverse environmental impacts. The results of the EA are contained in the Environmental Impact Statement [R-3], the technical support documents, and the CNSC decision as documented in the CNSC’s Record of Proceedings [R-4].

2. Integrated Safety Review (ISR)

   The ISR is a systematic and comprehensive assessment of the plant design and actual condition, and of the management system used to operate and maintain the nuclear plant. The ISR enabled determination of the reasonable and practical modifications that should be made to the plant design or the management system to further enhance future safe operation. The results of the ISR are documented in a series of reports based on established Safety Factor review topics listed in N-PROC-LE-0005 “Nuclear Refurbishment Integrated Safety Review – Darlington” [R-5].

3. Global Assessment (GA)

   The Global Assessment used the results of the EA and ISR and examined them in an integrated manner. It assessed the strengths, opportunities for improvement, and actions to address the opportunities for improvement, in order to provide an overall judgment on the acceptability of the risk arising from continued operation. The GA further assessed the adequacy, and implementation timing of the actions arising from the EA and ISR that are identified to extend the life of the plant.

The IIP presents the scope and schedule for the implementation of actions identified through the ISR and the EA.

1.1 CNSC Review and Assessment of the GAR and IIP

Canadian Nuclear Safety Commission (CNSC) staff completed their review and assessment OPG's submission of the Global Assessment Report (GAR) and Integrated Implementation Plan (IIP). As documented in the CNSC correspondence letter [R-6], OPG's GAR as submitted was acceptable to CNSC staff as it meets all applicable requirements of RD-360. CNSC staff accepted OPG's IIP Revision 001 with implementation of several required specific changes [R-7].

2.0 INTEGRATED IMPLEMENTATION PLAN (IIP) SCOPE

The scope of OPG's Integrated Implementation Plan (IIP) includes:

- Mitigating measures and follow-up program activities from the Environmental Assessment (EA)
- Actions from the Integrated Safety Review:
  - Recommendations from Component Condition Assessments (CCA);
  - Actions to close gaps identified through the balance of the Integrated Safety Review (ISR) and CNSC questions; and
  - Actions resulting from the review of updates to modern ISR Codes and Standards and significant operating experience since the submission of the ISR to the end of 2013.

1. The Environmental Assessment (EA)

The scope of the IIP resulting from the EA includes the mitigation measures, the Safety Improvement Opportunities (SIO's) committed in the EA and the follow-up program elements. The mitigation measures and SIOs address potential environmental effects. The follow-up program elements are actions to confirm that the predictions of environmental effects are accurate post refurbishment, and that the mitigation measures are effective.

2. Components Condition Assessments (CCAs)

CCAs were performed on critical components to determine condition, reliability of material and to ensure that required activities are in place to monitor the condition of the components going forward; or that components are repaired or replaced as necessary to ensure good system performance as the plant ages. The Aging and Actual Condition of SSCs Safety Factor Report presented a preliminary list of recommended actions required to allow each unit within the station to reach the end of its current life, as well as actions to be undertaken during and following the refurbishment.

Actions to address issues identified in the CCAs are included in the IIP based on the following criteria:

- Components that are part of the 58 Safety Related Systems identified in the ISR; and
- Components have high nuclear Safety Significance (Reactor Safety 1 or 2); and

- Components with a condition of less than “Good”, and the activities to bring them to “Good” condition are not already part of normal station maintenance; or

- Components rated with a condition of “Good” based solely on past performance history and no physical inspections have been done. Inspection activity is required to confirm actual physical condition of component;

Actions resulting from the CCA Recovery Project are included in the IIP if they met the criteria outlined above.

Any future CCA actions that meet the above criteria will be processed in accordance with the Aging Management Process [R-8].

3. Code Gaps

As part of the ISR, safety improvements were proposed to address gaps with respect to safety requirements identified during the review of modern codes and standards identified in N-PROC-LE-0005 [R-5]. Related gaps were consolidated into ISR Issues for prioritization and resolution. The safety significance of these ISR Issues was assessed in accordance with the Issue Prioritization Process N-INS-00770-10005 [R-9].

The code gaps have been consolidated into ISR Issues; ISR Issues with similar resolutions have been consolidated with a single action plan and completion date. TRF actions have been removed from the IIP as they will be managed by the TRF life cycle plan.

IIP scope will be monitored to completion and closed out through its own approved processes. Normal component ageing for the remaining station life will be managed in accordance with the Integrated Aging Management (IAM) Program N-PROG-MP-0008 [R-10] and executed as part of normal station practices. The IAM Program ensures that the condition of critical equipment is understood and that activities are in place to ensure the health of these components and systems while the plant ages. Elements of the IAM Program are detailed in Appendix D.

3.0 IIP SCHEDULE

The Darlington Life Extension Plan is to have:

- EA activities implemented in accordance with the EA Screening Report and EA Follow Up Program Report;
- The majority of unit specific physical work completed prior to restart of the first complete maintenance outage following the Refurbishment Outage for each respective unit;
- The majority of inspections required to confirm condition completed prior to unit restart from each respective Refurbishment Outage.
- The timing to execute contingency actions (repairs or replacements resulting from inspections) will be determined by using a graded approach:
    - Inspection results that are favourable will require no further action;
    - Inspections revealing minor degradation will require either enhanced monitoring or will be addressed by normal station practices;
    - Inspections revealing safety significant defects that would prevent unit start-up will be prioritized in alignment with the Technical Operability Evaluation Process N-PROC-MP-0045 [R-11] and corrected as required prior to unit restart of each respective Refurbishment Outage.
- The majority of safety improvements applicable to the entire station will be implemented prior to the restart from the Unit 2 Refurbishment Outage;

Specific year end completion dates have been identified for all actions in the IIP for unitized and non-unitized work, unless otherwise noted. There are cases where the activity will be completed by the restart of a unit outage rather than the year end date. These details have been provided in the ‘Date’ column of the subsequent tables.

4.0 DESCRIPTION OF APPENDICES

Appendix A - IIP Commitments

Activities identified in Appendix A are open actions which are required for Life Extension. These include:

- EA Mitigation Program Elements including SIO's (Table 1);
- EA Follow-Up Monitoring Program Elements (Table 2);
- Component Condition Assessments (Table 3);
- Code Gaps (Table 4).

Appendix B - Completed Activities

Activities identified in Appendix B have been completed since the submission of IIP R000 and R001. These include:

- EA Activities (Table 5);
- Component Condition Assessments (Table 6,7);
- Code Gaps (Table 8, 9).

Reference to the associated completion documentation has been provided.

Appendix C - IIP Mapping

In R001 of the IIP, new IIP Item Numbers were assigned to each activity as multiple line items were consolidated into a single line item. Appendix C identifies the mapping between the IIP Item Number in IIP R000 and IIP R001. The numbering established in R001 of the IIP remains the same in R002 of the IIP.

Appendix D – Integrated Aging Management Program

Appendix D describes the elements of the OPG equipment aging management process.

Appendix A: Open Activities

Table 1 is a summary of the activities to address the EA Mitigation Measures. Table 2 is a summary of the activities to address EA Follow-up Program Elements. The following is a brief description of the columns for both tables:

1. The 'IIP Item Number' column lists a unique identifier. This number remains the same as was produced in R001 of the IIP. Appendix C identifies the mapping between the IIP Item Number in IIP R000 and IIP R001.
2. The 'Environmental Component' column identifies the source reference(s) for the line item.
3. The 'Mitigation Objective' or 'Monitoring and Follow-up Objective' column lists the high level mitigation measure or follow-up program elements.
4. The 'Action Plan' column lists the proposed strategy to meet the objectives of the mitigation measures and follow-up program elements.
5. The 'Tracking Number' column lists the Action Request (AR) number or Darlington Scope Request (DSR) number that internally tracks each item to completion.
6. The 'Completion Date' column identifies the year end date in which the identified actions will be completed. 'Refurbishment Outage' completion dates are linked to the Refurbishment Outage restart dates and not the year end date.

Table 1: EA Mitigation Measures (Open Activities)

IIP Item Number	Environmental Component (Reference)	Mitigation Objective (In design and Additional Mitigation Measures)	Action Plan	Tracking Number	Completion Date
IIP-EA 001	Aquatic CNSC Screening Report - page 90 (also in EIS Table 5.15)	Mitigate fish impingement and entrainment losses by means of offsetting.	1) Evaluate the need for a *Fisheries Act* authorization and document rationale for decision. Reference: NK38-CORR-00539.4-10001 Authorization under the Fisheries Act for DNGS 2) Submit application to obtain authorization under section 32 of the *Fisheries Act* as appropriate. Application will assess the need for long term impingement and entrainment monitoring beyond those required as part of the Follow-up monitoring program. 3) Develop any compensation program and update environmental monitoring program/procedures to include requirements defined by the Fisheries Act authorization which may include impingement and entrainment monitoring, thresholds to trigger review of mitigation options and compensation/offset program.	Complete [R-13] Complete [R-14] AR# 28159540-17	2014 2014 2016
IIP- EA 003	Socio-Economics CNSC Screening Report – page 108, 109 and 111 (also in EIS Table 5.15) Traffic and Transportation CNSC Screening Report – page 107 (also in EIS Table 5.15)	Reduce traffic disruption during peak periods and maintain safe traffic conditions both on-site and off-site during the Refurbishment Phase.	1) Develop a Traffic Management Working Group (TMWG) Terms of Reference between the interested parties (OPG, Ministry of Transportation, Durham region and Clarington) to plan a coordinated program of road improvements to maintain safe and efficient transportation operations in the Local Study Area. Darlington Nuclear Traffic Management "Working Group" (TMWG), NK38-CORR-13110-0456325, provides the Terms of Reference (purpose, mandate, scope of activities, membership, schedule and agenda/minutes) 2) Develop and implement a Travel Demand Management (TDM) program to reduce and control DN site traffic during peak periods and to reduce disruption to the use or enjoyment of community and recreational facilities on or off the DN site. Issue a report documenting the TDM initiatives that were implemented. TDM initiatives will consider shift changes at times other than traditional peak travel periods; shuttle/transit service to DN site, and carpool incentives. 3) Perform an assessment to confirm effectiveness of traffic management and travel demand management initiatives by periodically assessing levels of service at key intersections and road links during Refurbishment phase (until Horizon 2021 which represents peak Project-related traffic conditions).	Complete [R-15] AR# 28159540-02 AR# 28159540-01	2014 2017 2022

IIP Item Number	Environmental Component (Reference)	Mitigation Objective (In design and Additional Mitigation Measures)	Action Plan	Tracking Number	Completion Date
IIP- EA 005	Socio-Economics CNSC Screening Report – page 110 and 111 (also in EIS Table 5.15)	Inform neighbours and the public of the refurbishment project and on-going activities of the DNGS operations.	1) Ensure activities to periodically inform the public about the progress of the Project; share information with key stakeholders regarding the timing and magnitude of the on-site labour force; and work in partnership with government and educational institutions through existing liaison mechanisms and programs, are identified in communication plans in accordance with NK38-PLAN-09701-10067 Refurbishment Program Communications Plan. Issue annual communication reports documenting the above. 2) Communicate information to the public based on level of public interest of station operations, activities, and anticipated effects on environment and the health and safety of persons. "Nuclear Public Information and Disclosure," N-STD-AS-0013 defines the on-going public and stakeholder communication program.	AR# 28159540-38 to -46 2014 report completed [R-16] AR# 28159540-38 to -46 2014 report completed [R-16]	Annually from 2014 to 2025 Annually from 2014 to 2025
IIP-EA 006	Socio-Economics CNSC Screening Report – page 110 (also in EIS Table 5.15)	Minimize disruption of recreation facilities and amenities on the DN site which includes maintaining public access to the Waterfront Trail.	1) Establish and maintain agreements with the Municipality of Clarington to ensure safe public access of the Waterfront trail that traverses the DN site. Site Plan Agreement (G14375) item #8 specifies the OPG lands set aside for the Waterfront trail and the Licensing agreement (Licence P502128) for the Waterfront trail. 2) Undertake a Recreational User Survey of DN site recreation facilities for two seasons in one year after the restart of all reactors. 3) Results of the Recreation User Survey will be reviewed as part of the DN Public Affairs program and with the Community Advisory Committee.	Complete [R-17] [R-18] AR# 28159540-03 AR# 28159540-04	2012 2026 2026

IIP Item Number	Environmental Component (Reference)	Mitigation Objective (In design and Additional Mitigation Measures)	Action Plan	Tracking Number	Completion Date
IIP-EA 009	Accidents & Malfunctions CNSC Screening Report Section 7.5.2	Implement the following design modifications as identified in Section 7.5.2 in the CNSC Screening Report through the Safety Improvements for the DNGS Refurbishment Project. Credit for these improvements were taken in the EA resulting in RC7 as the representative accident scenario: 1. Containment Filtered Venting System (CFVS) 2. Powerhouse Steam Venting System (PSVS) 3. Third Emergency Power Generator (EPG) 4. Provision of Alternate and Independent Supply of Water to Heat Transport System (Emergency Heat Sink).	Implement the following modifications: 1) A Containment Filtered Venting System (CFVS). The purpose of the CFVS is to provide controlled and filtered emergency venting of containment to prevent over-pressurization and assure containment integrity in the unlikely event of a multi-unit Severe Accident. A Severe Accident is a Beyond Design Basis Accident [1](BDBA) that involves significant core degradation. To enhance the CFVS modification, a Shield Tank Overpressure Protection modification will be implemented. The purpose of this modification is to enhance the relief capacity of the shield tank surrounding each unit's calandria vessel to prevent shield tank catastrophic failure and to limit the containment over pressurization in the unlikely event of a multi unit Severe Accident. 2) Powerhouse Steam Venting System (PSVS) enhancements. These enhancements are related to duplication of the programmable controller logic of the current PSVS to improve the reliability of the PSVS which is an important system to protect plant systems following a steam line break. 3) A third Emergency Power Generator (EPG3). The third EPG is planned to be able to withstand a seismic event which is more demanding than the Design Basis Earthquake for which the existing two EPGs are designed, and to increase emergency power reliability when one EPG is not available. A Design Basis Earthquake is a representation of the combined effects, at the site, of a set of possible earthquakes having a very small probability of being exceeded during the life of the plant. 4) Provide an alternate and independent source of Emergency Water supply to the Heat Transport System by: a. Installing Emergency Mitigation Equipment. b. Installing permanent Fire Water pumps and a permanent line from the Emergency Service Water System to the Heat Transport System and using an existing Emergency Coolant Injection System line for injection to the Heat Transport System..	DSR# IP0030-1 DSR# IP0540-1 DSR# SI0040-1 DSR# SI0030-1 Complete [R-19] DSR# SI0050-1	U0: 2016[2] U3: 2015 U4: 2016[2] U1: 2017[3] U2: 2019 (Refurbishment Outage Restart) U1: 2016[2] U2: 2016[2] U3: 2016[2] U4: 2016[2] U0: 2016[2] 2012 U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)

[1] A BDBA is an event with a frequency of occurrence less than 1 in 100,000 reactor years.
[2] Activity will be completed prior to U2 Refurbishment breaker-open.
[3] Activity will be completed prior to U2 Refurbishment Outage Restart (breaker-closed) and prior to bulkhead installation.

Table 2: Follow-up Program Elements (Open Activities)

IIP R001 Item Number	Environmental Component (Reference)	Monitoring and Follow-up Objective	Action Plan	Tracking Number	Completion Date
IIP EA-010	Surface Water CNSC Screening Report – page 167	Characterize the conventional chemical (i.e., non-radiological) parameters present in DNGS effluent streams.	1) Develop a sampling plan. Measured parameters will be based on sources of chemicals, metals of construction (e.g. corrosion product transport), and review of Constituents of Potential Concern (COPCs) considered in the EA studies (see Non-Human Health – Ecological Risk Assessment TSD (OPG 2011d) and Human Health TSD (OPG 2011e)). The monitoring frequency will be determined considering the range of conditions encountered under normal operations. Proposed sample locations are at the point of discharge (i.e., MISA or ECA control point). Condenser cooling water (CCW) sampling is also proposed as confirmation of the parameters measured in the systems and to compare with ECA limits.	Complete [R-20]	2014
			2) Conduct effluent characterization according to sampling plan.	AR# 28159540-19	2016[2]
			3) Document and report findings. Update the Liquid Effluent Assessment performed during the EA studies considering the results of the effluent characterization. The measured concentrations will be used to identify Constituents of Potential Concern (COPC). Assess the exposure to the COPCs and provide an assessment of environmental risk to receptors. The ERA will be revised according to these new insights. If the ERA identifies new environmental issues or the need to study an environmental issue further, additional site data may be needed to refine exposure calculations, reduce uncertainty and identify risk management or remediation measures if required. These recommendations identified as part of this follow-up program element will be addressed as part of compliance with CSA N288 series standards and incorporated in the site Emergency Management Plan accordingly, and this follow-up monitoring will be complete.	AR# 28159540-20	2016

[2] Activity will be completed prior to U2 Refurbishment breaker-open.

IIP R001 Item Number	Environmental Component (Reference)	Monitoring and Follow-up Objective	Action Plan	Tracking Number	Completion Date
IIP EA-011	Surface Water CNSC Screening Report – page 167	Confirm the effectiveness of mitigation measures to protect stormwater quality in the area subject to refurbishment activities (i.e., Protected Area).	1) Develop a sampling plan. Measured parameters will include MISA parameters as well as other historic relevant parameters based on water quality monitoring. The sample design should be based on the methodologies employed in the DNGS EA to allow comparison with historical studies. Sampling locations will be established during development of the study plan and focus on areas within the Protected Area (e.g., 2010/2011 stormwater control study catchment areas K1, K2, K3, J, L and M).	AR# 28159540-06	2018
			2) Conduct a stormwater control study according to the sampling plan.	AR# 28159540-07	2019
			3) Document and report findings. Include a comparison to previous stormwater sampling results and recommendation for additional monitoring if required.	AR# 28159540-08	2020
IIP EA-012	Aquatic CNSC Draft Report – page 97, 160 and 168 (Also in EIS Table 11.6.2)	Confirm the accuracy of the predictions made in the EA concerning changes in lakewater temperatures in the vicinity of the CCW discharge, and their associated possible effects on survival rates for round whitefish embryos.	1) Obtain and review the results of an in-progress CANDU Owners Group (COG) study examining thermal effects to round whitefish eggs over the two winter seasons (2011/2012 and 2012/2013).	Complete [R-21]	2015
			2) Develop a sampling plan. A Thermal Monitoring Protocol Agreement established through consultations with regulatory agencies and other stakeholders will be included in the sampling plan. The Protocol should consider the results of the COG study in establishing: • Thermal benchmark(s) for comparison of measured values. • Determination of location(s) for ambient water temperature monitoring; and • Temperature thresholds that would trigger adaptive management response (e.g., increased thermal monitoring).	AR# 28159540-22	2015
			3) Implement annual ambient water temperature monitoring.	AR# 28159540-23	2016
			4) Conduct thermal monitoring during Refurbishment outage.	AR# 28159540-24	2020
			5) Report monitoring data collected during Refurbishment outage and assess likely effects on the survival of round white fish embryos. If the performance threshold is exceeded, review available mitigation options to determine if additional technically and economically feasible opportunities are available to further reduce the potential for effects.	AR# 28159540-25	2021
			6) Conduct thermal monitoring after restart of all reactors (i.e. Continued Operation phase).	AR# 28159540-26	2026
			7) Report monitoring data collected during Continued Operation phase and assess likely effects on the survival of round white fish embryos. If the performance threshold is exceeded, review available mitigation options to determine if additional technically and economically feasible opportunities are available to further reduce the potential for effects.	AR# 28159540-27	2027

IIP R001 Item Number	Environmental Component (Reference)	Monitoring and Follow-up Objective	Action Plan	Tracking Number	Completion Date
IIP EA-013	Aquatic CNSC Screening Report – pages 168 to 171 (Also in EIS Table 11.6.2 and "Adaptive Management for Impingement and Entrainment Effects During Continued Operations of DNGS" (Discussion Draft))	<u>Benthic Invertebrate Community Study</u> Determine baseline abundance and species diversity of benthic invertebrates in the vicinity of the DNGS intake. Species presence will be classified to order (or genus if possible) and will be compared to future entrainment study results. These benthic results will also be compared to near shore benthic studies conducted in 2008 in the vicinity of the proposed New Nuclear at Darlington (NND) infill area. <u>Entrainment Monitoring</u> • Characterize early life stages of fish and macro invertebrates being entrained by station operation. The sampling should be conducted in a manner sufficient to reflect the diel and seasonal cycles in organism abundance within the capture zone of the intake; • Monitor at a level capable of detecting fish Species at Risk and aquatic species of conservation concern that have been identified by provincial or federal agencies. Sampling should target species based on life history characteristics and potential for interaction with station operation; and, • Determine the total fish and macro invertebrate losses and associated impact. <u>Impingement and Entrainment</u> • Characterize early life stages of fish and macro invertebrates being entrained and fish impinged by station operation. The sampling should be conducted in a manner sufficient to reflect the deil and seasonal cycles in organism abundance within the capture zone of the intake; • Monitor at a level capable of detecting fish Species at Risk and aquatic species of conservation concern that have been identified by provincial or federal agencies. Sampling should target species based on life history characteristics and potential for interaction with station operation; and, • Determine the total fish and macro invertebrate losses and associated impact.	<u>Benthic Invertebrate Community Study</u> 1) Develop a sampling plan for Benthic Invertebrate Community Study in the vicinity of DNGS intake. 2) Conduct Benthic Invertebrates Community study. 3) Document and report findings including a comparison to the 2008 study in the vicinity of NND. <u>Entrainment Monitoring</u> 1) Develop a sampling plan which includes entrainment sampling methodology. The selected methodology will consider methodologies from other jurisdictions. Sampling plan should include development of performance threshold(s) for impingement and entrainment (i.e. unacceptable levels of impingement and entrainment losses especially in reference to Species at Risk and aquatic species of conservation concern) through consultations with regulatory agencies and other stakeholders. 2) Using the methodology developed from activity 1), conduct entrainment study prior to start of the refurbishment outage. 3) Document and report findings. <u>Impingement and Entrainment</u> 1) Prepare sampling plan for impingement and entrainment. 2) Conduct impingement and entrainment monitoring according to the sampling plan.	AR# 28159540-28 AR# 28159540-29 AR# 28159540-30 AR# 28159540-31 AR# 28159540-32 AR# 28159540-33 AR# 28159540-34 AR# 28159540-35	2015 2016[2] 2016 2015 2016[2] 2016 2025 2027

[2] Activity will be completed prior to U2 Refurbishment breaker-open.

IIP R001 Item Number	Environmental Component (Reference)	Monitoring and Follow-up Objective	Action Plan	Tracking Number	Completion Date
			3) Document and report findings. If the performance threshold(s) are exceeded, review available mitigation options to determine if additional technically and economically feasible opportunities are available to further reduce the potential for effects (see Section 3.3).	AR# 28159540-36	2027
IIP EA-014	Malfunction and Accidents CNSC Screening Report – page 169	Update the station PRA to confirm that the assignment of probabilities appropriately represent the SIO changes. This will take place after the station design has been finalized, all the design changes with supporting Safety Analysis and procedural documents (e.g., Emergency Operating Procedures, Abnormal Incident Manual) and the plant modifications are declared Available for Service (AFS) are complete prior to bringing the refurbished units back on-line. The PRA will be updated and reported to the CNSC as per S-294 requirements.	1) Provide the SIO implementation status update prior to the restart of each the refurbished units. 2) Once all of the refurbished units are back on-line, update the PRA to reflect the plant changes in all units. A review of the PRA results will be completed to confirm that the event frequencies predicted in the EA based on conceptual design features are consistent with the installed equipment.	AR# 28159540-09,-10,-11,-12 AR# 28159540-13	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart) 2026

IIP R001 Item Number	Environmental Component (Reference)	Monitoring and Follow-up Objective	Action Plan	Tracking Number	Completion Date
IIP EA-015	Effects of the Environment on the Project CNSC Screening Report – page 169	Confirm the liquefaction potential of foundation materials in the Protected Area is acceptably low.	1) Carry out a review including the following general steps: • Compile and review all available data regarding the fill material in the Protected Area where there are relevant safety-related systems, structures and components on their liquefaction potential. This material is readily available from sources accessed for the EA studies and the ISR. • For contextual purposes, review the geotechnical conditions relevant to the construction history for DNGS. • Based on relevant collected data, undertake an evaluation of the stability of the fill materials with regard for liquefaction potential under seismic and static load conditions. The evaluation criteria will be established based on the objectives, scope and methods adopted for the evaluation program. They will incorporate geotechnical guidance and standards as they are appropriate and applicable. • Should sufficient verification not be realized for the prediction of low liquefaction potential, recommendations for further investigation will be provided as appropriate.	AR# 28159540-14	2019 (U2 Refurbishment Outage Restart)
			2) If required, conduct a liquefaction assessment study based on recommendations of the review in activity 1).	AR# 28159540-14	2019 (U2 Refurbishment Outage Restart)

Table 3 provides a summary of the activities to address CCAs in support of the ISR. The activities are categorized based on whether they were identified based on input from the Major Components Program [R-22] or from the ISR System Reviews which is documented in the Aging and Actual Condition of SSCs Safety Factor Report [R-23]. The following is a brief description of the columns in the table:

1. The 'IIP Item Number' column lists a unique identifier. This number remains the same as was produced in R001 of the IIP. Appendix C identifies the mapping between the IIP Item Number in IIP R000 and IIP R001.
2. The "CCA" column lists a sequential CCA number, if applicable, for the Commodity Group included in a particular system.
3. The "System" column lists the applicable system.
4. The "Description" column lists the name of the Commodity Group (e.g. Vault Coolers). This is the generic name for components in a Commodity Group.
5. The "Condition" column lists the overall condition of components in each Commodity Group, if applicable. The condition is ranked "Very Good", "Good", "Satisfactory", "Poor" or "Very Poor" in accordance with Section 1.10.6.2 of N-PROC-MP-0060 [R-8].

Condition Classification	Criteria
Very Good	a) The component meets all functional design requirements, with no reduction in operating margin and exhibits no apparent degradation, i.e., is in "like new" condition, **and** b) The ageing management practices have been optimized to ensure the component remains in a "like new" condition.
Good	a) The component meets all its functional design requirements, with only a slight reduction in operating margins. Some slight ageing degradation is evident, **or** b) The ageing management practices are adequate but have not been optimized to ensure that the component remains in "like new" condition.
Satisfactory	a) The component still meets all its functional design requirements, but operating margins are significantly eroded. This can be attributed to evidence of significant ageing degradation, **or** b) The ageing management practices are ineffective in only one area and should be reviewed and/or changed.
Poor	a) The component can only marginally meet its functional design requirements and has lost all its operating margin. Severe aging degradation is evident, **or** b) The ageing management practices are ineffective in a number of areas and need to be revised.
Very Poor	a) The component cannot meet one or more of its functional design requirements The component needs immediate or near term maintenance, repair and/or replacement to restore its condition, **or** b) The current ageing management practices are completely ineffective and need revision.

6. The "Activity Description" column identifies the required activities to resolve the issues or recommendations. A detailed assessment of adequacy of these activities to address the identified degradation by the CCAs was performed as part of the Global Assessment.
7. The "DSR#" column identifies the tracking number originating from the Darlington Scope Request (DSR) Database in accordance with NK38-INS-09701-10001 [R-24].
8. The "Date" column either identifies the end year or the unit restart date in which the IIP item will be completed. A date for each affected unit is provided, if applicable.

Table 3: CCAs (Open Activities)

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 001	N/A	N/A	Shutdown Cooling Pumps	N/A	Install two Shutdown Cooling (SDC) "Auxiliary" pumps which are physically separate and of diverse design than the existing SDC pumps.	TS0500-1	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 002	N/A	Major Components Program	Feeders	N/A	Replace Feeders	TS0010-4	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 003	N/A	Major Components Program	Fuel Channels	N/A	Replace Fuel Channels	TS0010-4	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 004	N/A	Major Components Program	Calandria Tubes	N/A	Replace Calandria Tubes	TS0010-4	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 005	N/A	Major Components Program	End Fittings	N/A	Replace End Fittings	TS0010-4	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 006	N/A	Major Components Program	Calandria	N/A	Conduct an internal inspection of the calandria	TS0010-4	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 007	N/A	Major Components Program	Lattice Tubes	N/A	Perform visual inspection of all Lattice Tubes for leaks	TS0010-4	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 008	936	G.05 Boiler Feedwater System, USI# 43000, System #: 0005	Auxiliary Boiler Feed Pumps	Good	Perform an internal inspection of a selected Auxiliary Boiler Feed Pump. Repair/replace based on inspection results.	IP1400-1	U2: 2019[4] U3: 2022[4] U1: 2024[4] U4: 2025[4] (Each Unit Refurbishment Outage Restart)
IIP-CC 009	49	Class II Power System, USI# 50320, System #: 0011	Distribution Bus	Satisfactory	Clean and test MCC (three 120/208Vac buses per unit) per NK38-CMP-53307-03.	TS0540-1	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 010	3244	Class IV Power System, USI# 50340, System #: 0013	Transformers, 4 kV (10MVA) (silicone)	Poor	Complete the tapchanger bypass modification on 0-53240-T59 and 0-53240-T60.	TS0560-6	U0: 2019
IIP-CC 011	710	Digital Control Computers System, USI# 69000, System #: 0016	Computer - DCC	Satisfactory	Replace the DCC, CP and SEM CPUs.	TS0360-3	U0-U4: 2024
IIP-CC 014	1456	Emergency Coolant Injection System, USI# 34320, System #: 0018	Check Valves > 3"	Good	Inspect representative sample of check valves (3 of 10 large NVs) and repair as required[5].	TS0150-1	U0: 2019[4] (U2 Refurbishment Outage Restart)
IIP-CC 015	3491	Emergency Coolant Injection System, USI# 34320, System #: 0018	Check Valves < 3"	Good	Inspect representative sample of NVs and repair as required[5].	TS0150-5	U3: 2018 U4: 2019 U1: 2020 U2: 2022 (Each Unit Planned Outage Restart)
IIP-CC 016	1535	Emergency Coolant Injection System, USI# 34320, System #: 0018	Heat Exchanger (HX) – R/S	Satisfactory	Inspect the inlet and outlet nozzles of 0-34330-HX1 and HX2 for pitting corrosion.	TS2260-1	U0: 2019[4] (U2 Refurbishment Outage Restart)
IIP-CC 017	2094	Emergency Coolant Injection System, USI# 34320, System #: 0018	Hydraulic Power Unit	Satisfactory	Conduct a detailed study to evaluate options for potential ECI Hydraulic Control Circuit replacement.	TS2520-1	2017
IIP-CC 018	339	Emergency Filtered Air Discharge System , USI# 73750, System #: 0019	Moisture element	Satisfactory	Replace 4 moisture probes and transmitters for EFADS.	TS0160-6	U0: 2023
IIP-CC 019	2071	Emergency Filtered Air Discharge System , USI# 73750, System #: 0019	Rad Monitor computer and peripherals.	Satisfactory	Replace EFADS computer and associated components.	TS0160-8	U0: 2023
IIP-CC 020	3524	Emergency Power Generators System, USI# 49200, System #: 0020	Gas Producer / Power Turbine Unit	Poor	Replace EPG 1 and EPG2 degraded Gas Generator.	TS0480-1	U0: 2019

[4] If safety significant defects are found as a result of inspections, they will be corrected by the date specified.
[5] Sample sizes for inspections are based on similarity of materials of construction, fabrication, procurement, design, installation, operating conditions/environment, system function, location, existing technical information, system and structure design, OPEX and previous failure history

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 021	2090	Emergency Service Water System, USI# 72800, System #: 0022	Butterfly and Ball MOV (EQ)	Satisfactory	Replace valve body on 0-72800-MV29, MV30, MV34, & MV35. Overhaul actuator on 0-72800-MV29, MV30, MV34, & MV35 and overhaul PAWCS HX1 ESW Supply Valve 0-72800-MV168, based on inspection results.	TS0180-7	Replace U0: 2015 Overhaul U0: 2022 (U2 Planned Outage Restart)
IIP-CC 022	2667	Emergency Service Water System, USI# 72800, System #: 0022	Globe and Gate Valve Motor Operated (MV)	Satisfactory	Inspect/overhaul and/or replace ECIS IWST ESW Supply valve. Replace bellows assembly IWST ESW supply valve (plug, bonnet included in the assembly). Overhaul or replace ESW steam generator injection valves.	TS0180-8	U0: 2015 U3: 2018 U4: 2019 U1: 2020 U2: 2022 (Each Unit Planned Outage Restart)
IIP-CC 023	1842	HVAC System for Main Control Room & Secondary Control Area, USI# 73910, System # 0032	Fire Damper	Satisfactory	Test required fire dampers and replace as necessary.	TS0190-3 TS0190-14	U0: 2019[4] (U2 Refurbishment Outage Restart) U2: 2019[4] U3: 2022[4] U1: 2024[4] U4: 2025[4] (Each Unit Refurbishment Outage Restart)
IIP-CC 024	1514	Main Condensate System, USI# 44000, System #: 0036	Drains Cooler/LP Heater Motor Operated Valves (RS)	Satisfactory	Inspect a representative sample of MVs to determine condition of stem, gate, seat and body. Overhaul/replace based on inspection[5].	TS1790-1 TS1790-2	U3: 2018 U4: 2019 U1: 2020 U2: 2022 (Each Unit Planned Outage Restart)
IIP-CC 025	2253	Miscellaneous Air Conditioning System, USI# 73940, System #: 0040	Air Conditioning Unit (RS)	Satisfactory	Replace the entire ACU.	TS0710-7	U012/U034/U1-U4: 2022 (U2 Planned Outage Restart)
IIP-CC 026	2274	Miscellaneous Air Conditioning System, USI# 73940, System #: 0040	Fire Damper (FDP)-R/S	Satisfactory	Test required fire dampers and replace as necessary.	TS0710-13 TS0710-18	U0: 2019[4] (U2 Refurbishment Outage Restart)

[4] If safety significant defects are found as a result of inspections, they will be corrected by the date specified.
[5] Sample sizes for inspections are based on similarity of materials of construction, fabrication, procurement, design, installation, operating conditions/environment, system function, location, existing technical information, system and structure design, OPEX and previous failure history

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 027	2275	Miscellaneous Air Conditioning System, USI# 73940, System #: 0040	Damper (DP)-R/S	Satisfactory	Do a sample inspection of the dampers and determine the scope of replacement. Replace dampers as required[5].	TS0710-12 TS0710-17	U2: 2019[4] U3: 2022[4] U1: 2024[4] U4: 2025[4] (Each Unit Refurbishment Outage Restart)
IIP-CC 028	13	Moderator and Auxiliary Systems, USI# 32000, System #: 0042	Velan Swing Check Valves	Satisfactory	Overhaul X-32110-NV3/4/9/10/23/24/28 with new seat and disk material. Replace X-32210-NV112 in all units.	TS1450-1 TS1450-2	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 029	23	Moderator and Auxiliary Systems, USI# 32000, System #: 0042	Manual Valves	Satisfactory	Replace the following isolating valves: 1/2/3/4-63253-V52 V53 and 1/2/3/4-32110-V5, V6, V21, V22, V25, V26, and 1/2/3/4-32110-MV1, MV2, MV7, MV8, MV11, MV12, MV31, MV32	TS1070-3	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 031	449	Negative Pressure Containment System, USI# 34200, System #: 0044	Radiation Detector and Monitor	Satisfactory	Replace activity monitors.	TS0210-9	U012/U034/U1-U4: 2022 (U2 Planned Outage Restart)
IIP-CC 032	1008	Negative Pressure Containment System, USI# 34200, System #: 0044	Piping (line) PRV VAC DWS	Good	Develop program to address the aging related degradation mechanisms identified and perform condition assessment of the exposed piping to water and stagnant conditions.	TS1860-1	2016
IIP-CC 033	2526	Powerhouse Ventilation System, USI# 73220, System #: 0050	Air Cooling Units - R/S	Satisfactory	Replace 0-73260-ACU5 to 16, 1,2,3,4-73220-ACU2 to 10, ACU17 to 22.	TS0700-2	U0: 2022 (U2 Planned Outage Restart) U3: 2018 U4: 2019 U1: 2020 U2: 2022 (Each Unit Planned Outage Restart)
IIP-CC 034	2527	Powerhouse Ventilation System, USI# 73220, System #: 0050	Fire Damper (FDP)-R/S	Satisfactory	Test required fire dampers and replace as necessary.	TS0700-3 TS0700-10	U012/U034: 2019[4] (U2 Refurbishment Outage Restart)
IIP-CC 035	2459	Powerhouse Ventilation System, USI# 73220, System #: 0051	Pneumatic Operator (PO)-R/S	Poor	Refurbish Power Operators[6]	TS1240-1	U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart)

[5] Sample sizes for inspections are based on similarity of materials of construction, fabrication, procurement, design, installation, operating conditions/environment, system function, location, existing technical information, system and structure design, OPEX and previous failure history

[6] The majority (more than 70%) of the Power Operators (POs) will be refurbished prior to 2022 as online work. However, some areas may require an outage so a full unit outage cycle is required to ensure 100% completion of the work. The IIP committed completion date should be viewed as the latest possible completion date. Continuous monitoring of PO failures is done through safety related system tests (functional and stroke tests twice per year), as well as walk downs by the system responsible engineer. It should be noted that there have not been a significant number of PO failures so far that have caused system unavailability.

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 036	1156	PHT and Auxiliaries System, USI# 33100, System #: 0053	Main HT Interconnect Motor Operated Valves	Good	Inspect two representative PHT loop isolation / interconnect MOVs to determine condition and provide an inspection and rehab strategy.	TS0090-2	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 037	1198	PHT and Auxiliaries System, USI# 33100, System #: 0053	Main HT Pump Trip Pressure Switches	Satisfactory	Replace the cable associated with PHT trip pressure switches and perform any corrective maintenance for switch modules and pressure switches in all units.	TS0090-7	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 039	1148	PHT and Auxiliaries System, USI# 33100, System #: 0053	Main HT Pumps	Good	Inspect 2-33120-P3 and fix the gasket leaks. Repair gasket leaks on 1-33210-P2. Inspect one Unit 3 pump and repair/replace if required.	TS0090-1 TS0090-12	U2: 2019 U3: 2022 U1: 2024 (Each Unit Refurbishment Outage Restart)
IIP-CC 040	1149	PHT and Auxiliaries System, USI# 33100, System #: 0053	Main HT Pump Motors & Heaters	Satisfactory	Replace all PHT pump motors.	TS0320-1	U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart)
IIP-CC 041	161	PHT Pressure and Inventory Control System, USI# 33300, System #: 0054	Dresser Control Valves	Satisfactory	Inspect a representative sample of system AOVs to determine condition of valve internals (e.g. CV 3, 4, 11, 13, and 14). Replace or repair based on inspection[5].	TS0100-4	U3: 2018 U4: 2019 U1: 2020 U2: 2022 (Each Unit Planned Outage Restart)
IIP-CC 042	170	PHT Pressure and Inventory Control System, USI# 33300, System #: 0054	Bleed Cooler Temperature Control Valves	Satisfactory	Inspect a representative sample(s) of 1/2/3/4-67220-TCV36/37 and determine the scope of replacement/repair[5].	IP1380-1	U3: 2018 U4: 2019 U1: 2020 U2: 2022 (Each Unit Planned Outage Restart)
IIP-CC 043	490	Radiation Monitors and Samplers System, USI# 67989, System #: 0057	Noble Gas Monitor, Iodine Monitor, Particulate Monitor	Satisfactory	Replace computers and modicons for the stack monitor system.	TS0740-4	U012/U034/U0-U4: 2023
IIP-CC 044	3490	Radiation Monitors and Samplers System, USI# 67989, System #: 0057	Tritium Oxide Collectors	Satisfactory	Replace Labserco Tritium collectors on all affected stacks.	TS0740-1	U012/U034/U0-U4: 2023
IIP-CC 045	3493	Radiation Monitors and Samplers System, USI# 67978, System #: 0057	Rate meter	Poor	Replace Liquid Effluent Monitoring System[7].	TS0740-2	U0: 2023

[5] Sample sizes for inspections are based on similarity of materials of construction, fabrication, procurement, design, installation, operating conditions/environment, system function, location, existing technical information, system and structure design, OPEX and previous failure history

[7] Poor condition is based on past frequent battery failures along with other maintenance issues including decay of source, electronic component degradation and obsolescence issues. Risk Mitigation Strategy: A bridging strategy to find a suitable replacement for the computer backup battery has been completed. The batteries have been sourced and installed. Maintenance practices to ensure condition of the rate meter does not degrade prior to monitoring system replacement include periodic calibration and prompt repair/replacement if required.

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 046	2192	Reactor Vault and Fuelling Duct Atmosphere Cooling System, USI# 73720, System #: 0060	Vault Coolers (RS)	Satisfactory	Replace coils (like-for-like).	TS0280-1	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 047	2193	Reactor Vault and Fuelling Duct Atmosphere Cooling System, USI# 73720, System #: 0060	Temperature Controllers, Vault Coolers (RS)	Satisfactory	Replace all 16 Temperature Controllers. (4 per unit).	TS0880-21	U1-U4: 2023
IIP-CC 048	3071	Reactor Vault and Fuelling Duct Atmosphere Cooling System, USI# 73720, System #: 0060	Backpressure Damper, Vault Cooler (RS)	Satisfactory	Perform an investigation to determine which components are failing and their associated failure modes.	TS0280-8 TS0280-9	U3: 2018 U4: 2019 U1: 2020 U2: 2022 (Each Unit Planned Outage Restart)
IIP-CC 049	1465	Shutdown Cooling System, USI# 33410, System #: 0067	Heat Exchangers	Poor	Replace heat exchangers[8].	TS0110-16	U2: 2019 U3: 2022 U1: 2024 U4: 2025
IIP-CC 050	1467	Shutdown Cooling System, USI# 33410, System #: 0067	Motor Operated Valves	Satisfactory	-Inspect 5 representative MOVs on U2. Inspect 4 representative valves each in U1, U3 and U4. -Inspect MOV intergate drain lines. -Replace bellows sealed valves, 33410-MV28 MV97 in U2. -Disassemble and inspect removed valves to determine path forward for remaining Units. -Provide an inspection and rehab strategy prior to and after inspections are complete in Unit 2.	TS0110-2 TS0110-13	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 051	1471	Shutdown Cooling System, USI# 33410, System #: 0067	Manual Valves	Poor	Complete an engineering assessment of manual valves to determine if repacking is required. Repack the SDC manual valves as required[9].	TS0110-8	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)

[8] Per the current schedule, the HX replacement will start in 2016 and be complete by 2019, based on the assumption that all the work will be executed Online. However, a contingency is in place in case of potential passing isolation of PULSW and PHT isolation valves. Based on the contingency plan, the OPG commitment dates for SDC HX replacement are for U2 2019, U3:2022, U1: 2024, U4: 2025. Risk Mitigation Strategy: Response to an SDC HX tube leak is addressed under NK38-OM-09013B-03.01.04, Abnormal Incidents Manual, SDC HX Tube Failure, wherein the leaking HX. is isolated, drained, disassembled, and the leaking and degraded tubes would be plugged or repaired.

[9] The valves are scheduled for replacement during the refurbishment outage because that is the only time that the shutdown cooling system can be taken out of service safely. Risk Mitigation Strategy: Because the valves are only required for maintenance they are operated infrequently and as a result the risk of failure is minimized. There are also alternatives available for isolating portions of the SDC system if one of the manual valves fails.

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 052	3439 3440 3441 3442 3444	Shutdown System Computer Hardware System, USI# 68240, System #: 0068	SDS1 GA Computers	Satisfactory	Design and Replace SDS1 Trip Computer and the Display / Test Computer.	TS0350-5 TS0350-7	U2: 2022 (Planned Outage Restart) U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 053	779	Shutdown System Process System, USI# 68200, System #: 0069	Element, Flow	Satisfactory	Conduct design review to select/modify the flow element prior to refurbishment. Replace SDS1 Flow Elements.	TS0010-4	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 054	2789	Shutdown System Process System, USI# 68200, System #: 0069	S/A Clutch Power Supply	Satisfactory	Replace Shutoff Rod Clutch Power Supplies on all Units	TS0240-2	U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart)
IIP-CC 055	3446 3447 3449 3450 3451 3455 3456	Shutdown System Computer Hardware System, USI# 68340, System #: 0070	SDS2 GA Computers	Satisfactory	Design and replace the SDS2 Trip Computer and the Display / Test Computer.	TS0350-6 TS0350-8	U2: 2022 (Planned Outage Restart) U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 056	853	Shutdown System Process System, USI# 68300, System #: 0071	Poison Tank Ball Position Level Alarm	Satisfactory	Replace LISS poison tank ball position level alarm system.	TS0260-3	U4: 2019 U1: 2020 U2: 2022 U3: 2025 (Each Unit Planned Outage Restart)
IIP-CC 057	861	Shutdown System Process System, USI# 68300, System #: 0071	Element, Flow	Satisfactory	Conduct design review to select/modify the flow element prior to refurbishment. Replace SDS2 Flow Elements.	TS0010-4	U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart)
IIP-CC 059	3525	Standby Generators System, USI# 49100, System #: 0073	Standby Generator Building	Satisfactory	Perform an inspection for Standby Generator complex. Perform required repairs.	TS1590-1 TS1590-2	U0: 2018 U0: 2022 (U2 Planned Outage Restart)
IIP-CC 060	76	Structures - Reactor Building and Fueling Facilities, USI# 21000, System #: 0080	Reactor Building Structure	Satisfactory	Perform required inspections for Reactor Building Structure. Perform required repairs.	TS0510-1 TS0510-16	U014: 2018 U014: 2022 (U2 Planned Outage Restart)

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 061	77	Structures - Reactor Building and Fueling Facilities, USI# 21000, System #: 0080	Reactor Building Internal Structure	Satisfactory	Perform inspections for the Reactor Building Internal Structures. Perform required repairs.	TS0510-2 TS0510-17	U014: 2018 U014: 2022 (U2 Planned Outage Restart)
IIP-CC 062	78	Structures - Reactor Building and Fueling Facilities, USI# 21000, System #: 0080	Reactor Auxiliary Bay including structural and architectural elements	Good	Perform inspections for the civil structures located in the Reactor Auxiliary Bay (RAB). Perform required repairs.	TS0510-11 TS0510-18	U014: 2018 U014: 2022 (U2 Planned Outage Restart)
IIP-CC 063	79	Structures - Reactor Building and Fueling Facilities, USI# 21000, System #: 0080	FFAA - West & East	Good	Perform required inspections for the civil structures located in Fuelling Facilities Auxiliary Areas (FFAA). Perform required repairs.	TS0510-12 TS0510-25	U012/U034: 2018 U012/U034: 2022 (U2 Planned Outage Restart)
IIP-CC 064	80	Structures - Reactor Building and Fueling Facilities, USI# 21000, System #: 0080	Irradiated Fuel Area	Satisfactory	Perform required inspections for irradiated fuel area. Perform required repairs.	TS0510-14 TS0510-28	U014: 2018 U014: 2022 (U2 Planned Outage Restart)
IIP-CC 065	81	Structures - Reactor Building and Fueling Facilities, USI# 21000, System #: 0080	Fuel Handling & Service Area	Good	Perform required inspections for fuel handling and service area. Perform required repairs.	TS0510-15 TS0510-29	U012/U034: 2018 U012/U034: 2022 (U2 Planned Outage Restart)
IIP-CC 067	84	Structures - Powerhouse System, USI# 22000, System #: 0081	Turbine Hall & Turbine Auxiliary Bay civil/ structural elements	Good	Perform required inspections for turbine hall and turbine auxiliary bay. Perform required repairs.	TS0510-9 TS0510-26	U014: 2018 U014: 2022 (U2 Planned Outage Restart)
IIP-CC 069	86	Structures - Powerhouse System, USI# 22000, System #: 0081	Central Control Area	Good	Perform inspection of civil structures located in the central control area. Perform required repairs.	TS0510-4 TS0510-30	U0: 2018 U0: 2022 (U2 Planned Outage Restart)
IIP-CC 071	90	Circulating Water Systems System, USI# 27100, System #: 0083	Pumphouse	Good	Perform required inspections on Pumphouse Structures. Perform required repairs.	TS0510-6 TS0510-22	U0: 2018 U0: 2022 (U2 Planned Outage Restart)
IIP-CC 072	94	Emergency Power System & Emergency Service Water Complex System, USI# 28300, System #: 0084	EPS Buildings Including EPS, EPG, ESW and EPS Fuel Management	Good	Perform required inspections on EPS Buildings, including EPS, EPG, ESW and EPS Fuel Management Structures. Perform required repairs.	TS0510-8 TS0510-24	U0: 2018 U0: 2022 (U2 Planned Outage Restart)

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	DSR#	Date
IIP-CC 073	2712	Fuel Handling Trolley System, USI# 35700, System #: 0206	Cable-Power-Harsh-Trolley-I&C	Satisfactory	Perform a visual inspection and megger testing on cables and connections and send power cable sample for analysis. Change the power cables as required based on results of inspection. Replace all catenary power cables.	TS0430-1 TS0430-6 TS0430-18	U0: 2019[4] (U2 Refurbishment Outage Restart) U0: 2025 U0: 2025
IIP-CC 074	2713	Fuel Handling Trolley System, USI# 35700, System #: 0206	Cable-Signal-Harsh-Trolley-I&C	Satisfactory	Perform a visual inspection and megger testing on the signal cables and connections and send sample for analysis. Change the signal cables as required based on results of inspection. Replace all catenary signal cables.	TS0430- 2 TS0430-7 TS0430-19	U0: 2019[4] (U2 Refurbishment Outage Restart) U0: 2025 U0: 2025
IIP-CC 075	2930	Fuel Handling Trolley System, USI# 35700, System #: 0206	Catenary – Mechanical	Satisfactory	Perform verification of the chain for length Perform any necessary contingency work.	TS0430-4 TS0430-15	U0: 2019[4] (U2 Refurbishment Outage Restart) U0: 2025
IIP-CC 076	2931	Fuel Handling Trolley System, USI# 35700, System #: 0206	Fuelling Machine Support Frame Catenary Support – Mechanical	Good	Visually inspect welds for cracks and visually inspect frame and attachment hardware for corrosion. Repair as required.	TS0430-5 TS0430-16	U0: 2019[4] (U2 Refurbishment Outage Restart) U0: 2025
IIP-CC 077	2685	Fuel Machine Head System, USI# 35210, System #: 0208	Homing & Locking (Snout) Assembly	Satisfactory	Replace manifolds for fine homing and gap sensing on all fuel machine heads.	TS0450-9	U0/U012/U034: 2025
IIP-CC 078	2741	Irradiated Fuel Bay System, USI# 34410, System #: 0209	Heat Exchanger	Poor	Change gasket and plate material on the heat exchangers.	TS0460-13	U012/U034: 2015

[4] If safety significant defects are found as a result of inspections, they will be corrected by the date specified.

Table 4 provides a summary of the activities to address the Code Gaps resulting from the ISR and CNSC comments. The following is a brief description of the columns in the table:

1. The 'IIP Item Number' column lists a unique identifier. This number remains the same as was produced in R001 of the IIP. Appendix C identifies the mapping between the IIP Item Number in IIP R000 and IIP R001.
2. The "Issue Number and Title" column lists the following:
    a. Issue Number assigned by the ISR Gap Resolution Process N-INS-00770-10004 [R-25].
    b. Title of the ISR Issue including the PROL (Power Regulator Operating License) and non-PROL Code(s) and Standard (s) in which the ISR Issue was discovered.
3. The "Issue Description" column lists a high level description of the ISR Issue.
4. The "Action Plan" column includes a description of the required activities to address the ISR Issue. A detailed assessment of adequacy of these activities to address the identified issues at a gap level was performed as part of the Global Assessment.
5. The "Tracking #" column identifies the DSR tracking number originating from the Darlington Scope Request (DSR) Database in accordance with NK38-INS-09701-10001 [R-24] or the OPG internal Action Request (AR) number, or CNSC Action Item (AI) Number.
6. The "Date" column either identifies the end year or the unit restart date in which the IIP item will be completed. A date for each affected unit is provided, if applicable.

Table 4: Code Gaps (Open Activities)

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 001	D044 – Fire Alarm Systems (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	The scope of the Integrated Safety Review (ISR) Issue covers new requirements for fire alarm systems. The outstanding actions are related to transfer of the Fire Alarm system to the Secondary Control Area (SCA), display of all unit alarms in the applicable unit SCA's and some isolation modules were found to be missing from selected stairwells. Also CNSC has challenged the analysis to justify no fire alarm system in the CCW pump houses and Water Treatment plant.	1) Upgrade the station fire alarm system to allow transfer of the fire alarm to the secondary control areas where all applicable alarms will be displayed. 2) Add fault isolation modules where missing from stairwells. 3) The rationale in the analysis will be improved to justify no fire alarm system in the CCW pump houses and Water Treatment plant, or fire alarm systems will be added.	IP1220-5 IP1270-1 Complete [R-26]	U0: 2019 (U2 Refurbishment Outage Restart) U0: 2019 (U2 Refurbishment Outage Restart) 2015
IIP-OI 002	D045 – Fire Suppression (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	The design criteria used for the existing fire suppression and extinguishing systems do not meet some of the modern design standards referenced in CSA-N293-07. Design requirements in modern codes are typically grandfathered for existing facilities however they are being re-evaluated as part of the Darlington Refurbishment. Upon completion of analysis it has been determined that there are 2 areas where corrective actions are required for refurbishment. Outdoor transformer protection and the fire loading in Central Services Area (CSA) storage area.	Additional Analysis complete and has resulted in the following two corrective actions: 1) Outdoor Transformer Protection • To prevent a Main Output Transformer (MOT) fire from damaging the Powerhouse wall or spreading fire into the Unit 0 lunchroom, the existing containment dikes in each unit will be filled with rock to reduce the risk of fire spread. • To prevent against a potential Unit Service Transformer or System Service Transformer fire from damaging the Powerhouse wall, the associated containment dikes will be filled with rock to reduce the risk of fire spread. 2) CSA Stores Sprinkler System Commodity Storage To avoid over taxing the existing CSA Stores Sprinkler systems in S-119 and S-219 the plastic storage bins will be removed and replaced with metal wire baskets or steel drawers.	Complete [R-27] IP1220-2 IP1470-1	Additional Analysis 2016 U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart) U2: 2019 (U2 Refurbishment Outage Restart)

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 003	D046 - Fire Protection Seismic Requirements (CSA N293-07 “Fire Protection for CANDU Nuclear Power Plants”)	This ISR Issue addresses the seismic restraint requirements related to fire protection. The risk to the station is low and mitigating actions are not required. The installation of seismic restraints provides an additional level of safety at Darlington during seismic events, however the current configuration is compliant with existing requirements.	1) Complete an additional analysis to determine if seismic restraints are required for fire protection equipment located in the areas specified by this clause. 2) As a result of the additional analysis seismic restraints will be provided for fire extinguishers in the areas specified by this clause.	Complete [R-28] IP1220-6	2015 Modifications: U0: 2019 (U2 Refurbishment Outage Restart) U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart)
IIP-OI 004	D048 – Fire Protection Requirements for Storage Tanks (NFCC 2005 “National Fire Code of Canada”)	The scope of this ISR Issue covers requirements for combustible fuel oil tanks, associated piping and secondary containment construction. At Darlington, this applies to the Standby Generator and Emergency Power Supply Generator combustible fuel oil tanks.	Complete an evaluation of the existing SG combustible fuel oil tanks secondary containment dykes to confirm that the dyke's permeability is not deteriorating. Additionally, inspect the Standby Generator and Emergency Power Generator combustible fuel oil tanks secondary containment penetration locations to confirm their integrity is not deteriorating. Correct any deficiencies.	IP1220-14	Evaluation: 2016 Inspection/Repairs: U0: 2019 (U2 Refurbishment Restart)
IIP-OI 006	D080 – Fire Separation (CSA N293-07 “Fire Protection for CANDU Nuclear Power Plants” & NFCC 2005 “National Fire Code of Canada”)	No documentation or procedural requirements were found for fire separations.	Document the existing fire-stops for the following barrier types: Life safety barriers (i.e. exit stair-shafts), combustible storage rooms, radioactive storage rooms, Main Control Room Complex, Secondary Control Area rooms, and barriers separating redundant fire safe shutdown systems. In addition, update the applicable station procedures/ standards to ensure documentation of future Fire stops.	IP1220-3 IP1220-15	2016

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 008	D116 – Fire Protection Requirements for Building Materials (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants", NFCC 2005 "National Fire Code of Canada")	No documentation found driving compliance with the new requirements for building materials which establish specific restrictions on combustible contents in building materials, fixtures, impermeable finishes, and epoxy linings.	1) Implement a technical specification for future purchases of carpet, drapes and decorative wall covering materials to ensure that new materials meet the requirements. 2) Revise paint specification to ensure future compliance.	Complete [R-29] IP1220-15	2015 2019
IIP-OI 009	D119 – Storage Tank Leak Detection(NFCC 2005 "National Fire Code of Canada")	No evidence in the design documentation regarding requirements to monitor fuel storage tanks for leakage, to take remedial action to repair leaks, to record all leak testing and to conduct reconciliations of the fuel oil inventory.	Implement predefines and develop procedures to limit the probability that defects in storage tanks, sumps or piping systems or the escape of liquid will go unnoticed.	IP1140-1	2017[10]
IIP-OI 010	D167 – Ventilation Systems Disconnect Switch Testing (NFCC 2005 "National Fire Code of Canada")	No documentation found regarding the testing of disconnect switches for mechanical air-conditioning and ventilating systems to ensure operation at intervals not greater than 12 months to establish that the system can be shut down in an emergency	Implement a procedure to ensure the disconnect switches for mechanical air conditioning and ventilating systems are tested at 12 month intervals or implement an alternate compliance.	IP1140-1	2017[10]
IIP-OI 011	D170 – Fire Safety Plan Requirements (NFCC 2005 "National Fire Code of Canada")	The DNGS fire safety plan does not include the indoor storage the following indoor storage information: a) product classification, b) storage method including aisle widths for rack storage, c) maximum permitted storage height and area	Update the Fire Safety Plan and Pre-Fire Plans to incorporate the missing information related to a) Product classification, b) Storage method including aisle widths for rack storage, c) Maximum permitted storage height and area and signage.	IP1140-1	2017[10]
IIP-OI 012	D181 – Fire Safety Training Requirements (NFCC 2005 "National Fire Code of Canada")	No documentation found outlining requirements for all employees concerned with transfer operations involving transfer of flammable or combustible liquids.	Revise the operating procedures and training associated with the transfer of liquid fuel to require that a Fire Watch Qualified staff member is to be present during fuel transfer operations or implement an alternate compliance.	IP1140-1	2017[10]

[10] Code of Record Gap [R-30], the IIP date should be viewed as the latest possible completion date for code of record action. Where it is possible that the resolution of a code of record gap may lead to a modification, the IIP dates include additional time to accommodate this contingency.

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 015	D225 – Fire Protection Water Supply (CSA N293-07 “Fire Protection for CANDU Nuclear Power Plants” & RD-337 “Design of New Nuclear Power Plants”)	Non-compliances identified with the requirements related to design requirements for the fire protection water supply, and the interconnection between the Fire Protection water supply and the Emergency Service Water system.	Perform an assessment of the Fire Protection Water supply loop to evaluate current condition with additional demands and verify that fire protection system demands can still be achieved. In addition, increase the system demands to include an additional 500 USgpm. Complete a modification to provide a new supply of Fire Protection Water separate from the ESW system.	IP1220-19 IP1220-2 IP1220-12	Assessment: 2016 Modification: 2019
IIP-OI 016	D227 – Fire Hydrant Requirement (CSA N293-07 “Fire Protection for CANDU Nuclear Power Plants” & NFPA-24-2007 “Standard for the Installation of Private Service Mains and Their Appurtenances”)	Markings on fire hydrants are not addressed in NK38-DM-78100, “Fire Protection Water Supply and Distribution System”.	Perform flow testing and marking of the hydrants in accordance with NFPA 291 and fit the yard hydrants with a sign to indicate the need for pumping out after usage.	IP1220-20 IP1220-16 IP1320-1	2018
IIP-OI 018	D428 – Detection of Significant Fire Hazards (CSA N293-07 “Fire Protection for CANDU Nuclear Power Plants”)	Significant Fires need to be quickly detected.	1) Develop a justification for all screen 2 and 3 rooms which do not have automatic detection installed. 2) Install automatic Fire detection in rooms with Major Fire hazard rooms as identified in the FHA table 4-1.1 In NK38-REP-78000-10002 R001. 3) Install detection in high Fire hazard rooms Rx-109 and Rx-121.	Complete [R-31] IP1280-1 IP1280-1	Justification: 2016 Modifications: U0-U4: 2022 (U2 Planned Outage Restart)

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 019	D429 – Fire Separation Corrective Actions(NFCC 2005 "National Fire Code of Canada", NBCC 2005 "National Building Code of Canada", & CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	A review of Darlington Nuclear Generating Station against fire separation requirements identified that Door S-213A to the laundry shaft and room R3-241 do not meet the requirements.	Replace door S-213A to the laundry shaft in room S-213 with a listed and labelled fire door having a rating of not less than 45 minutes. Remove the storage from room R3-241, construct a vestibule as a 1 h fire separation so that the storage area does not open directly into the stair or implement an alternate compliance to justify the existing room configuration.	IP1220-3 IP1220-15 IP1140-1 IP1220-2	U0: 2019 (U2 Refurbishment Outage Restart) U3: 2025[10] (U3 Planned Outage Restart)
IIP-OI 022	D436 – Emergency Lighting in airlocks and Transfer Chambers (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	A Transfer Chamber was found to not be provided with Class II lighting or emergency backup.	Provide emergency lighting in Fuel Handling Transfer Chamber S120.	IP1220-4 IP1220-15	U0: 2019 (U2 Refurbishment Outage Restart)
IIP-OI 023	D442 – Fire Endurance of Fire Alarm Cable (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	This issue is related to the endurance of Fire Alarm cables. While the original station cables do not meet the 1 hour requirement additional analysis has shown that the only location where the loss of a Fire Alarm signal is at risk is above the unit instrument air compressors where the unit Fire Alarm system truck cable is located.	Protect the Fire and Smoke Detection system cabling located above the unit instrument air compressors in R-108.	IP1220-18	U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart)
IIP-OI 024	D444 – Fire Stopping (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	A material used for fire-stopping (Sikaflex) at the Darlington Nuclear Generating Station does not meet acceptance criteria outlined in Clause 3.1.5.2 of the NBCC for use in a building of non-combustible construction.	Perform a review of penetration seals larger than a single cable, a single tube, or 13 mm wide construction joint seal, in required fire separations, to confirm that listed fire stopping materials are used. Replace unlisted materials if they have been used.	IP1220-3	Review and replacement: U0: 2019 (U2 Refurbishment Outage Restart) U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart)

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IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 025	D448 – Fire Dampers (NBCC 2005 “National Building Code of Canada”)	Some fire separations in the plant require appropriately rated fire dampers to be installed as per Code requirements.	Install fire dampers in ducts penetrating Service Shafts S-289 and S-290 on the 107.5m and 110.9m elevations of the CSA, in the normally occupied areas.	IP1220-2	U0: 2019 (U2 Refurbishment Outage Restart)
IIP-OI 026	D461 – Means of Egress (NBCC 2005 “National Building Code of Canada”)	The scope of this ISR issue covers egress requirements which were found to not meet the requirements for numbers of exits in S-510 and S-141.	Provide an additional means of egress from room S-141, preferably at the west end of the room. Also provide a second means of egress from room S-510 or implement an alternate compliance.	IP1140-1	Alternate Compliance 2016[10] Modifications if required U0: 2019 (U2 Refurbishment Outage Restart)
IIP-OI 027	D467 – Vertical Service Shafts (NBCC 2005 “National Building Code of Canada”)	This issue addresses concerns with the fire separations for vertical spaces in the Central Services Area.	- Install fire dampers at the duct penetrations of vertical service shafts S-289 and S-290 between the Central Services Area 107.5m and 110.9m elevations in normally occupied areas and seal any penetrations. -Enclose the top of the two laundry shafts in rooms SM-215 and SM-208 by construction that would provide a 1 h fire separation.	IP1220-2	U0: 2019 (U2 Refurbishment Outage Restart)
IIP-OI 028	D469 – Inspection Testing and Maintenance Requirements (NFCC 2005 “National Fire Code of Canada”)	No documentation was found detailing testing requirements for the general oil transfer system piping valves, and there were findings regarding the inspection, testing and maintenance of water-based fire protection systems, in conformance with NFPA 25, “Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.”	Resolve Inspection Testing and Maintenance related deficiencies associated with fuel management system valves and safety devices and confirm that the previously identified deficiencies from report NK38-REP-78000-10047 "Third Party Review Fixed Fire Protection Systems Inspection Testing and Maintenance Review" are resolved.	IP1140-1	2016[10]
IIP-OI 029	D472 – Oil Storage Tank and Piping Requirements(NFCC 2005 “National Fire Code of Canada”)	No inspection reports were found for the Emergency Power Generators fuel tank or Turbine Generator lube oil storage tanks that would indicate compliance or operational suitability of the tanks for life extension	Complete an assessment of the Emergency Power Generators fuel tanks and Turbine Generator lube oil storage tanks existing conditions to confirm the tanks' suitability for the extended life of the Station. Correct any deficiencies.	IP1220-14	Assessment: 2016 Repairs: U0: 2019 (U2 Refurbishment Outage Restart)

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IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 030	D475 – Valves Controlling Water Supplies (NFPA-24-2007 "Standard for the Installation of Private Service Mains and Their Appurtenances", NFPA-20-2007 "Standard for the Installation of Stationary Pumps for Fire Protection")	This issue is related to the requirements for valves controlling Fire Protection Water supplies.	Complete the following actions related to Valves Controlling Water Supplies: -Test all private fire service main control valves to confirm operability. -Replace the unlisted hose valves downstream of the fire pumps with listed devices that will have an appropriate pressure rating or implement an alternate compliance. -Disconnect the cross connection between ASW and Fire Protection Water on Elevation 107.5.	IP1220-1 IP1220-14	Tests: 2016 Modifications/Repairs: U0: 2019 (U2 Refurbishment Outage Restart) U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart)
IIP-OI 031	D476 – Underground Pipe (NFPA-24-2007 "Standard for the Installation of Private Service Mains and Their Appurtenances")	This issue is related to discrepancies associated the underground piping system for fire protection water supply between the Water Treatment plant and the unit pumphouses.	Conduct an inspection and assess the state of the buried steel pipe between the Water Treatment Plant and the Unit Pumphouses to determine if it is still suitable for life extension purposes. Replace pipes if necessary.	IP1140-1	Inspection & Assessment: 2016[10] Modifications: Between U1 and U2 CCW pipes: 2022[10] Between U3 and U4 CCW pipes: 2025[10]
IIP-OI 033	D482 – Monitoring of Fire Pump Alternate Power Source (NFPA-20-2007 "Standard for the Installation of Stationary Pumps for Fire Protection")	This issue is related to monitoring of the Fire protection Water booster pump power supplies for phase loss. Additionally, no documentation of the acceptance testing procedures was found to verify the pumps were operated for the required minimum of one hour.	Switch the Fire Pump Controller to its alternate position monthly in order to monitor the Fire Protection Water booster pump odd and even power supplies for phase loss on a bi-monthly basis. Also test run the Fire Protection Water booster pumps for a duration of 1 hour to meet a pump acceptance testing requirement.	IP1140-1	2016[10]

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IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 034	D260 – Human Factors - Annunciation Improvements (NUREG 0700 "Human-System Interface Design Review Guidelines & IAEA NS-R-1 "Safety of Nuclear Power Plants: Design")	An assessment was performed on the human-machine interface for the Emergency Coolant Injection system and the Annunciation system. Two areas for improvement were identified: 1. Improve annunciation conditioning capability to reduce the number of nuisance alarms in the annunciation system to minimize operator distraction. 2. Improve the control scheme for the annunciation acknowledge function.	OPG has already completed the work committed in D260 to reduce nuisance alarms. Nuisance alarms associated with shutdown, start-up, and turbine trip have been reduced by 85% and current levels are acceptable to operations and human factors engineering. This meets the intent of the first area for improvement identified in D260. The second area for improvement in D260 is in the control scheme for acknowledging annunciations in the control room. The current state is acceptable however some improvements will be made to further reduce the potential for error in acknowledging annunciations.	IP0430-2	U1: 2020 U2: 2022 U3: 2025 U4: 2028 (Each Unit Planned Outage Restart)
IIP-OI 035	D027 - Severe Accident and Beyond Design Basis Accident (BDBA) Analysis/ SAMG (IAEA NS-G-1.2 "Safety Assessment and Verification For Nuclear Power Plants")	A systematic analysis of BDBA and Severe Accidents is required and Severe Accident Management Guidelines must be fully implemented.	-Implement the Safety Improvement Opportunities (SIOs) resulting from the Environmental Assessment. -Complete the Reg Doc 2.4.1 Compliance Activities. -Complete the remaining SAMG activities which involve enhancements to the suite of guidelines.	SIO's: Refer to IIP-EA 009 AI 2014-OPG-5461 AR 28174352-02,05,09	SIO's: Refer to IIP-EA 009 Reg Doc 2.4.1: 2024 SAMG: 2015
IIP-OI 036	D068 - Severe Accident and Beyond Design Basis Accident (BDBA) Design/ SAMG (IAEA NS-R-1 "Safety of Nuclear Power Plants: Design" & CNSC RD-337 "Design of New Nuclear Power Plants")	The scope of this ISR issue covers the design requirements of the plant with respect to its capability to safely respond to Beyond Design Basis Accidents (BDBA) and Severe Accidents, and that will reduce any impact to the plant, during and after the accident. Although the clauses specify aspects of the design of a nuclear power plant, all of these Integrated Safety Review (ISR) gaps were declared because a Severe Accident Management Guidelines (SAMG) program has not been fully implemented at Darlington.	-Implement the Safety Improvement Opportunities (SIOs) resulting from the Environmental Assessment. -Complete the remaining SAMG activities which involve enhancements to the suite of guidelines. -Address equipment and instrument survivability under Severe Accident conditions. -Install Passive Autocatalytic Re-combiners (PARS) in all 4 Units at Darlington.	SIO's: Refer to IIP-EA 009 AR 28174352-02,05,09 Complete [R-32] Complete [R-33]	SIO's: Refer to IIP-EA 009 SAMG: 2015 Instrument Survivability PARS: 2015

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 037	D143 - Severe Accident and Beyond Design Basis Accident (BDBA) Program/ SAMG (CNSC G-306 "Severe Accident Management Programs for Nuclear Reactors")	The scope of this Integrated Safety Review (ISR) Issue includes the requirements for Severe Accident Management Guidelines (SAMG) and their implementation at Darlington.	-Implement the Safety Improvement Opportunities (SIOs) resulting from the Environmental Assessment -Complete the remaining SAMG activities which involve enhancements to the suite of guidelines. -Address equipment and instrument survivability under Severe Accident conditions.	SIO's: Refer to IIP-EA 009 AR 27174352-02,05,09 Complete [R-32]	SIO's: Refer to IIP-EA 009 SAMG: 2015 Instrument Survivability: 2015
IIP-OI 038	D300 – Inspection Requirements for Safety-Related Structures (CSA N291-08 "Requirements for safety-related structures for CANDU nuclear power plants & RD-337 "Design of New Nuclear Power Plants")	There is a need to conduct regular in-service examinations of safety-related structures for evidence of degradation. The structures covered include: -Those that support, house or protect nuclear safety systems,-Components of structures required for the safe operation or reactor shutdown, and -Facilities for storage of irradiated fuel and other radioactive waste material.	Prepare and implement inspection programs for the following Safety Related Structures (SRS): - Reactor Building Structures - Reactor Building Internal Structures - Central Services Area Civil Structures - Central Control Area Civil Structures - Turbine Supporting Structures - Pumphouse Structures - Intake Pipes, Ducts & Encasements Structures - Emergency Power Supply and Emergency Service Water Complex - Turbine Hall and Turbine Auxiliary Bay - Central Services Area Buildings consisting of Workshop and Laydown Area and Service Auxiliary Bay - Reactor Auxiliary Bay Civil Structures - Fuelling Facilities Auxiliary Areas Civil Structures - Irradiated Fuel Area - Fuel Handling and Services Area - Forebay Intake System Structures - Emergency Coolant Injection Tanks - Standby Generator Buildings Perform repairs as required.	TS0510-1 through TS0510-12, TS0510-14, TS0510-15, TS0510-19, TS0510-20, TS0510-21, TS0510-25 TS0510-26 TS0510-27 TS0510-30 & TS2530-1	Inspections & Repairs 2019[4] (U2 Refurbishment Outage Restart)

[4] If safety significant defects are found as a result of inspections, they will be corrected by the date specified.

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 039	D328 - Post Accident Monitoring - Configuration Management (CSA N290.6-2009, “Requirements for Monitoring and Display of Nuclear power Plant Safety Functions in the Event of an Accident”)	Less than adequate configuration management of the Post-Accident Monitoring (PAM) system exists. This has resulted in the design and design documents not adequately identifying the appropriate post accident information displays.	Revise the Post-Accident Monitoring (PAM) system Design Description [NK38-DD-60350 R002], Operational Safety Requirements [NK38-OSR-08131.02-10021-R02] and operating documentation [NK38-OM-09013A R005] to be consistent with the Design Basis Document [NK38-REP-03651-10010 R003]. If required, initiate a Design Modification to modify to the appropriate PAM indicators in the MCR and USCA panels as required to comply with NK38-REP-03651-10010 “Technical Basis Document for Environmental Qualification of Post-Accident Monitoring”.	IP1240-1	2019
IIP-OI 040	D345 - Consolidated Seismically Qualified Equipment List (CSA-N289.1-08, "General Requirements for Seismic Design and Qualification of CANDU Nuclear Power Plants" & NK38-REP-03680-10079 R001, "Darlington NGS Integrated Safety Review Equipment Qualification Safety Factor Report")	OPG does not have a single consolidated list that includes all the seismically qualified Systems, Structures and Components for Darlington Nuclear Generating Station. It is the responsibility of the owner/licensee to submit this list for acceptance by the regulatory authority. However, there is no evidence that OPG has created and submitted the list.	Develop a Consolidated Seismically Qualified Equipment List for Darlington Nuclear Generating Station.	A/R 28175244-01	2016

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 041	D301 - Potential Impacts from Channel Defueling (NK38-REP-03680-10116, "Review of Licensing Issues for DNGS Integrated Safety Review")	The closed Station Specific Action Item 20021306 "Darlington NGS - Units 1 and 4, Feeder Vibration During Flow Defueling" was assessed as relevant and applicable to Refurbishment. This Action Item (AI) is concerned with the various potential impacts on the reactor of employing "flow defueling". The AI was closed and OPG has subsequently defueled a varying number of channels in other outages. For Refurbishment, the entire reactor will be defueled. As such, this issue may impact Refurbishment and is applicable and relevant to Refurbishment.	- Perform necessary nuclear safety analyses and develop a defueling plan to ensure reactor defueling is performed in a manner that ensures adequate fuel cooling at all times, taking into account relevant operating experience (OPEX). -Perform assessments to determine the defueling conditions under which pressure tube fracture (e.g. due to DHC, hydride overload, fatigue cracking) is not a concern. -Perform thermal hydraulic analysis to demonstrate flow evolution in channels during defueling, placement of Flow Restricting Outlet Bundles, and the number of dummy bundles required. -Perform required nuclear safety assessments to examine impact of defueling on feeder vibration, fuel channel vibration, and fuel bundle vibration. -Perform required nuclear safety analysis to determine neutron flux monitoring requirements and expected detector response as defueling proceeds.	SI0200-1	2016
IIP-OI 042	N/A – Heat Transport Liquid Relief Valve water hammer	The Global Assessment performed a review of the licensing issues addressed in the Integrated Safety Review (NK38-REP-03680-10104 Appendix H). The path forward on the Heat Transport Liquid Relief Valve (HT LRV) water hammer issue resulted in a design change.	Replace the Primary Heat Transport Liquid Relief Valves (LRVs) to limit the risk of water hammer loading. Retain sections of removed piping for a metallurgical assessment following replacement of the Liquid Relief Valves (LRVs) in the first refurbished unit. Complete the metallurgical assessment and report results to CNSC.	A/R 28116373-03 IP0010-1 AI20101307	Replacement: U2: 2019 U3: 2022 U1: 2024 U4: 2025 (Each Unit Refurbishment Outage Restart) Assessment: 2019

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 043	D028 - Systematic Analysis of Anticipated Operational Occurrences (AOO's) D030 - Identification and Classification of Events per CNSC RD-310 D332 - Reactor Control System Requirements for Anticipated Operation Occurrences (AOOs) D346 - Environmental Qualification of Equipment for Beyond Design Basis Accident (BDBA) Analysis D399 - Acceptance Criteria for Anticipated Operational Occurrences (AOO's) D400 - Deterministic Safety Analysis Uncertainties D424 - Anticipated Operational Occurrences (AOOs)	Comply with the new requirements of CNSC Reg Doc 2.4.1	Complete the Reg Doc 2.4.1 compliance activities which includes: 1) Carrying out a comprehensive review of Event Identification and Classification 2) Performing AOO analysis 3) Performing DBA analysis 4) Associated documentation updates 5) Developing analysis rules, coordinating with other COG members, and interactions on technical matters with the CNSC	AI 2014-OPG-5461	2024

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 044	D416 - N285.4 Periodic Inspection Program (PIP) Governance References N285.4-05 not N285.4-09 UPD2 D420 - New Erosion and Corrosion Inspection Requirements in N285.4-09 UPD2 not Reflected in Current PIP Governance, D421 - Extended Life Inspection Schedules in N285.4-09 UPD2 are not Reflected in PIP Governance D422 - Assessment of Prior Operating Non-Conforming State is required when Dispositioning Inspection Results D423 - Governance does not Ensure that Qualifications of Examination Personnel are Included Within Inspection Reports (CSA N285.4 “Periodic Inspection for CANDU Power Plants”)	Perform compliance activities to meet CSA N285.4 including appropriate assessments and PIP updates.	When the Darlington licence is updated to include the 2014 edition of CSA N285.4, update the Darlington Periodic Inspection Plans (PIPs) for Piping and Components, Fuel Channels, Feeders and Steam Generators as necessary to address the requirements of N285.4.	A/R 28168387-02	2019
IIP-OI 046	D426 - Source Term Analysis Not Complete for BDBEs (IAEA-SSG-2-2009 “Deterministic Safety Analysis for Nuclear Power Plants”)	Assess Emergency Response Projection (ERP).	Assess the Emergency Response Program (ERP) for potential enhancements to address multi-unit BDBE (Beyond Design Basis Events) scenarios.	A/R 28175339-01	2016

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 049	D356 - Compliance with ASME BPVC, Section III NF (CSA N285.0 “General Requirements for Pressure-Retaining Systems and Components in Nuclear Power Plants”	The jurisdictional boundary between ASME III and the building structure defined for Darlington NGS does not meet the current requirements of ASME Section III.	When the DNGS licence is updated to include the 2014 edition of CSA N285.4, update the DNGS Periodic Inspection Plans (PIPs) for Piping and Components to address the requirements of N285.4.	A/R 28168387-02	2019
IIP-OI 050	D370 - Qualification of Inspection Procedures and Demonstration of their Effectiveness (CSA N285.4 “Periodic Inspection of CANDU Nuclear Power Plant Components")	Periodic inspection procedures for volumetric inspections of pressure tubes are to be documented and proven capable of yielding results to a sensitivity that is appropriate for the system or components being inspected. All inspection procedures used in periodic inspections need to be qualified. Inspection procedures applied to pressure tube inspections are to be qualified by the CANDU Inspection Qualification Bureau (CIQB).	Complete initial Inspection Qualification process for applicable Darlington Major Components per CSA N285.4 (clauses 12, 13, and 14) requirements.	A/R 28169447-02	2019
IIP-OI 051	D344 - Self-Vented Pressure Regulating Valves (CSA N290.5, “Requirements for Electrical Power and Instrument Air Systems of CANDU Nuclear Power Plants”)	Self-vented pressure regulating valves are required to be used to supply air to components with design pressures lower than the air system design pressure. Evidence that Darlington NGS is compliant with this requirement is not readily available.	Verify that the equipment design pressures for Pressure Regulating Valves (PRV’s) that are not self-vented are not less than the design pressure of the air supply system or the equipment is otherwise provided with overpressure protection.	A/R 28175245-03	2016

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 053	D397 - Time Limited Aging Analysis for Civil Structures and Components (NK38-REP-03680-10078 R001, "Darlington NGS Integrated Safety Review - Ageing and Actual Condition of Systems Structures and Components Safety Factor Report")	The acceptance criterion for fitness for service is based on Time Limited Aging Analysis (TLAA) which was generally established from the original safety analysis. The acceptance criterion for TLAA of the Safety Related SSCs for a nuclear station which undergoes refurbishment should be re-evaluated and re-established to demonstrate their continued validity that aging effects will be effectively managed.	An assessment of TLAAs for Darlington has been performed and it identified the following actions to be completed. 1. Inspect external concrete components for depth of concrete carbonation and develop corrective actions to mitigate degradation if required. 2. Review the design calculations for the reactor building, vacuum structure and steam turbine and auxiliary structure to determine if concrete creep and shrinkage loads were based on an assumed service life for these structures (e.g. 30 years) and if that assumption remains valid. Perform further analysis if required. 3. The civil structure inspection program at Darlington inspects for concrete degradation due to Alkali Aggregate Reactivity (AAR) and none has been observed at Darlington to date. These inspections will continue through the extended life of Darlington. In addition, the documentation from the construction of Darlington will be reviewed to determine how AAR was addressed in the selection of aggregates to provide further confirmation that AAR degradation will not occur at some point in the future.	IP1440-1	Inspection: 2019[4] (U2 Refurbishment Outage Restart) Review & Analysis: 2019
IIP-OI 054	D398 - Transient/Fatigue Monitoring Program (NK38-REP-03680-10078 R001, "Darlington NGS Integrated Safety Review - Ageing and Actual Condition of Systems Structures and Components Safety Factor Report")	While there is little evidence of fatigue induced degradation of Systems, Structures and Components (SSCs) during current life, fatigue is a time dependent mechanism and a fatigue monitoring program could be a valuable tool for problem characterization and the implementation of mitigation strategies during post refurbishment operation.	Develop, and implement a Transient/Fatigue Monitoring Program at Darlington.	IP1260-1	U2: 2019 U3: 2022 U1: 2024 U4: 2025
IIP-OI 055	D425 – No Best Estimate Analysis of Operational Events (IAEA-SSG-2-2009 “Deterministic Safety Analysis for Nuclear Power Plants”)	There was no evidence found that the best estimate approach is used for analysis of operational events.	Revise OPG Governing document N-MAN-03600-10005, Nuclear Safety Analysis to require the use of best estimate approach or a similarly conservative approach for analysis of operational events.	A/R 28175247-01	2019

[4] If safety significant defects are found as a result of inspections, they will be corrected by the date specified.

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 056	D498 - Airflow from Zone 3 to Zone 2 Does not Meet Design Requirements(NS-G-1.13 “Radiation Protection Aspects of Design for Nuclear Power Plants”)	The as-built condition of the Powerhouse Ventilation System does not meet the following requirement: “The airflow in the ventilation system should be such that the pressure in a region of lower airborne contamination is higher than the pressure in a region of potentially higher contamination. Thus the airflow in the ventilation system should be directed from regions of lower airborne contamination to regions of higher contamination and air should be extracted from the latter. The airflow should be such as to minimize the re-suspension of contamination.”	Repair and return to service Units 1 and 3 supply fans and non-contaminated exhaust fans. Once returned to service in all units, conduct smoke tests to confirm inter-zonal airflow direction at the Zone 2/3 boundaries in all units.	IP1290-1	2019
IIP-OI 058	D502 - Foundation Steel Piling Condition Assessment for Life Extension (National Building Code of Canada (2005))	CNSC staff requested OPG to provide comprehensive site-specific assessment that can provide thorough information on the potential for pile corrosion at the Darlington site. Based on the available evidence, there is no immediate risk to the buried steel piles on the Darlington site. In addition, periodic civil structural inspections will identify the early warnings signs should there be any significant pile corrosion. As a result the safety risks associated with this IIP item are very low and no additional mitigating actions are necessary.	Evaluate options available to better characterise the corrosion of buried steel foundation piles, using conservative assumptions, to ensure that they can continue to fulfill their function for extended life. Options may include further analysis, testing, or inspections.	A/R 28175343-01	2028
IIP-OI 059	D504 – Electrical Equipment and Wiring (CSA N293-12 “Fire Protection for CANDU Nuclear Power Plants”)	Changes to the 2009 edition of the CSA C22.1 may impact protection from fire.	1) Perform a code refresh between the Canadian Electrical Code (CEC) Part 1 2006 Edition [R-34] and the 2009 edition [R-35]. 2) The code refresh concluded that there are no significant code changes that impact protection from fire. One minor modification is required: Replace the water tight conduit seals with explosion proof seals on the Heat Transport Hydrogen Addition system, units 1 to 4 -63352-FT6.	Complete [R-36] IP1460-1	Code Refresh: 2015 Modifications: U2: 2022 U3: 2025 U1: 2026 U4: 2028 (Each Unit Planned Outage Restart)

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 060	D517 – Electrical Protections and Requirements for Fire Pump Systems (NFPA-20-2013 “Standard for the Installation of Stationary Pumps for Fire Protection”)	This issue is related to the requirements for electrical protection of Fire Pump systems. As per the code requirement, ground fault interruption should not be installed in any fire pump control or power circuit. The existing installation includes a ground fault interruption on the Fire Protection Water booster pump. Also it could not be confirmed based on the documentation if the fire pump motor terminal boxes are a listed means of connection. This issue is low risk, mitigating actions are not required since the pumps are tested monthly, have redundant power supplies and in the unlikely event that the fire booster pump in one unit is unavailable, a fire booster pump in an adjacent unit can be used.	Modify the Fire Protection Water booster pump electrical installation to eliminate ground fault interruption and ensure the electrical connections at the fire pump motor terminal boxes are a listed means of connection.	IP1310-1	U0-U4: 2023
IIP-OI 061	D521 – Fire Safety Plan for Storage of Group A Plastics, Rubbers, Aerosols and Dangerous Goods (NFCC 2010 “National Fire Code of Canada”)	The DNGS Fire Safety Plan, NK38-PLAN-08965.91-10001-R006, does not document the location or quantities of storage of Group A plastics, rubber products, Level 2 or 3 aerosols, or dangerous goods.	Update the Fire Safety Plan and the Pre-Fire Plans to the NFCC 2010 requirements to ensure that they are aligned and detail the location and quantity of all stored substances as required.	A/R 28175258-01	2016
IIP-OI 062	D522 – Tank Storage of Combustible Liquids (NFCC 2010 “National Fire Code of Canada”)	These issues are related to the requirements for Fuel Oil storage tanks and the associated piping.	-Initiate predefines for continuous and periodic in-service monitoring of the SG and the EPG tanks and implement a Fuel Oil reconciliation process, in accordance with the requirements of the 2010 NFCC. - Revise N-PROC-MA-0088, Buried Piping Program Requirements, to use a graded approach for the replacement of single-walled piping with double walled material in instances of leakage, rather than “repair” or “accept as is”. - Prepare an alternate compliance to justify the graded approach for the replacement of single-walled piping with double walled material in instances of leakage.	A/R 28175303-01, 04, 05	2019

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 063	D523 – Piping System Requirements (NFCC 2010 "National Fire Code of Canada")	These issues are related to the requirement to replace single wall fuel oil piping with double wall piping if degraded buried piping is found.	Revise N-PROC-MA-0088, Buried Piping Program Requirements, to use a graded approach for the replacement of single-walled piping with double walled material in instances of leakage, rather than "repair" or "accept as is". - Prepare an alternate compliance to justify the graded approach for the replacement of single-walled piping with double walled material in instances of leakage.	A/R 28175307-01, 04	2019
IIP-OI 064	D565-Implementation of Severe Accident Management Guidelines (SAMG) Validation and Refinement (CNSC Regulatory Document REGDOC-2.3.2, "Accident Management: Severe Accident Management Programs for Nuclear Reactors")	The implementation of Severe Accident Management Guidelines (SAMG) at Darlington is ongoing.	There is already a project in progress to complete SAMG at Darlington. The majority of the work has been completed, guidelines are in place and staff have been trained and exercises are conducted using SAMG. The remaining work involves enhancements to the suite of guidelines and for IFB and multi-units guidelines.	AR 28174352-02,05,09	2016
IIP-OI 066	D607 - Severe Accident and Beyond Design Basis Accident (BDBA) Design Severe Accident Management Guidelines (SAMG) (CSA N290.3 "Requirements for the Containment System of Nuclear Power Plants")	CSA N290.3 requirements for new build are a Containment Filtered Venting System to protect containment integrity, Shield Tank Overpressure Protection to promote In-Vessel Retention of corium to prevent Core Concrete Interaction, and Severe Accident Management Guides to monitor hydrogen.	-Implement the Safety Improvement Opportunities (SIOs) resulting from the Environmental Assessment. -Complete the remaining SAMG activities which involve enhancements to the suite of guidelines. -Install Post Autocatalytic Re-combiners (PARS) in all 4 Units at Darlington.	SIO's: Refer to IIP-EA 009 AR 28174352-02,05,09 Complete [R-33]	SIO's: Refer to IIP IIIP-EA 009 SAMG: 2015 2015
IIP-OI 069	D612 - Containment Boundary Report Open Items (CSA N290.3-11 "Requirements for the Containment System of Nuclear Power Plants")	The following open Design Guide (DG-7) exceptions were found in the Containment Boundary Report: Powerhouse Service Air System V234 listed as Containment Boundary (CB) on the flow sheets. D20 Leakage Collection System containment boundary for L82-D2 is not being met.	Retrieve and review NK38-CORR-34280-{123889} and NK38-CORR-34280-{123891} to determine whether the requirements of Clause 12.1.2 and Annex A.2 Figure A.1, respectively of CSA 290.3 have been met. Determine if a design guide exception is required and if so, prepare the design guide exception.	A/R 28175283-01 ,02	2017

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Tracking #	Date
IIP-OI 071	D618 - Soil Liquefaction Potential (N289.3" Design Procedures for Seismic Qualification of CANDU Nuclear Power Plants")	No evidence was found that the identification and evaluation of the potential for soil liquefaction at Darlington site was completed.	Review the available information to verify that the liquefaction potential for fill materials in the Protected Area related to safety related systems and structures is low. Otherwise, complete a liquefaction assessment study.	A/R 28175301-01	2019
IIP-OI 072	D619 - Control of Combustible Liquids (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	Combustible liquids must be controlled where uncontrolled leakage could jeopardize FSSA systems.	Install 25ft squared dykes around all 4 Emergency Service Water (ESW) pumps to contain a potential spill/fire of the 135L of oil contained in each ESW pump motor to the pump motor of origin.	IP1280-1	U0: 2019 (U2 Refurbishment Outage Restart)

Appendix B: Completed Activities

Table 5: EA (Completed Activities)

IIP Item Number	Environmental Component (Reference)	Mitigation Objective (In design and Additional Mitigation Measures)	Action Plan	Completion Reference
0002	Atmospheric, Geology, Hydrology, Surface Water, Terrestrial CNSC Screening Report – page 79, 80, 83, 84, 85, 100, 101, 102, 104, 105, 110 and 111. (also in EIS Table 5.15)	Demonstrate that implementation of good industry management practices are effective in minimizing air, soil and water quality effects on humans and biota.	1) Incorporate applicable Good Industry Management Practices as suggested in the EA and include consideration for enhancing wildlife crossings where feasible, in the "Nuclear Projects – Environmental Requirements Guideline," N-GUID-09701-10013. Issue document for contractors to develop and implement project-specific Environmental Protection Plans. 2) Establish environmental oversight and monitoring requirements for Nuclear Projects. Environmental oversight and monitoring specified in "Darlington Refurbishment – Environmental Program Management Plan", NK38-NR-PLAN-09701-10001 Sh. 004 Section 2.5. 3) Incorporate consideration of Good Industry Management Practices in all projects which may have an environmental impact. The Project Charter Template (N-TMP-10117-R005), which defines the need for a project, was revised to include the Environmental Impact Worksheet (N-FORM-10422). After the project has been approved a Project Management Plan is developed (PMP-TMP-00001-R002) which references N-GUID-09701-10013 Nuclear Projects – Environmental Requirements Guideline in Section 1.5	[R-37] [R-38] [R-39] [R-40] [R-37]
0004	Land Use CNSC Screening Report – page 106 (also in EIS Table 5.15)	Monitor and consult municipalities on land use policies and future developments proposed in the vicinity of DN site with focus on sensitive land uses (e.g. hospitals, schools) which may result in incompatible uses and effects on implementation of the emergency plans.	Update emergency management governance to include a statement that Real Estate Services (RES) is the Primary OPG Department responsible for monitoring of land use activities and policies in proximity to DNGS. The wording of the update will include the fact that EP supports this activity when required, including providing information on risk of incompatible uses with respect to implementation of nuclear emergency plans.	[R-41]
0007	Physical and Cultural Heritage CNSC Screening Report, page 112	Protect and avoid the potential impact on the Van Camp cemetery which has archaeological and cultural heritage resource interest.	• OPG Guide "Excavation, Concrete Drilling, and Anchoring Process," N-GUID-01983-10001, section 1.13.5 provides the approximate location of the Van Camp cemetery and actions to be taken to protect the cemetery should it be encountered. The Guide is referenced in OPG Procedure "Identification of Buried or Embedded Services", OPG-PROC-0138 and Engineering Design Standard "Excavation and Backfill Practices", N-STC-02110-10000.	[R-42] [R-43] [R-44]
0008	Malfunctions and Accidents CNSC Screening Report, page 123, 124, 126, 127, 145 and 146	Maintain emergency response procedures to protect the health and safety of people and the environment.	OPG has the following emergency response procedures to protect the health and safety of people and the environment. • "Consolidated Nuclear Emergency Plan," N-PROG-RA-0001 and • "Abnormal Waterborne Tritium Emission Response," N-PROC-OP-0038.	[R-45] [R-46]

Table 6: CCAs (R001 Completed Activities)

IIP R000 Item Number	CCA	System	Description	Condition	Activity Description	Completion Reference
0063	2547	G.31 Powerhouse Ventilation System, USI# 73220, System #: 0050	HVAC Fan(F)-Non R/S	Satisfactory	Replace remaining non-contaminated fans found with low speed blades.	[R-47]

Table 7: CCAs (R002 Completed Activities)

IIP R001 Item Number	CCA	System	Description	Condition	Activity Description	Completion Reference
IIP-CC 012	729	Digital Control Computers System, USI# 69000, System #: 0016	Interprocess Communication & Transfer of Control	Satisfactory	Assess I/O subsystems WIBA terminal blocks. Replace terminal blocks based on assessment.	[R-48]
IIP-CC 013	1441	Emergency Coolant Injection System, USI# 34320, System #: 0018	ECI Water Storage Tank	Satisfactory	Inspect civil structure of ECI Storage tank and repair as required.	[R-49]
IIP-CC 030	585	Moisture Separator Reheater System, USI# 41800, System #: 0043	Motorized Valves	Satisfactory	Perform internal inspection for a representative sample of system MOVs.	[R-50]
IIP-CC 038	153	PHT Pressure and Inventory Control System, USI# 33300, System #: 0054	Pressurizer	Satisfactory	Extend inspection of the pressurizer to all units as required.	[R-51]
IIP-CC 058	2964	Shutdown System Process System, USI# 68300, System #: 0071	LISS Injection & Mixing Tanks	Good	Perform video/visual inspection on 1-34710-TK4 during outage conditions to provide baseline inspections for the LISS tanks.	[R-52]
IIP-CC 066	83	Structures - Reactor Building and Fueling Facilities, USI# 21000, System #: 0080	Central Service Area - Nuclear	Good	Perform inspections on the civil structures located in Central Service Area-Nuclear. Perform repairs based on inspection results.	[R-53]
IIP-CC 068	85	Structures - Powerhouse System, USI# 22000, System #: 0081	Central Service Area - Conventional Part	Good	Perform required inspections for Central Service Area (CSA) buildings consisting of Workshop and Laydown Area (WLA) and Service Auxiliary Bay (SAB). Perform repairs based on inspection results.	[R-54]
IIP-CC 070	87	Structures - Powerhouse System, USI# 22000, System #: 0081	Steam Turbine Supporting Structures	Satisfactory	Perform inspections on the Turbine Supporting Structures. Perform repairs based on inspection results. (Excludes trombik supports)	[R-55]

Table 8: Code Gaps (R001 Completed Activities)

IIP R000 Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
0149	D081 – Radioactive Material Storage (CSA N293-07 “Fire Protection for CANDU Nuclear Power Plants”)	The scope of this issue covers the requirements for the storage of radioactive materials.	Implement a radioactive material storage evaluation and approval process to ensure that the intended level of safety is not compromised in the event of changes in the location, nature and/or loading of radioactive materials related to the analyzed conditions under the FHA.	[R-56]
0178 0179 0180 0181 0182 0183	D251 – Fire Protection Requirements for Air-Cleaning Units (ASME N509-2002 “Nuclear Power Plant Air-Cleaning Units and Components”)	This Issue covers fire protection requirements for air cleaning systems listed in ASME N509-2002. There is no evidence in Darlington Nuclear Generating Station documentation as to whether or not the requirements are being met.	Analyze charcoal filter hazards to determine appropriate protection measures.	[R-57]
0279	D445 - Combustible Insulation (NBCC 2005 “National Building Code of Canada”)	Documentation could not be found to confirm that if foamed plastic insulation was present in vertical service shafts, or if it was properly protected.	Investigate vertical service shafts S-289 and S-290 to determine if foamed plastic insulation exists in the spaces. If so, initiate a modification to either remove or protect it by the appropriate thermal barrier.	[R-58]
0280 0281	D446 - Combustible Material In Ducts (NBCC 2005 “National Building Code of Canada”)	Insufficient evidence was found to confirm if combustible coverings and linings on vibration isolation connectors and ducts are interrupted at fire separations.	Confirm the type of duct linings and coverings. If combustible, confirm that the criteria of Sentences 3.6.5.4.(2), (4) and (5) below are satisfied. Initiate a modification to remove any foamed plastic insulation found. Evaluate others for continued use based on their properties.	[R-59]
0283	D452 – Spatial Separation and Exposed Building Face (NBCC 2005 “National Building Code of Canada”)	Documentation could not be found to confirm that foamed plastic insulation is not used in exterior walls of the buildings within the scope of the review, and if it is, that the wall assembly meets the requirement for protection on the exterior side.	Confirm the type of insulation used in the metal panel exterior walls. If the insulation is foamed plastic, confirm that the panels comply with the testing criteria indicated in clause b). If the panels do not conform to clause b), complete an evaluation of the potential fire impact.	[R-60]
0287 0288	D464 – Signage Requirements (NBCC 2005 “National Building Code of Canada”, NFCC 2005 “National Fire Code of Canada”)	There are no signs posted in the Powerhouse on elevation 100 in exit stair indicating that that level is the level of exit discharge, and the Cafeteria in Unit 0 is an assembly occupancy and the occupant load exceeds 60 persons, but no documentation was found indicating the occupant load sign is posted.	Provide appropriate signs at the exit discharge level of exit stairs that do not terminate and discharge to the exterior at El. 100, but continue on to lower elevations.	[R-61]
0292	D468 - Pipe Insulation Requirements (NBCC 2005 “National Building Code of Canada”)	Insufficient evidence was found to confirm if pipes reach 120°C, and if they do, if insulation meets the ASTM C 411 "Hot-Surface Performance of High-Temperature Thermal Insulation".	Post appropriate signage as required by Clause 2.7.1.4 of NFCC – 2005 in the Cafeteria.	[R-62]
0295	D469 - Inspection, Testing and Maintenance Requirements (NFCC 2005 “National Fire Code of Canada”)	Testing of emergency power systems is carried out on the battery banks, but it has not been confirmed whether the Standby Generators are adequately tested to the CAN/CSA-C282 standard.	Update the existing Preventative Maintenance Identification (PMID) or create a new one for the SG for inspection and testing as per the requirements of CAN/CSA-C282, “Emergency Electrical Power Supply for Buildings”.	[R-63]

IIP R000 Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
0297 0298 0299	D472 - Oil Storage Tank and Piping Requirements (NFCC 2005 “National Fire Code of Canada”)	This Integrated Safety Review (ISR) issue covers the requirements of oil storage tanks and their associated piping as per the fire protection codes and standards. The requirements such as tank construction and ventilation, piping installation, foundations and supports, shut-off valves, locations and clearances, maximum quantities of stored materials and manual fire protection provided.	Complete an assessment of the EPG and Lube Oil tanks existing tank conditions to confirm the tanks' suitability for the extended life of the Station. Correct any deficiencies.	[R-64]
0300 0301	D473 – Documentation (NFPA-24-2007 “Standard for the Installation of Private Service Mains and Their Appurtenances”)	Hose Houses have been deleted as per PCP 84900. However, Drawing NK38-F5H-78110-0004-R019 still shows a hose house symbol adjacent to Hy-10.	Revise documentation to eliminate the hose house references from NK38-F5H-78110-0004 and the design manual NK38-DM-78100 as the Hose Houses have been previously removed in the field as approved by PCP84900.	[R-65]
0311 0312	D477 - Size of Bypass(NFPA-20-2007 “Standard for the Installation of Stationary Pumps for Fire Protection”)	The bypass is 4” which does not meet the requirement of the discharge pipe being a minimum 5" in size.	Perform a hydraulic analysis to compare the friction losses in the 4 inch diameter bypass to the required 5 inch diameter pipe to demonstrate that the 4 inch pipe is sufficient.	[R-66]
0320	D484 - Magnetic Locks (NBCC 2005 “National Building Code of Canada”)	Documentation on the operation of the electromagnetic locking devices could not be found.	Review the operation of the electromagnetic locking devices with all main control room staff to confirm that they are comfortable with their operation and the risks involved should the locks not comply with the requirements of NBCC Clause 3.4.6.15 (4).	[R-67]
0352 0353 0354 0355 0356 0357 0358 0359 0360 0361	D247 - In-service Testing of Air Treatment Systems (ASME N510 - “Testing of Nuclear Air Treatment Systems”)	Routine practices are not followed for tests which would determine; filter housing leakage, filter bypass leakage, degradation of filter media following inadvertent exposure degradation agents (solvents, paints, or other organic fumes or water intrusion).	Adopt CSA N288.3.4, "Performance Testing of Nuclear Air Cleaning Systems at Nuclear Facilities" which was issued in April 2013. Review CSA N288.3.4 as part of the ISR Code Refresh process and resolve any gaps.	[R-68]
0463	D027 - Severe Accident and Beyond Design Basis Accident (BDBA) Analysis/ Severe Accident Management Guidelines (SAMG) (IAEA NS-G-1.2 “Safety Assessment and Verification for Nuclear Power Plants”)	The safety analysis should aim to quantify a plant safety margin and demonstrate that a degree of defence is provided for this class of accidents.	The SAMG Guides make use of insights from the Level 2 analysis to guide the emergency response on-site to prevent/control the progression of severe accidents and limit releases of radioactive material. It has been issued and the validation is in progress. Several SAM exercise drills have already been performed. Off-site emergency response is managed by the provincial emergency response organization. The Level 2 analysis demonstrates that there is an acceptable risk associated with all severe accident scenarios. No further action is required.	[R-69]

IIP R000 Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
0477 0478 0479 0480 0481 0482 0483 0484 0485 0486 0487 0488	D337 – No Governance Reference for Zone Definitions (Province of Ontario Nuclear Emergency Plan (PNEP))	There is no suitable governance reference for Zone Definitions, Zone Radii, Zone Response Sectors, Primary Zone Response Sector Pattern, Primary Zone Response Sector Demarcation, Secondary Sub Zones, Actual Zones and Response Sectors, Restricted and Buffer Zones, delineated by Field monitoring, DNGS Contiguous Zone definition, DNGS Primary Zone definition, DNGS Secondary Zone definition and DNGS Primary Zone Response Sectors.	Revise OPG Program, N-PROG-RA-0001 R010, "Consolidated Nuclear Emergency Plan" and/or N-STD-RA-0004, "Emergency Off-Site Radiological Monitoring Process for Airborne Releases of Radioactive Materials" to reference Zone Definitions, Zone Radii, Response Sector Boundaries, Desirable Pattern of Response Sectors, Secondary Sub Zones, Actual Zones and Response Sectors, Restricted and Buffer Zones, delineated by Field monitoring, DNGS Contiguous Zone definition, DNGS Primary Zone definition, DNGS Secondary Zone definition and DNGS Primary Zone Response Sectors.	[R-70]
0489	D338 - No Governance to Maintain 5 MDUs (Province of Ontario Nuclear Emergency Plan (PNEP))	There is no governance reference to demonstrate that OPG will continue to retain and maintain the 5 MDUs as required by the PNERP.	Revise N-PROG-RA-0001, Consolidated Nuclear Emergency Plan (CNEP) to comply with the requirements of Ontario Provincial Nuclear Emergency Response Plan (PNERP), 2009 Clause 4.7.5 with regard to radiation monitoring and decontamination units (MDUs).	[R-71]
0490	D339 - Radiological Event Monitoring Support for Non-OPG Events (Province of Ontario Nuclear Emergency Plan (PNEP))	PNERP requires OPG to provide a radiation monitoring service to the Emergency Management Ontario (EMO) Environmental Radiation Monitoring Group for a non-OPG radiological event.	Prepare and issue a Letter of Understanding to EMO that will confirm and define OPG's responsibility to provide radiological event monitoring support for a non OPG event.	[R-72]
0491	D115 - Fire Protection Requirements for Laboratories (NFCC 2005 "National Fire Code of Canada")	Available documentation could not verify compliance with the requirements for ignition sources and combustible material control in a laboratory, including the requirements for high temperature limit switches for heating equipment, and restrictions when an ignition source is used in conjunction with flammable and combustible liquids.	Evaluate the use of the heaters to confirm whether they will be used in unattended applications, and whether overheating of the heater could cause a fire or explosion. If so, equip the heater with an audible alarm or some other type of alarm notification that would alert personnel to the fault.	[R-73]
0495	D460 – Fuel Supply Shut Off Valves (NBCC 2005 "National Building Code of Canada")	An emergency fuel shut off valve for engines or turbines used for an emergency electric power supply must be provided and have a sign.	Add the required signs or revise Pre-Fire Plans.	[R-74]
0496	D482 – Monitoring of Fire Pump Alternate Power Source (NFPA-20-2007 "Standard for the Installation of Stationary Pumps for Fire Protection")	The power to the monitoring loop is drawn from only two of the three phases with no evidence that a signal would be initiated on loss of control power. Also, no documentation has been found indicating the phase loss signal is monitored for each of the feeds	Review the existing MCC current tap relay should be reviewed to confirm that it is fail safe. If it is not, install an alternative circuit separate from the MCC circuit. Review and confirm both the primary and alternate power sources.	[R-75]
0502	D266 - Lack of ALARA & Radiation Protection Training for Plant Design Staff (NK38-REP-03680-10077 "Darlington NGS-A Integrated Safety Review Plant Design Safety Factor")	The current program provides no specific training course or Computer Based Training (CBT) to ensure staff applies As Low As Reasonably Achievable (ALARA) to radiation protection within the design process.	Complete the following activities: - The creation of the CAL - The implementation of the CAL	[R-76]

IIP R000 Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
0503	D303 - Extension of the Containment Envelope Requirements (CNSC R-7 “Requirements for Containment Systems for CANDU Nuclear Power Plants", DG-38-03650-7 “Nuclear Safety Design Guide - Darlington NGS Extensions of the Containment Envelope")	CNSC staff has requested that OPG provide evidence that the calculation and analysis was completed to support the statement as presented in the Design Guide Exception that "For large, fluid filled structures such as the Shield tank extension, the internal design pressure is not indicative of its capacity to withstand the external pressure resulting from Loss of Containment Accident (LOCA) (48 kPa(g). Such a structure can withstand external pressures significantly higher than the limiting internal pressures. The Shield tank assembly has been analyzed for a containment positive pressure test of 111 kPa(g) and the stresses are well within the acceptable limit."	Either retrieve the required documents from CANDUEnergy or recreate the documents / analysis required to close the gap.	[R-77]
0504	D304 - Change to Extension of the Containment Envelope (CNSC R-7 “Requirements for Containment Systems for CANDU Nuclear Power Plants", DG-38-03650-7 "Nuclear Safety Design Guide - Darlington NGS Extensions of the Containment Envelope"	CNSC have requested OPG to provide the reference document to support the following statement made in the Design Guide Exception: "The maximum pressure (in Line 12) following an accident would be 98 psia (static 85 psia pressure rinse in the vacuum structure of about 13 psia). This small incremental pressure rise from the normal operating pressure is unlikely to affect the integrity of the piping, as it is still well below the piping design pressure."	Either retrieve the required documentation or recreate the documents / analysis required to close the gap.	[R-78]
0505	D321 - Threaded Connections (CSA N285.2 “Requirements for Class 1 C, 2C and 3C Pressure-Retaining Components and Supports in CANDU Nuclear Power Plants")	Threaded connections to Fuelling Machine Class 1 vessel walls do not meet all of the requirements of Clause 9.5 of CSA N285.2-99.	Perform additional analysis of threaded connections in Fuelling Machine Extension Tube and Drive Housing. Verify that reinforcement of the threaded connections meets the requirements of Paragraph NB-3300 of the ASME Boiler and Pressure Vessel Code, or that the stresses at the threaded connections meet the requirements of ASME Section III Subsection NB.	[R-79]
0508	D355 - Library Functions (N286.7-99, "Quality Assurance of Analytical, Scientific, and Design Computer Programs for Nuclear Power Plants")	The applicable OPG governing document, N-PROC-MP-0095, does not include the requirement that the design description include library functions.	Revise Table 2 “Graded Application for Design and Development Tasks” of N-PROC-MP-0095 to require that library functions are included in the design description. Incorporate this requirement into N-PROC-MP-0095 at the first opportunity to revise this governing document.	[R-80]
0511	D412 - Predicted Failure mode of Anchorage Systems (CSA N287.3 "Design Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants")	There is a lack of documentation requiring anchorage systems to be designed to exhibit ductile behaviour in safety related structures.	Perform calculations and/or finite element limit load analysis for selected anchorage/support configurations using actual material properties for the anchorage system to demonstrate that the predicted failure mode is a ductile failure.	[R-81]
0512	D413 - Concrete Cover for Reinforcement (CSA N287.3 "Design Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants")	There is a lack of accounting for the design requirements for actual concrete cover of containment structures in relation to actual environment conditions (humidity, temperature, chemicals, etc.).	Undertake an assessment on actual concrete cover of safety-related structures in relation to actual environment conditions (humidity, temperature, chemicals, etc.).	[R-82]

IIP R000 Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
0515	D500 - Adequacy of the N289.3-M81 Code Review Report (CSA-N289.3 “Design Procedures for Seismic Qualification of CANDU Nuclear Power Plants”)	There is a lack of a listing of systems and structures that were considered in the N289.3-M81 code review report.	Clearly identify the systems and structures including SCI/USI in the code refresh review for the 2010 edition CSA N289.3. Also describe the methodology that was used to identify the systems and structures that are within the scope. When assessing compliance against the clauses in CSA N289.3-201 0, demonstrate compliance for all of the systems and structures within the scope of the review.	[R-83]
0517	N/A – Life Extension Activities resulting from CCA Adequacy Review and CCA Recovery Project	Review the results of the Component Condition Assessment (CCA) Adequacy Review and CCA Recovery Project for potential actions required for life extension.	Update the Integrated Implementation Plan (IIP) with the results of the CCA Adequacy Review and CCA Recovery Project.	The following line items have been added to Appendix A of the IIP R001: IIP-CC 008 IIP-CC 009 IIP-CC 016 IIP-CC 017 IIP-CC 023 IIP-CC 038 IIP-CC 040 IIP-CC 043 IIP-CC 051 IIP-CC 075 IIP-CC 076 IIP-CC 077
0518	N/A- Improve the Aging Management Process documentation	The Global Assessment identified a recommendation to improve the Aging Management Process documented in N-PROC-MP-0060 to better address consideration for life extension.	Modify the Aging Management Program governance to address life extension.	[R-8]

Table 9: Code Gaps (R002 Completed Activities)

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
IIP-OI 005	D059 – Lightning Protection (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	The scope of this ISR Issue covers the protection of all structures and equipment from lightning. This includes buildings, above ground tanks, stacks construction cranes, and meteorological towers.	Complete a review of the current lightning protection at the Station to determine if it is compliant with NFPA 780 - 2004. Install upgrades where required to achieve compliance with NFPA 780 – 2004.	[R-84]
IIP-OI 007	D115 – Fire Protection Requirements for Laboratories (Powerhouse) (NFCC 2005 "National Fire Code of Canada")	Documentation could not be located to demonstrate compliance with requirements for cleaning, inspection and maintenance of electrical equipment, mechanical systems, piping, valves, automatic and manual control and safety devices, and ventilation systems within laboratories.	Implement Inspection Testing and Maintenance requirements for the mechanical, electrical and control systems in the Chemical laboratories.	[R-85][5]
IIP-OI 013	D182 – Thermal Insulating Materials (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	Existing documentation does not provide requirements for protection, inspection and replacement of thermal insulating materials to prevent them from becoming fire hazards.	Revise procedures to ensure compliance with the requirements for protection, inspection and replacement of thermal insulating materials to prevent them from becoming fire hazards.	[R-86][5]
IIP-OI 014	D184 – Fire Protection Program Audit (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	The following review elements are not covered in the current scope of the Performance Improvement and Nuclear Oversight (PINO) annual fire protection audits: -Fire protection procedure for inclusion of industry OPEX and evolving industry standards; -A sample of plant modifications to ensure compliance with National Building Code of Canada (NBCC) and National Fire Code of Canada (NFCC), as well as to ensure that the impact on the Fire Safe Shutdown Analysis (FSSA) has been evaluated; -At least one emergency response team drill;	Review Nuclear Oversight audit scope for 2012, 2013, 2014 pertaining to CSA N293-07 compliance elements documented in gap D184. If gaps related to audit scope per D184 are identified, re-scope future audit plans per N-PROC-RA-0048 to ensure appropriate elements are audited once every 3 years to close D184 gap and to adhere to CSA N293-07 requirements.	[R-87]
IIP-OI 017	D297 – Fire Protection Air Filter Media Requirements (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	The system Design Manual does not confirm that the originally installed pre-filter meets the combustibility requirements of Class 1, per CAN/ULC-S111or that the HEPA filters meet the combustibility requirements of ANSI/UL-586.	Ensure replacement pre-filters used in the main Powerhouse and supporting out buildings comply with the Class 1 requirements in accordance with CAN/ULC-S111, where available. Also ensure replacement HEPA filters used in the main powerhouse and supporting out buildings comply with the combustibility requirements in accordance with ANSI/UL-586. Implement applicable station procedures regarding the air handling systems and the HEPA filters to drive compliance with this clause.	[R-88]

[5] Code of Record Gap [R-30]

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
IIP-OI 020	D116, D226, D430, D431, D439, D441, D445, D466, D503 Resolution of issues tied to the CCR, FHA and FSSA (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants", CSA N293-12 "Fire Protection for Nuclear Power Plants" NBCC 2005 "National Building Code of Canada", NK38-REP-03680-10179, "Fire Protection Specialists Review of the Fire Protection Issues Identified through the Darlington Integrated Safety Review")	Scope of these ISR issues covers issues tied to analysis of code compliance review requirements for facilities licensed for operation prior to the publication of CAN/CSA N293-07, and analysis of potential fire hazards and the impacts and consequences of such fires on the safety objectives of the Station.	Review the agreement on the Code Compliance Review (CCR), FHA and FSSA reached between the station and CNSC and determine if the actions when implemented will close these issues. If not, utilize data extracted from the FHA and FSSA to document an assessment on how the FHA and FSSA goals for the station can be met without additional modifications or develop and implement an action plan to close the gaps.	[R-89]
IIP-OI 021	D432 – Canadian Electrical Code Review for Changes Impacting Fire Protection (CSA N293-07 "Fire Protection for CANDU Nuclear Power Plants")	There is a lack of gap analysis between the 2006 Canadian Electrical Code [R-34] and the edition of the Code at the time of station design and construction. For any major changes implement upgrades.	Review the changes between the CEC Part 1 code of record and the 2006 Edition to verify there are no major code changes that impact protection from fire. If required, implement any modifications.	[R-90]
IIP-OI 032	D479 – Fire Pump Disconnecting Means (NFPA-20-2007 "Standard for the Installation of Stationary Pumps for Fire Protection")	This issue is related to the requirements for fire pump controller disconnection means, signage and seals or locks	Add the required seals or locks and the prescribed signage to the Fire Protection booster pumps power supply as described in the NFPA 20-2007.	[R-91][5]
IIP-OI 045	D013 - Long Term Control of Hydrogen in Containment (IAEA NS-R-1 "Safety of Nuclear Power Plants: Design" & CNSC RD-337 "Design of New Nuclear Power Plants")	There is a need for systems to control the fission products, hydrogen, oxygen, and other substances that could be released into containment.	Install Passive Autocatalytic Re-combiners (PARS) in all 4 Units at Darlington which will provide an additional capability to reduce hydrogen concentration.	[R-33]
IIP-OI 047	D141 – Fire Protection Requirements for Indoor Fuel Oil Systems (NFCC 2005 "National Fire Code of Canada")	No documentation found indicating compliance with the requirement for signs indicating the location of valves used for operation of fire protection equipment and manual emergency shut-off valves to be posted in conspicuous locations.	Install signs in conspicuous locations indicating the location of valves used for the operation of fire protection equipment and manual emergency shut-off of fuel oil.	[R-92]
IIP-OI 048	D011 - Changes to In-Service Examination and Testing Requirements for Concrete Containment Structures (RD-337, "Design of New Nuclear Power Plants")	Darlington is not fully compliant with the requirement to provide a list of requirements for design to facilitate inspection of civil structures.	Create a high level document for leakage rate testing and update the Periodic Inspection Programs for Concrete Containment Structures.	[R-93]

[5] Code of Record Gap [R-30]

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
IIP-OI 052	D352- Time History Compatibility with the Design Ground Response Spectrum (N289.3" Design Procedures for Seismic Qualification of CANDU Nuclear Power Plants") D617 - Seismic Time History Requirements (CSA N289.3 "Design Procedures for Seismic Qualification of Nuclear Power Plants")	Documented evidence in the form of a calculation to show that the generated time history correctly represents the design ground response spectrum within the prescribed requirements have not been provided.	Verify that the time histories used in seismic analyses of safety-related System, Structure and Components (SSCs) comply with the original and recent versions of N289.3.	[R-94]
IIP-OI 057	D501 - Aging and Actual Conditions of SSCs SFR - CNSC Type II Inspection of CCAs (NK38-REP-03680-10078 R01, "Ageing and Actual Condition of Systems, Structures and Components (SSC) Safety Factor Report")	There are quality issues with the Component Condition Assessments (CCAs) as identified in self-assessment D13-000070 and the preliminary findings of the CNSC Staff Type II Plant Condition Assessment Compliance Inspection.	Address all of the findings from the CNSC Type II Inspection report. Outstanding activities include: - N-PROC-MP-0060 Roll Out - N-PROC-MA-0077 Update - Effectiveness Review	[R-95]
IIP-OI 065	D606 - Darlington's Non-compliance with Hygrometer Probe Requirements(CSA N287.7 "In-service Examination and Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants"	Darlington is not compliant with the dewpoint requirements initially stated in the 2008 version of the standard.	Evaluate options and if required procure higher accuracy probes that will meet the dewpoint requirements or request a concession letter to the CNSC to use existing hygrometers.	[R-96]
IIP-OI 067	D610 - Long Term Control of Hydrogen In Containment (CSA N290.3 "Requirements for the Containment System of Nuclear Power Plants")	There is a lack of Post Autocatalytic Re-combiners (PARs) for long term hydrogen control.	Install Passive Autocatalytic Re-combiners (PARS) in all 4 Units at Darlington which will provide an additional capability to reduce hydrogen concentration.	[R-33]
IIP-OI 068	D611 - Coatings and Coverings Within Containment System (CSA N290.3 "Requirements for the Containment System of Nuclear Power Plants")	There is no evidence to confirm that post-accident conditions inside containment were considered when choosing the coating for civil structures and steel lined reactor structures. The interaction of some coatings in containment with the post-accident environment has the potential to produce hydrogen.	Install Passive Autocatalytic Re-combiners (PARS) in all 4 Units at Darlington which will provide an additional capability to reduce hydrogen concentration.	[R-33]
IIP-OI 070	D616 - Equipment Qualification for Beyond Design Basis Accidents (BDBAs) (CSA N290.0, "General Requirements for Safety Systems of Nuclear Power Plants")	There is a lack of completed qualification assessments for instrumentation and equipment required following a Beyond Design Basis Accident (BDBA).	Complete the instrumentation and equipment qualification assessments for Beyond Design Basis Accidents (BDBAs) (related to external initiating events) as part of the Fukushima follow-up work.	[R-32]

IIP Item Number	Issue Number & Title	Issue Description	Action Plan	Completion Reference
IIP-OI 073	D620 - Section 5 of the CSA N289.5-12 Code Refresh (CSA N289.5-12 “Seismic instrumentation requirements for nuclear power plants and nuclear facilities")	The code refresh report for CSA N289.5-12 did not include a review of Section 5 of the code. Section 5 is titled ‘New nuclear power plants and on-site nuclear facilities’ and although it would not normally be applicable to an existing station, it is a requirement for the review of modern codes and standards for the Darlington Integrated Safety Review.	Perform a review of Section 5 of CSA N289.5-12. If any gaps are identified as a result of the review they will be resolved in accordance with N-INS-00770-10004, “Nuclear Refurbishment Gap Resolution Process – Darlington”.	[R-97]

Appendix C: IIP Mapping

EA IIP Items

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0001	IIP-EA 001	Open	Appendix A
0002	IIP-EA 002	Complete	Appendix B
0003	IIP-EA 003	Open	Appendix A
0004	IIP-EA 004	Complete	Appendix B
0005	IIP-EA 005	Open	Appendix A
0006	IIP-EA 006	Open	Appendix A
0007	IIP-EA 007	Complete	Appendix B
0008	IIP-EA 008	Complete	Appendix B
0009	IIP-EA 009	Open	Appendix A
0010	IIP-EA 010	Open	Appendix A
0011	IIP-EA 011	Open	Appendix A
0012	IIP-EA 012	Open	Appendix A
0013	IIP-EA 013	Open	Appendix A
0014	IIP-EA 014	Open	Appendix A
0015	IIP-EA 015	Open	Appendix A

CCA IIP Items

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0016	IIP-CC 001	Open	Appendix A
0017	IIP-CC 002	Open	Appendix A
0018	IIP-CC 003	Open	Appendix A
0019	IIP-CC 004	Open	Appendix A
0020	IIP-CC 005	Open	Appendix A
0021	IIP-CC 006	Open	Appendix A
0022	IIP-CC 007	Open	Appendix A
0023	N/A	Asset Preservation	NK38-CORR-00531-16866
0024	N/A	Asset Preservation	NK38-CORR-00531-16866
0025	N/A	Asset Preservation	NK38-CORR-00531-16866
0026	N/A	Asset Preservation	NK38-CORR-00531-16866
0027	N/A	Asset Preservation	NK38-CORR-00531-16866
0028	IIP-CC 010	Open	Appendix A
0029	IIP-CC 011	Open	Appendix A
0030	IIP-CC 012	Complete	Appendix B
0031	IIP-CC 013	Complete	Appendix B
0032	IIP-CC 014	Open	Appendix A
0033	N/A	Asset Preservation	NK38-CORR-00531-16866
0034	N/A	Asset Preservation	NK38-CORR-00531-16866
0035	IIP-CC 015	Open	Appendix A
0036	N/A	Asset Preservation	NK38-CORR-00531-16866
0037	IIP-CC 018	Open	Appendix A
0038	N/A	Asset Preservation	NK38-CORR-00531-16866
0039	N/A	Asset Preservation	NK38-CORR-00531-16866
0040	N/A	Asset Preservation	NK38-CORR-00531-16866
0041	N/A	Asset Preservation	NK38-CORR-00531-16866
0042	IIP-CC 019	Open	Appendix A
0043	IIP-CC 020	Open	Appendix A
0044	N/A	Asset Preservation	NK38-CORR-00531-16866
0045	IIP-CC 021	Open	Appendix A
0046	IIP-CC 022	Open	Appendix A
0047	N/A	Asset Preservation	NK38-CORR-00531-16866
0048	N/A	Asset Preservation	NK38-CORR-00531-16866
0049	N/A	Asset Preservation	NK38-CORR-00531-16866
0050	IIP-CC 024	Open	Appendix A
0051	N/A	Asset Preservation	NK38-CORR-00531-16866
0052	IIP-CC 025	Open	Appendix A
0053	IIP-CC 026	Open	Appendix A
0054	IIP-CC 027	Open	Appendix A
0055	N/A	Asset Preservation	NK38-CORR-00531-16866
0056	IIP-CC 028	Open	Appendix A
0057	IIP-CC 029	Open	Appendix A

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0058	IIP-CC 030	Complete	Appendix B
0059	IIP-CC 031	Open	Appendix A
0060	IIP-CC 032	Open	Appendix A
0061	IIP-CC 033	Open	Appendix A
0062	IIP-CC 034	Open	Appendix A
0063	0063	Complete	Appendix B
0064	IIP-CC 035	Open	Appendix A
0065	IIP-CC 036	Open	Appendix A
0066	IIP-CC 037	Open	Appendix A
0067	IIP-CC 038	Complete	Appendix B
0068	IIP-CC 041	Open	Appendix A
0069	N/A	Asset Preservation	NK38-CORR-00531-16866
0070	IIP-CC 0423	Open	Appendix A
0071	IIP-CC 044	Open	Appendix A
0072	IIP-CC 045	Open	Appendix A
0073	N/A	Asset Preservation	NK38-CORR-00531-16866
0074	IIP-CC 046	Open	Appendix A
0075	IIP-CC 047	Open	Appendix A
0076	IIP-CC 048	Open	Appendix A
0077	N/A	Asset Preservation	NK38-CORR-00531-16866
0078	N/A	Asset Preservation	NK38-CORR-00531-16866
0079	N/A	Asset Preservation	NK38-CORR-00531-16866
0080	IIP-CC 049	Open	Appendix A
0081	IIP-CC 050	Open	Appendix A
0082	N/A	Asset Preservation	NK38-CORR-00531-16866
0083	IIP-CC 052	Open	Appendix A
0084	IIP-CC 052	Open	Appendix A
0085	IIP-CC 052	Open	Appendix A
0086	IIP-CC 052	Open	Appendix A
0087	IIP-CC 052	Open	Appendix A
0088	IIP-CC 053	Open	Appendix A
0089	N/A	Asset Preservation	NK38-CORR-00531-16866
0090	N/A	Asset Preservation	NK38-CORR-00531-16866
0091	IIP-CC 054	Open	Appendix A
0092	IIP-CC 055	Open	Appendix A
0093	IIP-CC 055	Open	Appendix A
0094	IIP-CC 055	Open	Appendix A
0095	IIP-CC 055	Open	Appendix A
0096	IIP-CC 055	Open	Appendix A
0097	IIP-CC 055	Open	Appendix A
0098	N/A	Asset Preservation	NK38-CORR-00531-16866
0099	IIP-CC 056	Open	Appendix A
0100	IIP-CC 057	Open	Appendix A
0101	N/A	Asset Preservation	NK38-CORR-00531-16866

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0102	IIP-CC 058	Complete	Appendix B
0103	N/A	Asset Preservation	NK38-CORR-00531-16866
0104	IIP-CC 059	Open	Appendix A
0105	N/A	Asset Preservation	NK38-CORR-00531-16866
0106	IIP-CC 060	Open	Appendix A
0107	IIP-CC 061	Open	Appendix A
0108	IIP-CC 062	Open	Appendix A
0109	IIP-CC 063	Open	Appendix A
0110	IIP-CC 064	Open	Appendix A
0111	IIP-CC 065	Open	Appendix A
0112	IIP-CC 066	Complete	Appendix B
0113	IIP-CC 067	Open	Appendix A
0114	IIP-CC 068	Complete	Appendix B
0115	IIP-CC 069	Open	Appendix A
0116	IIP-CC 070	Complete	Appendix B
0117	IIP-CC 071	Open	Appendix A
0118	IIP-CC 072	Open	Appendix A
0119	IIP-CC 073	Open	Appendix A
0120	IIP-CC 074	Open	Appendix A
0121	N/A	Asset Preservation	NK38-CORR-00531-16866
0122	N/A	Asset Preservation	NK38-CORR-00531-16866
0123	N/A	Asset Preservation	NK38-CORR-00531-16866
0124	N/A	Asset Preservation	NK38-CORR-00531-16866
0125	N/A	Asset Preservation	NK38-CORR-00531-16866
0126	IIP-CC 078	Open	Appendix A
New Item	IIP-CC 008	Open	Appendix A
New Item	IIP-CC 009	Open	Appendix A
New Item	IIP-CC 016	Open	Appendix A
New Item	IIP-CC 017	Open	Appendix A
New Item	IIP-CC 023	Open	Appendix A
New Item	IIP-CC 039	Open	Appendix A
New Item	IIP-CC 040	Open	Appendix A
New Item	IIP-CC 042	Open	Appendix A
New Item	IIP-CC 051	Open	Appendix A
New Item	IIP-CC 075	Open	Appendix A
New Item	IIP-CC 076	Open	Appendix A
New Item	IIP-CC 077	Open	Appendix A

Code Gaps IIP Items

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0127	IIP-OI 001	Open	Appendix A
0128	IIP-OI 001	Open	Appendix A
0129	IIP-OI 001	Open	Appendix A
0130	IIP-OI 001	Open	Appendix A
0131	IIP-OI 001	Open	Appendix A
0132	IIP-OI 002	Open	Appendix A
0133	IIP-OI 002	Open	Appendix A
0134	IIP-OI 002	Open	Appendix A
0135	IIP-OI 002	Open	Appendix A
0136	IIP-OI 002	Open	Appendix A
0137	IIP-OI 002	Open	Appendix A
0138	IIP-OI 002	Open	Appendix A
0139	IIP-OI 002	Open	Appendix A
0140	IIP-OI 002	Open	Appendix A
0141	IIP-OI 003	Open	Appendix A
0142	IIP-OI 003	Open	Appendix A
0143	N/A	Asset Preservation	NK38-CORR-00531-16866
0144	IIP-OI 004	Open	Appendix A
0145	IIP-OI 005	Complete	Appendix B
0146	IIP-OI 005	Complete	Appendix B
0147	IIP-OI 006	Open	Appendix A
0148	IIP-OI 006	Open	Appendix A
0149	N/A	Complete	Appendix B
0150	IIP-OI 007	Complete	Appendix B
0151	IIP-OI 007	Complete	Appendix B
0152	IIP-OI 007	Complete	Appendix B
0153	IIP-OI 008	Open	Appendix A
0154	IIP-OI 008	Open	Appendix A
0155	IIP-OI 009	Open	Appendix A
0156	IIP-OI 009	Open	Appendix A
0157	IIP-OI 009	Open	Appendix A
0158	IIP-OI 010	Open	Appendix A
0159	IIP-OI 011	Open	Appendix A
0160	IIP-OI 012	Open	Appendix A
0161	IIP-OI 013	Complete	Appendix B
0162	IIP-OI 013	Complete	Appendix B
0163	IIP-OI 013	Complete	Appendix B
0164	IIP-OI 014	Complete	Appendix B
0165	N/A	Asset Preservation	NK38-CORR-00531-16866
0166	N/A	Asset Preservation	NK38-CORR-00531-16866
0167	N/A	Asset Preservation	NK38-CORR-00531-16866
0168	N/A	Asset Preservation	NK38-CORR-00531-16866

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0169	IIP-OI 015	Open	Appendix A
0170	IIP-OI 015	Open	Appendix A
0171	IIP-OI 015	Open	Appendix A
0172	IIP-OI 015	Open	Appendix A
0173	N/A	Asset Preservation	NK38-CORR-00531-16866
0174	N/A	Asset Preservation	NK38-CORR-00531-16866
0175	IIP-OI 016	Open	Appendix A
0176	IIP-OI 016	Open	Appendix A
0177	N/A	Asset Preservation	NK38-CORR-00531-16866
0178	0178	Complete	Appendix B
0179	0179	Complete	Appendix B
0180	0180	Complete	Appendix B
0181	0181	Complete	Appendix B
0182	0182	Complete	Appendix B
0183	0183	Complete	Appendix B
0184	IIP-OI 017	Complete	Appendix B
0185	IIP-OI 017	Complete	Appendix B
0186	IIP-OI 018	Open	Appendix A
0187	IIP-OI 018	Open	Appendix A
0188	IIP-OI 019	Open	Appendix A
0189	IIP-OI 019	Open	Appendix A
0190	IIP-OI 019	Open	Appendix A
0191	IIP-OI 019	Open	Appendix A
0192	IIP-OI 019	Open	Appendix A
0193	IIP-OI 019	Open	Appendix A
0194	IIP-OI 020	Complete	Appendix B
0195	IIP-OI 020	Complete	Appendix B
0196	IIP-OI 020	Complete	Appendix B
0197	IIP-OI 020	Complete	Appendix B
0198	IIP-OI 020	Complete	Appendix B
0199	IIP-OI 020	Complete	Appendix B
0200	IIP-OI 020	Complete	Appendix B
0201	IIP-OI 020	Complete	Appendix B
0202	IIP-OI 020	Complete	Appendix B
0203	IIP-OI 020	Complete	Appendix B
0204	IIP-OI 020	Complete	Appendix B
0205	IIP-OI 020	Complete	Appendix B
0206	IIP-OI 020	Complete	Appendix B
0207	IIP-OI 020	Complete	Appendix B
0208	IIP-OI 020	Complete	Appendix B
0209	IIP-OI 020	Complete	Appendix B
0210	IIP-OI 020	Complete	Appendix B
0211	IIP-OI 020	Complete	Appendix B
0212	IIP-OI 020	Complete	Appendix B

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0213	IIP-OI 020	Complete	Appendix B
0214	IIP-OI 020	Complete	Appendix B
0215	IIP-OI 020	Complete	Appendix B
0216	IIP-OI 020	Complete	Appendix B
0217	IIP-OI 020	Complete	Appendix B
0218	IIP-OI 020	Complete	Appendix B
0219	IIP-OI 020	Complete	Appendix B
0220	IIP-OI 020	Complete	Appendix B
0221	IIP-OI 020	Complete	Appendix B
0222	IIP-OI 020	Complete	Appendix B
0223	IIP-OI 020	Complete	Appendix B
0224	IIP-OI 020	Complete	Appendix B
0225	IIP-OI 020	Complete	Appendix B
0226	IIP-OI 020	Complete	Appendix B
0227	IIP-OI 020	Complete	Appendix B
0228	IIP-OI 020	Complete	Appendix B
0229	IIP-OI 020	Complete	Appendix B
0230	IIP-OI 020	Complete	Appendix B
0231	IIP-OI 020	Complete	Appendix B
0232	IIP-OI 020	Complete	Appendix B
0233	IIP-OI 020	Complete	Appendix B
0234	IIP-OI 020	Complete	Appendix B
0235	IIP-OI 020	Complete	Appendix B
0236	IIP-OI 020	Complete	Appendix B
0237	IIP-OI 020	Complete	Appendix B
0238	IIP-OI 020	Complete	Appendix B
0239	IIP-OI 020	Complete	Appendix B
0240	IIP-OI 020	Complete	Appendix B
0241	IIP-OI 020	Complete	Appendix B
0242	IIP-OI 020	Complete	Appendix B
0243	IIP-OI 020	Complete	Appendix B
0244	IIP-OI 020	Complete	Appendix B
0245	IIP-OI 020	Complete	Appendix B
0246	IIP-OI 020	Complete	Appendix B
0247	IIP-OI 020	Complete	Appendix B
0248	IIP-OI 020	Complete	Appendix B
0249	IIP-OI 020	Complete	Appendix B
0250	IIP-OI 020	Complete	Appendix B
0251	IIP-OI 020	Complete	Appendix B
0252	IIP-OI 020	Complete	Appendix B
0253	IIP-OI 020	Complete	Appendix B
0254	IIP-OI 020	Complete	Appendix B
0255	IIP-OI 020	Complete	Appendix B
0256	IIP-OI 020	Complete	Appendix B

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0257	IIP-OI 020	Complete	Appendix B
0258	IIP-OI 020	Complete	Appendix B
0259	IIP-OI 020	Complete	Appendix B
0260	IIP-OI 020	Complete	Appendix B
0261	IIP-OI 020	Complete	Appendix B
0262	IIP-OI 020	Complete	Appendix B
0263	IIP-OI 020	Complete	Appendix B
0264	IIP-OI 020	Complete	Appendix B
0265	IIP-OI 020	Complete	Appendix B
0266	IIP-OI 021	Complete	Appendix B
0267	IIP-OI 021	Complete	Appendix B
0268	IIP-OI 022	Open	Appendix A
0269	IIP-OI 020	Complete	Appendix B
0270	IIP-OI 020	Complete	Appendix B
0271	IIP-OI 020	Complete	Appendix B
0272	IIP-OI 020	Complete	Appendix B
0273	IIP-OI 020	Complete	Appendix B
0274	IIP-OI 023	Open	Appendix A
0275	IIP-OI 023	Open	Appendix A
0276	IIP-OI 023	Open	Appendix A
0277	IIP-OI 024	Open	Appendix A
0278	IIP-OI 020	Complete	Appendix B
0279	0279	Complete	Appendix B
0280	0280	Complete	Appendix B
0281	0281	Complete	Appendix B
0282	IIP-OI 025	Open	Appendix A
0283	0283	Complete	Appendix B
0284	N/A	Asset Preservation	NK38-CORR-00531-16866
0285	IIP-OI 026	Open	Appendix A
0286	IIP-OI 026	Open	Appendix A
0287	0287	Complete	Appendix B
0288	0288	Complete	Appendix B
0289	IIP-OI 020	Open	Appendix A
0290	IIP-OI 020	Open	Appendix A
0291	IIP-OI 027	Open	Appendix A
0292	0292	Complete	Appendix B
0293	IIP-OI 028	Open	Appendix A
0294	IIP-OI 028	Open	Appendix A
0295	0295	Complete	Appendix B
0296	IIP-OI 029	Open	Appendix A
0297	0297	Complete	Appendix B
0298	0298	Complete	Appendix B
0299	0299	Complete	Appendix B
0300	300	Complete	Appendix B

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0301	301	Complete	Appendix B
0302	IIP-OI 030	Open	Appendix A
0303	IIP-OI 030	Open	Appendix A
0304	IIP-OI 030	Open	Appendix A
0305	IIP-OI 030	Open	Appendix A
0306	IIP-OI 031	Open	Appendix A
0307	IIP-OI 031	Open	Appendix A
0308	IIP-OI 031	Open	Appendix A
0309	IIP-OI 031	Open	Appendix A
0310	IIP-OI 031	Open	Appendix A
0311	0311	Complete	Appendix B
0312	0312	Complete	Appendix B
0313	IIP-OI 032	Complete	Appendix B
0314	IIP-OI 032	Complete	Appendix B
0315	IIP-OI 033	Open	Appendix A
0316	IIP-OI 033	Open	Appendix A
0317	IIP-OI 033	Open	Appendix A
0318	IIP-OI 033	Open	Appendix A
0319	IIP-OI 033	Open	Appendix A
0320	0320	Complete	Appendix B
0321	IIP-OI 034	Open	Appendix A
0322	IIP-OI 034	Open	Appendix A
0323	IIP-OI 034	Open	Appendix A
0324	IIP-OI 034	Open	Appendix A
0325	IIP-OI 034	Open	Appendix A
0326	IIP-OI 034	Open	Appendix A
0327	IIP-OI 034	Open	Appendix A
0328	IIP-OI 034	Open	Appendix A
0329	IIP-OI 034	Open	Appendix A
0330	IIP-OI 034	Open	Appendix A
0331	IIP-OI 034	Open	Appendix A
0332	IIP-OI 034	Open	Appendix A
0333	IIP-OI 034	Open	Appendix A
0334	IIP-OI 035	Open	Appendix A
0335	IIP-OI 035	Open	Appendix A
0336	IIP-OI 035	Open	Appendix A
0337	IIP-OI 036	Open	Appendix A
0338	IIP-OI 036	Open	Appendix A
0339	IIP-OI 036	Open	Appendix A
0340	IIP-OI 036	Open	Appendix A
0341	IIP-OI 036	Open	Appendix A
0342	IIP-OI 036	Open	Appendix A
0343	IIP-OI 036	Open	Appendix A
0344	IIP-OI 036	Open	Appendix A

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0345	IIP-OI 036	Open	Appendix A
0346	IIP-OI 036	Open	Appendix A
0347	IIP-OI 036	Open	Appendix A
0348	IIP-OI 036	Open	Appendix A
0349	IIP-OI 036	Open	Appendix A
0350	IIP-OI 037	Open	Appendix A
0351	IIP-OI 037	Open	Appendix A
0352	0352	Complete	Appendix B
0353	0353	Complete	Appendix B
0354	0354	Complete	Appendix B
0355	0355	Complete	Appendix B
0356	0356	Complete	Appendix B
0357	0357	Complete	Appendix B
0358	0358	Complete	Appendix B
0359	0359	Complete	Appendix B
0360	0360	Complete	Appendix B
0361	0361	Complete	Appendix B
0362	IIP-OI 038	Open	Appendix A
0363	IIP-OI 038	Open	Appendix A
0364	IIP-OI 038	Open	Appendix A
0365	IIP-OI 038	Open	Appendix A
0366	IIP-OI 038	Open	Appendix A
0367	IIP-OI 038	Open	Appendix A
0368	IIP-OI 039	Open	Appendix A
0369	IIP-OI 039	Open	Appendix A
0370	IIP-OI 039	Open	Appendix A
0371	IIP-OI 040	Open	Appendix A
0372	IIP-OI 040	Open	Appendix A
0373	IIP-OI 041	Open	Appendix A
0374	IIP-OI 041	Open	Appendix A
0375	IIP-OI 042	Open	Appendix A
0376	IIP-OI 035	Open	Appendix A
0377	IIP-OI 035	Open	Appendix A
0378	IIP-OI 043	Open	Appendix A
0379	IIP-OI 043	Open	Appendix A
0380	IIP-OI 043	Open	Appendix A
0381	IIP-OI 043	Open	Appendix A
0382	IIP-OI 043	Open	Appendix A
0383	IIP-OI 043	Open	Appendix A
0384	IIP-OI 043	Open	Appendix A
0385	IIP-OI 043	Open	Appendix A
0386	IIP-OI 043	Open	Appendix A
0387	IIP-OI 043	Open	Appendix A
0388	IIP-OI 043	Open	Appendix A

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0389	IIP-OI 043	Open	Appendix A
0390	IIP-OI 043	Open	Appendix A
0391	IIP-OI 043	Open	Appendix A
0392	IIP-OI 043	Open	Appendix A
0393	IIP-OI 043	Open	Appendix A
0394	IIP-OI 043	Open	Appendix A
0395	IIP-OI 043	Open	Appendix A
0396	IIP-OI 043	Open	Appendix A
0397	IIP-OI 043	Open	Appendix A
0398	IIP-OI 043	Open	Appendix A
0399	IIP-OI 043	Open	Appendix A
0400	IIP-OI 043	Open	Appendix A
0401	IIP-OI 043	Open	Appendix A
0402	IIP-OI 043	Open	Appendix A
0403	IIP-OI 043	Open	Appendix A
0404	IIP-OI 043	Open	Appendix A
0405	IIP-OI 043	Open	Appendix A
0406	IIP-OI 043	Open	Appendix A
0407	IIP-OI 043	Open	Appendix A
0408	IIP-OI 043	Open	Appendix A
0409	IIP-OI 043	Open	Appendix A
0410	IIP-OI 043	Open	Appendix A
0411	IIP-OI 043	Open	Appendix A
0412	IIP-OI 043	Open	Appendix A
0413	IIP-OI 043	Open	Appendix A
0414	IIP-OI 043	Open	Appendix A
0415	IIP-OI 043	Open	Appendix A
0416	IIP-OI 043	Open	Appendix A
0417	IIP-OI 043	Open	Appendix A
0418	IIP-OI 043	Open	Appendix A
0419	IIP-OI 043	Open	Appendix A
0420	IIP-OI 043	Open	Appendix A
0421	IIP-OI 044	Open	Appendix A
0422	IIP-OI 044	Open	Appendix A
0423	IIP-OI 044	Open	Appendix A
0424	IIP-OI 044	Open	Appendix A
0425	IIP-OI 044	Open	Appendix A
0426	IIP-OI 044	Open	Appendix A
0427	IIP-OI 044	Open	Appendix A
0428	IIP-OI 044	Open	Appendix A
0429	IIP-OI 044	Open	Appendix A
0430	IIP-OI 044	Open	Appendix A
0431	IIP-OI 044	Open	Appendix A
0432	IIP-OI 044	Open	Appendix A

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0433	IIP-OI 044	Open	Appendix A
0434	IIP-OI 044	Open	Appendix A
0435	IIP-OI 044	Open	Appendix A
0436	IIP-OI 044	Open	Appendix A
0437	IIP-OI 044	Open	Appendix A
0438	IIP-OI 044	Open	Appendix A
0439	IIP-OI 044	Open	Appendix A
0440	IIP-OI 044	Open	Appendix A
0441	IIP-OI 044	Open	Appendix A
0442	IIP-OI 044	Open	Appendix A
0443	IIP-OI 044	Open	Appendix A
0444	IIP-OI 044	Open	Appendix A
0445	IIP-OI 044	Open	Appendix A
0446	IIP-OI 044	Open	Appendix A
0447	IIP-OI 044	Open	Appendix A
0448	IIP-OI 044	Open	Appendix A
0449	IIP-OI 044	Open	Appendix A
0450	IIP-OI 044	Open	Appendix A
0451	IIP-OI 044	Open	Appendix A
0452	IIP-OI 044	Open	Appendix A
0453	IIP-OI 044	Open	Appendix A
0454	IIP-OI 044	Open	Appendix A
0455	IIP-OI 044	Open	Appendix A
0456	IIP-OI 044	Open	Appendix A
0457	IIP-OI 044	Open	Appendix A
0458	IIP-OI 044	Open	Appendix A
0459	IIP-OI 045	Complete	Appendix B
0460	IIP-OI 045	Complete	Appendix B
0461	IIP-OI 045	Complete	Appendix B
0462	IIP-OI 045	Complete	Appendix B
0463	0463	Complete	Appendix B
0464	IIP-OI 036	Open	Appendix A
0465	IIP-OI 036	Open	Appendix A
0466	IIP-OI 036	Open	Appendix A
0467	IIP-OI 036	Open	Appendix A
0468	IIP-OI 036	Open	Appendix A
0469	IIP-OI 036	Open	Appendix A
0470	IIP-OI 036	Open	Appendix A
0471	IIP-OI 036	Open	Appendix A
0472	IIP-OI 037	Open	Appendix A
0473	IIP-OI 037	Open	Appendix A
0474	IIP-OI 037	Open	Appendix A
0475	IIP-OI 037	Open	Appendix A
0476	IIP-OI 046	Open	Appendix A

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
0477	0477	Complete	Appendix B
0478	0478	Complete	Appendix B
0479	0479	Complete	Appendix B
0480	0480	Complete	Appendix B
0481	0481	Complete	Appendix B
0482	0482	Complete	Appendix B
0483	0483	Complete	Appendix B
0484	0484	Complete	Appendix B
0485	0485	Complete	Appendix B
0486	0486	Complete	Appendix B
0487	0487	Complete	Appendix B
0488	0488	Complete	Appendix B
0489	0489	Complete	Appendix B
0490	0490	Complete	Appendix B
0491	0491	Complete	Appendix B
0492	IIP-OI 009	Open	Appendix A
0493	IIP-OI 009	Open	Appendix A
0494	IIP-OI 047	Complete	Appendix B
0495	0495	Complete	Appendix B
0496	0496	Complete	Appendix B
0497	IIP-OI 048	Complete	Appendix B
0498	IIP-OI 049	Open	Appendix A
0499	IIP-OI 050	Open	Appendix A
0500	IIP-OI 050	Open	Appendix A
0501	IIP-OI 050	Open	Appendix A
0502	0502	Complete	Appendix B
0503	0503	Complete	Appendix B
0504	0504	Complete	Appendix B
0505	0505	Complete	Appendix B
0506	IIP-OI 051	Open	Appendix A
0507	IIP-OI 052	Complete	Appendix B
0508	0508	Complete	Appendix B
0509	IIP-OI 053	Open	Appendix A
0510	IIP-OI 054	Open	Appendix A
0511	0511	Complete	Appendix B
0512	0512	Complete	Appendix B
0513	IIP-OI 055	Open	Appendix A
0514	IIP-OI 056	Open	Appendix A
0515	0515	Complete	Appendix B
0516	IIP-OI 057	Complete	Appendix B
0517	0517	Complete	Appendix B
0518	0518	Complete	Appendix B
New Item	IIP-OI 058	Open	Appendix A
New Item	IIP-OI 059	Open	Appendix A

IIP R000 Item Number	IIP R001 Item Number	Status	IIP Appendix or Reference
New Item	IIP-OI 060	Open	Appendix A
New Item	IIP-OI 061	Open	Appendix A
New Item	IIP-OI 062	Open	Appendix A
New Item	IIP-OI 063	Open	Appendix A
New Item	IIP-OI 064	Open	Appendix A
New Item	IIP-OI 065	Complete	Appendix B
New Item	IIP-OI 066	Open	Appendix A
New Item	IIP-OI 067	Complete	Appendix B
New Item	IIP-OI 068	Complete	Appendix B
New Item	IIP-OI 069	Open	Appendix A
New Item	IIP-OI 070	Complete	Appendix B
New Item	IIP-OI 071	Open	Appendix A
New Item	IIP-OI 072	Open	Appendix A
New Item	IIP-OI 073	Complete	Appendix B

Appendix D: Integrated Aging Management Program

Aging management practices at Darlington Nuclear Generating Station (NGS) are managed through the implementation of an integrated set of managed systems and programs. These programs ensure that aging of critical equipment is managed such that the operation of Darlington NGS remains within the licensing basis and allows for station operational goals to be met. The Integrated Aging Management (IAM) Program ensures that the condition of critical equipment is understood and that activities are in place to ensure the health of these components and systems while the plant ages. The IAM program was developed on the basis of IAEA NS-G-2.12 which is in alignment with CNSC Reg Doc 2.6.3 and there are 4 elements which ensure success of the IAM program.

Element 1: Program Direction

OPG has developed an IAM Program on the basis of IAEA NS-G-2.12 which is in alignment with CNSC Reg Doc 2.6.3. The program integrates aging management functions that reside in a number of implementing work groups such as equipment reliability, safety analysis, maintenance, supply chain and work management.

Element 2: Equipment Reliability

OPG has implemented an extensive Equipment Reliability program in place for several years based on nuclear industry best practices. The Equipment Reliability Program applies a programmatic approach to the following elements: Scoping & Identification of Components, Performance Monitoring, Corrective Action, Continuing Equipment Reliability Improvement, Long-Term Planning & Life Cycle Management and Preventive Maintenance (PM) Implementation.

For components applicable to the IIP safety goals, *Scoping & Identification of Components* is based on the 58 Safety Related Systems identified in the ISR. Components whose failure results in a full or partial impairment of a System Important to Safety (SIS) are considered critical components and they receive high priority in maintenance, inspection, monitoring and replacement activities. All other components are prioritized based on other parameters which support the nuclear power plant's generation goals.

Performance Monitoring is evaluated through the monitoring of system and component performance and a comparison to the overall performance goals. The objective is to look for trends in overall performance and put action plans in place to address any issues to maintain or improve performance. These action plans are documented and prioritized in system health reports which are communicated to station stakeholders to support the improvement of the systems' performance. Should a failure or degradation be discovered through Performance Monitoring activities, appropriate *Corrective Actions* are taken to ensure the system or component performs to its intended safety function.

Continuing Equipment Reliability Improvements occur through continuous reviews of PM activities, industry OPEX, inspection and maintenance activities of components where frequencies and scope of activities are optimized to ensure high component reliability.

Long Term Planning & Life Cycle Management is an ongoing process to create a long-term strategy which integrates long-term plans with the overall station business plan. These strategies prioritize improvement activities based on station need. These strategies are incorporated into the business plan and the appropriate system or component health reports. Most recently, Component Condition Assessments were completed which identified and evaluated degradation mechanisms to determine the extent of degradation, and identify long range asset preservation activities such as replacements of components that are required to address aging and reliability.

The objective of the *Preventive Maintenance program* is to prevent or minimize equipment breakdown and to maintain equipment in a satisfactory condition for normal or emergency use. The output results in the identification of the optimal level of PM tasks necessary to achieve a balance between equipment performance and effective resources used. This involves the specification, scheduling and execution of time-based maintenance on systems and components to ensure continued reliable operation. Condition-based and predictive based activities are also included in the integrated approach used at OPG.

Element 3: Parts Availability

Supply chain personnel work with station organizations to maintain inventories of equipment and components that support plant reliability and nuclear safety. A spare parts process is in place which defines the criteria for identifying a component as a critical spare and to develop a strategy to mitigate obsolescence issues and lengthy lead times.

Element 4: Work Management

OPG's Work Management processes are based on Nuclear Industry best practices. Specific Work Management processes are in place for the work completed during a unit outage, a Refurbishment outage, or on-power. The work management processes specify how work is prioritized based on nuclear safety implications, regulatory requirements, preservation of special safety systems or systems important to safety, and threats to electrical generation.

Appendix E: Glossary

Asset Preservation activities are activities required to ensure long term preservation of equipment to achieve the greatest financial return and service life.

Component Condition Assessment (CCA) provides:

1. An assessment of the current condition of the safety system components
2. An assessment of component life, given the status of the current programs for inspection and maintenance
3. Recommendation of actions required for the components to reach the target extended plant life.

Component Condition Assessment (CCA) Recommendations are recommendations that fall into one of the following four broad implementation activity categories:

1. Improving the condition of components through replacement, refurbishment or repair.
2. Determining the condition of components through inspection or testing, followed by remedial actions if the components are found to be aged.
3. Improving the aging management practices to mitigate the effects of future aging through an adjustment to the Preventative Maintenance Program.
4. Addressing obsolescence.

Contingency Actions are repair or replace activities resulting from inspections.

Environmental Assessment (EA) is an assessment carried out under the Canadian Environmental Assessment Act to identify whether a specific project is likely to cause significant environmental effects.

Final ISR Report is the document that summarizes the results and major findings of all the Safety Factors, the ISR Aggregate Review and the disposition of all gaps that were identified.

Global Assessment provides an overall risk judgement on the acceptability of continued plant operation based on the significant ISR results and the EA mitigation measures and follow-up program elements, including plant strengths. The Global Assessment takes into account the safety improvements to address the issues identified in the EA and the ISR and the safety improvements resulting from identified opportunities to reduce the overall plant risk. The Global Assessment also incorporates the results of the Defense-in-Depth assessment.

Global Assessment Report (GAR) summarizes the results of the Global Assessment by providing a high level summary of the ISR and EA and an overall judgement on Nuclear Safety.

Integrated Implementation Plan (IIP) is the integrated result of the EA and ISR, identifying all necessary safety improvements, proposed plant modifications, safety

upgrades, compensatory measures and improvements to operation and management programs that will apply to the project and to long term operation.

Integrated Safety Review (ISR) is a comprehensive assessment of an existing nuclear generating station in order to determine:

1. Extent to which the plant conforms to modern high-level safety goals and requirements.
2. Extent to which Licensing Basis remains valid.
3. Adequacy and effectiveness of arrangements that are in place to maintain plant safety for long-term operation.
4. Safety improvements to address gaps with respect to modern safety requirements identified during the assessment.

ISR Gap is a clause for which a safety requirement in a code or standard is not met or for which the intent of the clause is not met depending on the type of code or standard. ISR Gaps exist for:

1. PROL Codes and Standards - the review finds that the safety requirement of a clause has not been met.
2. Non-PROL Codes and Standards – the review finds that it does not meet either the safety requirement or the intent of a clause (or set of clauses).
3. Review Task - the assessment of the Review Task finds that it does not meet either the safety requirement or the intent of the Review Task.

ISR Issue is a compilation of ISR Gaps with similar scope. The categorization, prioritization and resolution of an ISR Issue shall encompass all the included ISR Gaps.

Life Extension is a set of activities for extending the safe operating life of a nuclear power plant beyond its design life. It involves the replacement or refurbishment of major components (e.g. pressure tubes) or substantial modifications to the plant, or both.

Reactor Safety 1 (RS1) is an Operational Safety Requirement (OSR) system that is also a System Important to Safety (SIS) whose failure results in a Total Loss of Redundancy (TLR) or System Unavailability impairment condition.

Reactor Safety 2 (RS2) is an OSR system that is also a SIS whose failure results in a Partial Loss of Redundancy (PLR) impairment condition, or is an OSR system that is also a non-SIS system whose failure results in a Total Loss of Redundancy or System Unavailability impairment condition.

Safety Improvements are changes to processes or plant to address the issues identified in the EA, the ISR, and the safety improvements resulting from identified opportunities to reduce the overall plant risk.

Safety Related Systems are those systems, components and structures which, by virtue of their failure to perform in accordance with the design intent, would have the potential to impact on the radiological safety of the public or plant personnel from operation of the NPP.

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AMPCO Interrogatory #33

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-2 Page 1

Preamble: DRP is a multi-phased program made up numerous individual projects of various sizes.

a) Please provide the total number of individual projects for the DRP.

b) Please provide the number of individual projects under each of the five major work bundles.

c) Please confirm the total number of prime contractors working on the DRP.

d) Please provide a table that shows the number of projects managed under each prime contractor.

Response

a) There are 501 active projects within the DRP program and for all phases and units. An active project is defined as a project with a planned value (budget) which in summation totals $12.8B.

b) The following chart provides a breakdown of the 501 projects across the five major work bundles (Items 1-5), as well as the Facility and Infrastructure and Safety Improvement projects (Item 6) and the OPG oversight organizations (Item 7):

Chart 1

Project Bundle Grouping	# of Projects
1. Retube and Feeder Replacement	17
2. Turbine Generator	27
3. Balance of Plant	234
4. Fuel handling / Defuelling	26
5. Steam Generator	23
6. F&IP/SIO	24
7. OPG Programmatic/Functional	150

Grand Total	**501**

c) There are six prime contractors working on the DRP as listed in part d).

d) The following chart shows the number of projects managed under each prime contractor:

Chart 2

Prime Contractor	**# of Projects**
Alstom	5
Black & McDonald (ESMSA)	13
BWXT/Candu Joint Venture	10
E.S. Fox (ESMSA)	90
GE-Hitachi	4
SNC/Aecon Joint Venture	31
OPG - Inspection & Maintenance Services	10
OPG - Oversight	249
OPG - In-House Projects	74
Other	15
Grand Total	**501**

AMPCO Interrogatory #34

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: EB-2013-0321 D2-2-1

Preamble: In the last application, the following DRP Plans were filed as attachments in D2-2-1:

- Program Management Plans
- Refurbishment Program Structure and Summary Management Plan
- Refurbishment Program Scope Management Plan
- Program Cost Management Plan
- Program Schedule Management Plan
- Refurbishment Program Reporting Management Plan
- Darlington Refurbishment Risk Management Plan
- Refurbishment Program Communications Management Plan
- Refurbishment Program Staffing Management Plan
- Program Documentation and Project Closure Management Plan
- DNGS Refurbishment Management Plan – Refurbishment Engineering
- Program Assurance Plan for Darlington Nuclear Refurbishment
- Program Environmental Management Plan
- Program Management System Oversight Management Plan
- Program Site Implementation and Construction Management Plan
- Program Licensing Management Plan
- Nuclear Refurbishment Program Health and Safety Management Plan
- Program Contract Management Plan
- Program Return to Service Management Plan
- Darlington Refurbishment Supply Chain Management Plan

a) Please provide a listing of any additional key management plans that exist.

b) Please provide any updates to the above plans.

c) Please summarize the key changes by plan.

d) Please provide OPG's responsibility matrix for the project.

Response

a) Management plan documents were substantially revised since EB-2013-0321 and a number of new documents were written and approved. As a result, the majority of current management plans do not correspond to the plans filed in EB-2013-0321. The following is a list of the current management plans:

- Darlington Refurbishment Program Management Plan Structure
- Darlington Refurbishment Planning and Controls Management Plan
- Darlington Refurbishment Return to Service Program Management Plan
- Darlington Refurbishment – Environmental Program Management Plan
- Darlington Refurbishment Health and Safety Program Management Plan
- Darlington Refurbishment – Chemistry Program Management Plan
- Darlington Refurbishment Licensing Management Plan
- Nuclear Refurbishment Engineering Program Management Plan
- Darlington Refurbishment – Maintenance Program Management Plan
- Darlington Refurbishment Management Systems and Performance Improvement Management Plan
- Darlington Refurbishment Program Assurance Program Management Plan Darlington Refurbishment Construction Program Management Plan
- Darlington Refurbishment Contract Management Plan
- Darlington Refurbishment Communications Program Management Plan
- Darlington Refurbishment Supply Chain Program Management Plan
- Darlington Refurbishment Staffing Management Program Management Plan
- Darlington Refurbishment – Operations Program Management Plan
- Darlington Refurbishment – Radiation Protection Program Management Plan
- Darlington Refurbishment – Training Program Management Plan
- Nuclear Refurbishment Human Performance Management Plan
- Darlington Refurbishment Program Quality Plan
- Retube and Feeder Replacement (RFR) Project Management Plan
- Defuelling Project Management Plan
- Islanding Project Management Plan
- Steam Generator Project Management Plan
- Balance of Plant Project Management Plan
- Shutdown & Layup / Services / Refurbishment Support Facilities Project Management Plan
- Turbine Generator Project Management Plan

b) Updated plans are filed in response to L-4.3-1 Staff-48, L-4.3-15 SEC-12 and L-4.3-SEC-13.

c) As expected as part of Definition Phase planning, many of the management plans were substantially revised or new ones were written. Due to this, it is not possible to summarize the key changes. However, some of the documents will contain a revision history which highlights the significant changes.

d) Please see the Darlington Refurbishment Charter D-PCH-09701-10000 (Ex. D2-2-2, Attachment 2, pp. 13 to 30).

AMPCO Interrogatory #35

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-2 Page 4 Figure 1 DRP Organizational Structure

a) Please provide the total cost for OPG's ten Functional Teams.

b) Please provide the total cost for OPG's five Dedicated Project Management Teams. Please confirm where these costs are captured in the DSP RQE.

c) For each of the Functional Teams under Program Management and Execution and Management and Support please provide the number of FTEs (Regular & Non-Regular) by key job categories for the years 2016 to 2021.

d) For each of OPG's Dedicated Project Management Teams for each of the five major work bundles (each with an OPG Project Director) please provide the total FTEs (Regular and Temporary) by key job categories for the years 2017 to 2021.

e) Please explain OPG's Resource Optimization Strategy and Plan for the DRP.

f) Please explain how OPG's Dedicated Project Teams work with the contractors who have their own support project staff including finance and other non dedicated support staff.

Response

a) Please refer to Ex. D2-2-8, Chart 3 for the total cost estimate of all 10 functions.

b) The chart below provides the OPG project management and oversight costs included in these estimates. The Darlington Refurbishment Program (DRP) Release Quality Estimate (RQE) breakdown at Ex. D2-2-8 Chart 3 includes the cost of the dedicated project management teams in rows 1-5.

Chart 1 – OPG Project Management and Oversight Costs within Major Work Bundles

Bundle (M$)	Total RQE Cost		Vendor / EPC Cost	+	Total OPG PM & Oversight	Oversight % on EAC
RFR	3,598	=	3,431	+	167	5%
TG	657	=	617	+	41	7%
BOP	967	=	784	+	183	23%
FH/ DF	198	=	149	+	49	33%
SG	123	=	110	+	13	12%
Total	**5,543**	**=**	**5,091**	**+**	**452**	9%

c) Please refer to Attachment 1 for the estimated Full Time Employee table for the Functional Teams in years 2016-2021.

d) Please refer to Attachment 1 for the estimated Full Time Employee table for OPG's dedicated Project Management Team in years 2016-2021.

e) Please refer to L-4.3-1 Staff-48, Attachment 69, for the resource plans prepared in support of the RQE.

f) The OPG refurbishment project teams work as part of a matrix model, with project management resources assigned to each major bundle and functional support from Engineering, Project Planning and Controls, and Project Assurance and Contract Management provided. Project Directors In-Training have been identified for each bundle to ensure continuity and lessons learned for subsequent units. Refurbishment project teams oversee the work being carried out by the contractors for each of their projects who require support organizations as well to be successful in their work programs.

AMPCO 035 (C)(D)

DRP Organization FTEs by year by Job Category by Representation

Includes Regular & Temporary OPG Nuclear Staff supporting DRP

Excludes: Augmented staff and support from non Nuclear OPG organizations

Divisions	Job Categories	2016	2017	2018	2019	2020	2021
RFR (Retube Feeder Replacement)	Adminstrative Support	1	1	1	1	1	1
	Business Support	1	2	2	2	2	2
	Engineering	5	8	8	8	8	7
	Operations/Maintenance	2	6	6	6	6	6
	Senior Management	3	3	3	3	3	3
	Student	1	-	-			
RFR (Retube Feeder Replacement) Total		**12**	**20**	**20**	**20**	**20**	**20**
TG (Turbine Generator)	Engineering	2	6	5	6	7	6
	Operations/Maintenance	0	1	1	0	1	0
	Senior Management	2	2	2	2	2	2
	Technical	-	1	1	0	1	1
TG (Turbine Generator) Total		**5**	**9**	**8**	**8**	**11**	**9**
BOP (Balance of Plant)	Engineering	3	5	5	5	5	5
	Senior Management	1	1	2	2	2	2
	Student	2	2	2	2	2	2
BOP (Balance of Plant) Total		**6**	**8**	**8**	**9**	**9**	**9**
DF (Defueling)	Engineering	2	2	2	2	2	2
	Operations/Maintenance	2	2	2	2	2	2
	Senior Management	-	1	1	1	1	1
	Student	1	1	1	1	1	1
DF (Defueling) Total		**4**	**6**	**6**	**6**	**6**	**6**
FH (Fuel Handling)	Business Support	1	3	3	3	3	3
	Engineering	1	3	3	3	3	3
	Operations/Maintenance	1	4	4	4	4	4
	Senior Management	3	2	2	2	2	2
FH (Fuel Handling) Total		**7**	**11**	**11**	**11**	**11**	**11**
SG (Steam Generator)	Engineering	1	2	2	1	1	1
	Operations/Maintenance	1	1	1	1	1	1
	Senior Management	2	2	2	2	2	2
SG (Steam Generator) Total		**4**	**5**	**5**	**4**	**4**	**4**
SP (Specialized Projects)	Engineering	4	4	4	4	4	4
SP (Specialized Projects) Total		**4**	**4**	**4**	**4**	**4**	**4**
SL (Shutdown Layup)	Business Support	-	1	1	1	1	1
	Engineering	1	3	3	3	3	3
	Senior Management	1	1	1	1	1	1
	Student	1	1	1	1	1	1
SL (Shutdown Layup) Total		**3**	**4**	**4**	**4**	**4**	**4**
RSF (Refub Support Facilities)	Business Support	-	1	1	1	1	1
	Engineering	2	3	3	3	3	3
	Senior Management	-	1	1	1	1	1
	Student	1	1	1	1	1	1
RSF (Refub Support Facilities) Total		**3**	**4**	**4**	**4**	**4**	**4**
IL (Unit Islanding)	Business Support	1	1	1	1	1	1
	Engineering	4	5	7	6	6	5
	Operations/Maintenance	-	-	1	1	-	-
	Senior Management	2	2	2	2	2	2
	Student	2	2	3	3	3	3
IL (Unit Islanding) Total		**10**	**11**	**13**	**12**	**12**	**11**
Functional - Contract Mgmt	Adminstrative Support	0	1	1	1	1	1
	Business Support	3	8	7	8	8	8

Divisions	Job Categories	2016	2017	2018	2019	2020	2021
	Engineering	1	1	1	1	1	1
	Senior Management	3	6	6	6	6	6
Functional - Contract Mgmt Total		**8**	**16**	**15**	**16**	**16**	**16**
Functional - Engineering	Adminstrative Support	3	4	3	3	3	3
	Engineering	97	103	102	103	94	93
	Operations/Maintenance	2	1	3	4	4	4
	Senior Management	9	9	9	9	8	8
Functional - Engineering Total		**111**	**117**	**117**	**119**	**109**	**108**
Functional - Execution OH	Adminstrative Support	2	3	3	3	3	3
	Business Support	2	5	5	4	4	3
	Engineering	5	7	7	7	5	5
	Operations/Maintenance	6	10	10	10	9	9
	Senior Management	12	19	18	18	16	16
	Technical	33	49	49	49	48	46
Functional - Execution OH Total		**61**	**93**	**92**	**91**	**85**	**82**
Functional - Nuclear Safety	Engineering	22	21	21	20	15	17
	Senior Management	2	2	2	2	2	2
Functional - Nuclear Safety Total		**24**	**23**	**23**	**22**	**17**	**19**
Functional - Work Control	Adminstrative Support	1	1	1	1	1	1
	Business Support	2	4	6	6	6	6
	Operations/Maintenance	8	14	16	16	15	17
	Senior Management	2	3	4	4	3	3
Functional - Work Control Total		**13**	**22**	**27**	**27**	**25**	**27**
Functional - Mgmt System Oversight	Adminstrative Support	1	2	2	2	2	2
	Business Support	1	1	1	1	1	1
	Senior Management	4	4	4	4	4	4
	Technical	7	8	9	8	8	8
Functional - Mgmt System Oversight Total		**13**	**15**	**16**	**15**	**15**	**15**
Functional - Planning & Controls	Adminstrative Support	1	1	1	1	1	1
	Business Support	23	20	17	16	16	16
	Engineering	2	2	2	2	2	1
	Operations/Maintenance	1	1	1	1	1	1
	Senior Management	6	6	5	5	5	4
	Technical	1	1	3	2	1	1
Functional - Planning & Controls Total		**33**	**30**	**29**	**27**	**26**	**24**
Functional - Program Support	Engineering	4	4	4	4	4	4
	Senior Management	1	1	1	1	-	-
Functional - Program Support Total		**5**	**5**	**5**	**5**	**4**	**4**
Functional - Ops & Mtce	Adminstrative Support	2	2	2	2	2	2
	Business Support	1	14	14	14	14	14
	Engineering	4	5	5	5	3	3
	Operations/Maintenance	147	278	285	296	315	397
	Senior Management	7	10	10	11	10	10
	Technical	18	28	28	26	21	26
Functional - Ops & Mtce Total		**177**	**336**	**343**	**353**	**365**	**452**
Grand Total		**501**	**740**	**752**	**758**	**747**	**828**

AMPCO Interrogatory #36

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Ref: Exhibit D2-2-2 Page 5

Preamble: The evidence indicates that the project management teams are appropriately supported by Owner Support Services (AMEC NSS and Worley Parsons Canada), which provide engineering, project management, and functional support, and a Project Planning and Controls contractor (Faith and Gould), which provides project controls and contract management functional support.

a) Please explain how each of OPG's Dedicated Project Management Teams are supported by each of the above Owner Support Services and provide a breakdown of the costs of each service provided to each team.

b) Please explain how OPG manages any duplication of services between its teams and the Owner Support Services Teams (OSST). Is there any overlap between OSSTs? If so, please define.

Response

a) OPG's dedicated project teams are resourced in accordance with NK38-PLAN-09701-10001-0016-R003. In accordance with the plan, specialized resources are made available as required to support the projects and the functional groups via Owner Support Services contracts. The support offered by these contracts is normally for specialized services, tasks and urgent work that is required in order to maintain project milestones and deliverables.

Refer to Ex. L-4.3-15 SEC-10 for general scope of OSS services.

Below is a table of the cost-breakdown of the OSS services for each of the two OSS contractors.

AMEC

($M)	2012	2013	2014	2015	2016 (YTD)
RFR	0.6	5.7	11.2	11.2	9.0
TG	0	0	0.7	0.3	0.01
SG	0	0	0	0	0
Defuel/FH	0.2	0.3	0.2	0.2	0.2
BOP	1.5	6.7	4.1	4.5	1.6
Engineering	1.8	14.9	11.2	2.6	2.3
Operations & Mtce	0.2	0.3	0.4	0.1	0.1
Execution Programs	0	0	0	1.1	1.1

Worley Parsons

($M)	2012	2013	2014	2015	2016 (YTD)
RFR	0	0	0	0.2	0.1
TG	0.2	0	0.2	0.4	0.8
SG	0	0	0	0	0
Defuel/FH	0	0	0	0	0
BOP	1.3	4.4	3.1	1.7	0.1
Engineering	0.7	5.0	3.2	0.3	0.2
Operations & Mtce	0.2	1.3	4.8	6.0	3.3
Execution Programs	0	0	0	0.5	0.9

b) The OSS contractors are used for distinct pieces of specialized work in support of OPG teams as required and determined by OPG teams thereby preventing overlap.

The OSS contractors (AMEC and Worley Parsons) provide technical services such as engineering, operations and maintenance, nuclear project management.

Faithful and Gould provides project planning and controls support in areas such as planning and controls, estimating, contract management, construction expertise (non-nuclear), risk management and project management strategies.

AMPCO Interrogatory #37

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-2 Page 4

Please complete the following Table for Unit 2.

OPG Functional Teams	Payroll $	Non-Payroll $
Engineering		
Nuclear Safety		
Planning and Control		
Managed System Oversight		
Contract Management		
Program Fees and Other Support		
Supply Chain		
Project Execution Support		
Work Control		
Operations and Maintenance		

Response

OPG interprets the table column "Payroll $" to include OPG regular and temporary staff costs. Furthermore, OPG interprets "Non-Payroll $" as all other costs not included in "Payroll $".

The following chart provides the OPG functional team cost breakdown for Unit 2, excluding interest and expressed in $ millions. These costs are included in the overall $4.8B Unit 2 in-

service addition as noted in the Ex. D2-2-8, p. 9, Chart 4. Note that Unit 2 costs commence in 2016.

Chart 1

OPG Functional Teams	OPG Labour $	Non-labour $
Project Execution	68	70
Contract Management	11	6
Engineering	44	8
Managed System Oversight	10	2
Planning & Controls	22	17
Nuclear Safety	9	10
Program Fees & Other Support	17	76
Supply Chain	13	19
Work Control	16	7
Operations & Maintenance	173	43
Total	**383**	**258**

AMPCO Interrogatory #38

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-2 Page 4

Please complete the following Table for Unit 2.

OPG Dedicated Project Management Teams	Payroll $	Non-Payroll $
Retube and Feeder Replacement		
Turbine Generator		
Defueling and Fuel Handling		
Steam Generator		
Balance of Plant		

Response

Similar to L-4.3-2 AMPCO-37, OPG interprets the chart column "Payroll $" to include OPG regular and temporary staff costs, and "Non-Payroll $" as all other costs not included in "Payroll $".

Chart 1 provides the OPG Major Bundles Oversight breakdown for Unit 2, excluding interest, and expressed in $M. These costs are included in the overall $4.8B Unit 2 in-service addition as noted in the Ex. D2-2-8, p. 9, Chart 4. Note that Unit 2 costs commence in 2016.

Chart 1

Major Bundles	OPG Labour ($M)	Non-Labour ($M)
Retube and Feeder Replacement	12	19
Turbine Generator	6	6
Balance of Plant	15	25
Fuel Handling/Defueling	10	4
Steam Generator	2	0
Total	**45**	**55**

AMPCO Interrogatory #39

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-2 Attachment 2 Page 8

a) Please confirm which DRP Management Plans shown on Page 8 have not been filed in evidence.

Response

a) OPG filed the Darlington Refurbishment Charter (Ex. D2-2-2, Attachment 2, pp. 13-30) and the Darlington Refurbishment Program Structure (Ex. D2-2-2, Attachment 2, pp. 2-12) with its pre-filed evidence.

All other documents listed on Ex. D2-2-2, Attachment 2 can now be found as attachments to Ex. L-4.3-1 Staff-48, including a revision of the Darlington Refurbishment Program Structure (now referred to as the Darlington Refurbishment Program Management Plan Structure (Ex. L-4.3-1 Staff-048, Attachment 55)).

AMPCO Interrogatory #40

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-3 Page 4 Chart 2

a) For the RFR Work Bundle, please provide the contract value for each of the Target Price, Fixed Price and Cost + Mark-up contracts.

b) For each of the work bundle contractors shown in column 1, please provide a summary of the contractor's relevant past experience.

c) For each of the work bundle contractors and corresponding pricing models shown, please indicate which contracts include a contractor contingency.

d) For each of the work bundle contractors and corresponding pricing models with a contractor contingency, please provide the confidence levels that correspond to the contractor contingencies.

e) Please confirm the costs shown under Value of the Contract do not include any OPG costs.

f) For each contractor contract, please explain how OPG has assigned risks to the party that is best able to manage the risk and mitigate its impact on the DRP.

Response

a) Please see Ex. D2-2-3, p. 10, Chart 3 for a breakdown of the Retube and Feeder Replacement (RFR) Contract. The target price component is $2,417.5M, the fixed price component is $413M and the cost + mark-up component is $627M. There is also $6M of non-target, reimbursable work/costs.

b) Please see below:

- **Retube and Feeder Replacement** – SNC Lavalin purchased AECL in 2011, where AECL is the Original Equipment Manufacturer (OEM) for CANDU reactors. Both partners in the SNC/AECON Joint Venture have extensive experience in the nuclear industry. Since 1966, SNC-Lavalin has participated in 15 nuclear new build projects and 7 nuclear refurbishment projects. In the last 10 years Aecon has participated in

many nuclear projects at Pickering, Darlington and Bruce Nuclear Generation Stations.

- **Turbine Generator** – Alstom is the Turbine Generator OEM. Alstom is capable of manufacturing and replacing compatible turbine generator hardware within a reasonable timeframe, and compatible interfacing of the control systems and generator excitation with the turbine generator hydraulics is paramount. Alstom has also provided technical and maintenance support to Darlington since the station has been in-service since the late 1980s to early 1990s.

- **Defueling** – GE Hitachi is the OEM for the fuelling machines in the Darlington units and has completed this type of work at Bruce Power. GE has also provided technical and maintenance support to Darlington since commissioning of the station. The fuelling machines in the Darlington units and in the Bruce units are similar in that they operate within a fuelling duct on a trolley-based system which allows one fuelling machine to service more than one unit.

- **Fuel Handling** – ES Fox was awarded the Extended Services Master Services Agreement in February 2012 and has been installing and replacing components at Darlington Nuclear Generating Station and Pickering Nuclear Generating Station ever since, and is very experienced at doing work at OPG. While this specific fuel handling work related to power-track replacement will be first of a kind due to the magnitude of the replacement, OPG maintenance has been performing these tasks on a smaller scale for a number of years and will transfer its experience to ES Fox and ensure that staff with appropriate experience doing this work is performing oversight of the ES Fox team.

- **Steam Generators** – BWXT and Candu Energy have done this type of maintenance work before at OPG and Bruce Power. BWXT has installed over 200 access ports worldwide and has unique operational experience (OPEX) with critical pressure boundary modification. BWXT and Candu Energy have an exemplary history of performing Steam Generators maintenance services such as Water lancing (BWXT) and Primary Side Clean (Candu) around the world and also for Candu units.

- **Balance of Plant** – See above in the Fuel Handling bundle about ES Fox's past experience working at OPG.

c) All primary contracts except time and material include contractor contingency.

d) Of the major contracts, only the Retube and Feeder Replacement (RFR) and Turbine Generators Engineering, Procurement, and Construction (EPC) agreements have pricing models which include an explicitly identified contractor contingency calculation which is used in development of the Execution Phase Target Cost.

As part of the negotiations process, OPG and the contractor agreed on a P50 confidence level for contingency in the Execution Phase Target Cost developed during the Definition Phase.

At the time these contracts were executed, the planning and scope of work for the Execution Phase was not sufficiently developed to allow the contractor to commit to an Execution Phase Target Cost. Part of the Definition Phase work therefore, was to complete this planning process in order to allow the contractor to commit to a cost and schedule. OPG and the contractor agreed upon the process for developing the Execution Phase Target Cost in order to avoid OPG negotiating the Execution Phase Target Cost at the end of the Definition Phase essentially on a sole source basis, which would reduce OPG's negotiation leverage. This process is summarized in Exhibit 3.5 of the RFR Agreement at Ex. D2-2-3 Attachment 6 and Schedule 2.7 (d) of the Turbine Generators EPC Agreement at Ex. D2-2-3 Attachment 8, which describes the rule set for agreeing on the Execution Phase Target Cost breakdown. This includes use of a P50 confidence level.

e) Confirmed. No OPG costs are included in the Value of Contracts column of Ex. D2-2-3 p. 4, Chart 2.

f) OPG developed contracting strategies for each major work bundle where the contracting strategy recommended a specific pricing model based on OPG's experience and judgement. The choice of pricing model for each contract takes into account the appropriate allocation of risks between OPG and the contractor. Please see Ex. D2-2-3, pp. 7 to 22, which describes the contracting process for each of the major work bundles and L-4.3-15 SEC-31 for the contracting strategies for each respective work bundle.

AMPCO Interrogatory #41

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-3 Page 6 Figure 2

a) Please provide the $ values that correspond to the % shown for each pricing model.

Response

a) The RQE dollar values that correspond to the chart shown in Exhibit D2-2-3, p. 6 Figure 2 are as follows:

- Target Price $2.6B
- Fixed Price $0.9B
- Cost plus Markup $1.6B

For the purposes of this Ex. D2-2-3, Figure 2, the Extended Services Master Services Agreements (ESMSA) have been included in the "Cost plus Markup" category. The ESMSAs have elements of both cost plus markup and target pricing.

AMPCO Interrogatory #42

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-3 Page 10 Figure 3

a) For the Target Schedule, please confirm the neutral band represents 10%.

b) Please explain why there is no neutral band for less than the target schedule.

Response

a) Confirmed. As noted in part b) below, the neutral band only applies to completion longer than Target Schedule.

b) The reason there is no neutral band for less than the Target Schedule is that OPG wanted to provide incentive for the contractor to strive to achieve better than the prescribed Target Schedule. This incentive structure emphasizes the value of completing the work ahead of the Target Schedule, even by a small number of days. Early completion would provide an opportunity to return a unit to service earlier than planned, and reduce direct project costs as well as carrying costs.

AMPCO Interrogatory #43

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-3 Page 10 Chart 3

a) Please confirm the costs provided in Chart 3 do not include any OPG costs.

Response

a) The costs provided in Ex. D2-2-3, Chart 3, p. 10, do not include any OPG costs. The costs are all Retube and Feeder Replacement contract costs.

AMPCO Interrogatory #44

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-3 Attachment 1 Page 2

Preamble: The Summary of EPC Contract for RFR with SNC/Aecon JV states that the contractor and OPG developed an execution phase plan that included a cost estimate, schedules and a risk register for the execution phase. The evidence states "The cost and schedule estimates developed by the contractor were subject to a P50 analysis and the P50 analysis was the basis for establishing the target cost and target schedule under the agreement".

a) Please provide the risk register.

b) Please explain why a P50 analysis was selected.

c) Were higher confidence levels tested? If yes, please provide the results. If not, why not?

d) Please explain how the contractor's fixed fee was calculated based on the target cost.

Response

a) Please see Ex. D2-2-3 Attachment 6, the Retube and Feeder Replacement (RFR) contract; the risk register used for the purposes of developing the execution phase plan is Exhibit 3.5(g) to the contract.

b) P50 means that, all other things being equal, there is an equal probability of the final result being better than or worse than the calculated outcome. It would not be appropriate, when negotiating a contract, for either party to aim for higher than P50, as that would imply that one party was attempting to achieve greater certainty at the expense of the other party taking on more risks. P50 is also a standard analysis based on AACE International Recommended Practice No. 18R-97. A P50 analysis was established by OPG prior to the RFP process and agreed to by the contractor during the RFR negotiations.

c) Yes, higher confidence levels were tested, particularly for schedule confidence. The results, as expected, were that the target price would have increased, as higher confidence would have required the contractor to take accountability for a greater number

of risks, some of which they were not in the best position to manage. Please see Attachment 1, Darlington RFR Class II Estimate Monte Carlo Model Report, for more information.

d) Please see Attachment 1, Appendix I.

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Report

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Document Number: NK38-REP-09701-10320	Usage Classification: N/A
Sheet Number: N/A	Revision: R000

Title:

DARLINGTON RFR CLASS II ESTIMATE MONTE CARLO MODEL REPORT

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Darlington RFR Class II Estimate
Monte Carlo Model Report

NK38-REP-09701-10320-R000
2015-10-02

Order Number: N/A
Other Reference Number:

OPG Confidential

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Revision Summary

Revision Number	Date	Comments
R000	2015-10-02	Initial issue.

Records Table

The following Records may be generated by use of this document and shall be registered in the appropriate document management system in accordance with the following table:

Record Created	Associated Form or Template Number	QA Record? Y/N	Filing Information/Retention (AIMS Type/Sub-Type)

Executive Summary

As part of the Darlington RFR Class II estimate, the SLN-AECON Joint Venture (JV) is developing the Execution Phase base schedule estimate, cost estimate and risk register. OPG is developing the contingency duration and cost in a Monte Carlo Model using an integrated cost and schedule approach. In parallel with the OPG Monte Carlo Model, a similar model has been developed by JV. OPG contingency model is based on Section 3.5 of the RFR contract to determine the cost and schedule contingency amounts.

This report describes the contingency development work done by OPG. Model Inputs, Processing and Outputs are described and analyzed. The Monte Carlo Model calculations are performed using a Monte Carlo simulation method and Oracle's Primavera Risk Analysis software tool.

Model inputs consist of uncertainties and risks associated with project cost and schedule. The inputs were developed as part of the RFR Class II Estimate JV/OPG collaborative process by JV and OPG subject matter experts. Cost and Schedule uncertainty ranges are input to the model as 3-point estimates and risks are entered with probability and consequence values which are used in the Monte Carlo simulation to calculate project contingency at a P50 level. Identified schedule risks are separated into global risks, which affect multiple tasks or the entire unit, and mapped risks, which are linked to specific tasks.

The final P50 model results for cost and schedule are presented in the following table:

	Base ($M)	Rework ($M)	Contingency (adj.) ($M)	Execution Phase Target Cost ($M)	Fixed Fee ($M)	Target Cost + Fixed Fee* ($M)	Contingency Duration [Days]
Unit 2	[redacted]						
Unit 3							
Unit 1							
Unit 4							

Note: * Escalation not included.

The Cost Contingency has an adjustment of the Schedule Driven Rework Cost per individual unit, as results of the Rework Schedule Risks (A La Carte Rework Risks).

There are several project factors which result in reduced calculated contingency values. These include:

- Significant front-end planning completed in the definition phase
- Contractual arrangements for internal JV and OPG risks not included in the risk model
- Contract allowances for rework, spot OT and cost escalation not included in the risk model

1.0 INTRODUCTION

The RFR contractor, SNC-LAVALIN NUCLEAR INC. and AECON CONSTRUCTION GROUP INC. acting jointly and doing business as a contractual joint venture known as the "SLN-AECON Joint Venture" (JV), is responsible for the development of an AACE standard Class II estimate for the execution of RFR work during the Darlington nuclear generating station (DNGS) refurbishment.

Exhibit 3.5 Section 16 of the Agreement between JV and OPG specifies that the schedule contingency amount (in durations) will be developed in a Monte Carlo model that will be managed by OPG's authorized representative or an independent third party, and the output will be reviewed and agreed by JV and OPG to establish the required contingency for a 50% confidence level in achieving completion of the work within the relevant Execution Phase Schedule.

Exhibit 3.5 Section 17 of the Agreement between JV and OPG also specifies that the cost contingency amount (in dollar values) will be developed in a Monte Carlo model that will be managed by OPG's authorized representative or an independent third party, and the output will be reviewed and agreed by JV and OPG to establish the required contingency for a 50% confidence level in achieving completion of the work within the relevant Execution Phase Cost Estimate.

OPG has developed a Monte Carlo Model with Primavera Risk Analysis software which uses an integrated cost and schedule approach to determine the required contingency for schedule and the required contingency for cost. See 3.0 below.

In parallel with OPG, JV has developed the JV Risk Models as a reference for comparison purpose. The JV Risk Model is using Acumen Risk and @Risk software applications to develop the schedule risk model and the cost risk model respectively, according to JV's Risk Management Plan [5].

Both JV Risk Models and OPG Monte Carlo Model are following Exhibit 3.5 to determine the cost and schedule contingency amounts using a Monte Carlo sampling method.

2.0 SCOPE

The scope of this report is to describe the Inputs, Processing and Outputs of the OPG Monte Carlo Model (hereinafter Monte Carlo Model). Results are presented for cost and schedule, including probabilistic cash flow. These results are then analyzed and compared to other relevant projects.

3.0 SOFTWARE

Oracle's Primavera Risk Analysis software (previously known as Pertmaster) is a tool that helps model risks and performs analysis of cost and schedule impacts. By

integrating directly with project schedules as well as cost estimates to model risks and uncertainty, Primavera Risk Analysis (PRA) provides a full-lifecycle cost and schedule risk analytics solution. With the integrated cost and schedule approach such as PRA software, one model can be built to provide the schedule contingency and cost contingency simultaneously in one analysis based on the project schedule loaded with costed resources from the cost estimate.

The software version used for the Darlington RFR Class II Estimate is Oracle Primavera Risk Analysis Version 8.7.0056.

4.0 INPUTS

This section outlines the required inputs to the Monte Carlo Model, which has 4 separate models, one for each Reactor Unit at Darlington. For clarity, the entire model is referred to as the “Monte Carlo Model” and the individual models for the 4 separate units are referred to as the “risk models”.

Data on the following general parameters are input to the risk models:

- Cost Uncertainties
- Cost Risks
- Schedule Uncertainties
- Schedule Risks – Mapped
- Schedule Risks – Global

Inputs to the risk models were developed in risk workshops as per JV’s Risk Management Plan [5]. These risk workshops included holistic risk analysis workshops, which carried out qualitative risk analysis, and schedule risk analysis workshops and cost risk analysis workshops which carried out quantitative risk analysis, as per Exhibit 3.5.

As part of the RFR Class II Estimate JV/OPG collaborative process documented in Reference [1], JV and OPG SMEs reviewed risks and uncertainties and signed off the list of risks with quantification inputs of the risks. The list of risks and the quantification inputs were further reviewed and approved by JV/OPG management. This section outlines the methodology followed for the Monte Carlo Model, inputs and the source of the input data for uncertainties and risks associated with the cost and schedule.

4.1 Cost

This section describes the cost inputs to the Monte Carlo Model, as listed below:

a) Base Cost Items – Include Direct and Indirect Costs from the Class II Execution Phase Estimate. With Direct and Indirect Costs, the entire Estimate Base for each unit will be included in each risk model.

i. Direct Cost – Includes DFL (1.1) and Commissioning – part of target cost (1.8) as per the Cost Summary Table (Table 7) of the Class II Milestone Report [2]. Direct cost is captured in Series Summary Tasks (such as PT Removal and Lower Feeder Installation) in the Base Risk Schedule, such that all direct cost for each unit is included in each risk model.

ii. Indirect Cost – Includes Subcontractor Work, Training and PMT (all items in 1, 2 and 3, except 1.1) as per the Cost Summary Table (Table 7) of the Class II Milestone Report [2]. All Indirect Cost Items for each unit will be included in each risk model.

b) Cost Uncertainty Ranges – Represented by triangular distributions assessed by JV and OPG SMEs. Inputs to the risk models are 3-point cost estimates. These 3-point estimates are documented in Appendix A of the Risk Report [3].

The cost uncertainties were entered through the “resource dialog box” in PRA. For example, labour costs for Waste Processing (being part of 1.1 DFL as per the Cost Summary Table (Table 7) of the Class II Milestone Report [2]) are entered as triangular distribution with a range of [0%, 12%] for best case and worst case ranges, that is $100 as minimum, $100 as most likely, and $112 as maximum when we have the rate of $100 / hour applied. See Appendix A: List of Cost Uncertainties.

c) Cost Risk Consequence and Probability – Documented in Appendix A of the Risk Report [3], consequence values are inputs to the risk models as Uniform Distribution Ranges with each range composed of a set of a minimum value and a maximum value. Probability values are input into the risk model as Single Point Estimates, taking the average of each set of a minimum value and a Maximum value.

The cost risks were entered into the Risk Register in PRA and each of the cost risks is mapped to an Indirect Cost Item of long duration to incorporate the impacts to the entire project and spread the impacts on cash flow. Note that this mapped item cannot be a hammock task as the current version of PRA does not allow hammock tasks to have risks mapped. This arrangement supports (1) cost impacts on the risk model and (2) probabilistic cash flow. For example, Cost Risk #1.9 is mapped to DFL – Onboarding Training with a single percentage (25%) for probability and a Uniform distribution for a minimum of $0 and a maximum of $3M in Unit 3. See Appendix B: List of Cost Risks.

4.2 Schedule

This section describes the schedule inputs to the Monte Carlo Model, as listed below:

a) Base Risk Schedule – Derived from P6 Level 5 Schedule. Base Duration for Critical and Non-Critical Path follows the P6 Level 5 Schedule [4], but the tasks are rolled up to a CWP, or equivalent level. The Best Case duration from Class II estimate is taken as the Base Duration, which is the deterministic duration in the Monte Carlo Model.

b) Schedule Uncertainty Ranges – Represented by triangular distributions assessed by JV and OPG SMEs and Input to the risk models as 3-point duration estimates. The 3-point estimates are documented in CWP Basis Sheets [4] for Unit 2 and Appendix A of the Risk Report [3] for Subsequent Units.

c) Mapped Risk Consequence and Probability – Mapped Risks as captured in the CWP Basis Sheets that are risks mapped/"linked" to specific CWP level tasks.

   Mapped Risks are assessed by JV and OPG SMEs with consequence values and probabilities for the first unit initially and documented in Appendix A of the Risk Report [3].

   Consequence values are input into the risk models as Uniform Distribution functions with a minimum value and a maximum value, as documented in Appendix A of the Risk Report [3].

   As PRA only allows integers for risk probabilities, an average of the two probabilities (minimum and maximum of the uniform distribution functions) of each Mapped Risk, as per Basis Sheets, is rounded to an integer for input to the risk models.

   The probabilities for Subsequent Units are assessed per each individual unit, and maintained either the same percentage as the first unit (100%), reduced from the first unit (for example, 80%) or eliminated (0%) as per the Sign-off Risk Sheet documented in Appendix A of the Risk Report [3].

   For the list of Mapped Risks and CWP task mapping, see Appendix C: Mapped Risks.

d) Global Risk Consequence and Probability – Global Risks are risks applicable to multiple tasks, or to the entire unit.

   Global Risks are assessed by JV and OPG SMEs with consequence values and probabilities for the first unit initially and documented in Appendix A of the Risk Report [3].

   Consequence values are input into the risk models as Uniform Distribution Functions with each a set of a minimum value and a maximum value, as per documented in Appendix A of the Risk Report [3]. To simplify the risk models, the global risks are each mapped in the risk models to the most

applicable Series Work critical path summary task to represent the impacts for the entire unit.

As PRA only allows integers for risk probabilities, an average of the two probabilities (minimum and maximum of the Uniform distribution functions) of each Global Risk, is rounded to an integer before entering the risk models.

The probabilities for Subsequent units are assessed per each individual unit, and recorded as either factors of the first unit (i.e. 80%), the expected values (i.e. 2 days), or the individual probabilities (i.e. 20-40%) for the units.

As PRA only allows a single point value for risk probability, the average of the two probabilities (minimum and maximum of the Uniform distribution functions) of each Global Risk is rounded to integer before entering the risk model.

Risk #4.118 Calandria Seal Leak Test Failure is an exception that the risk is only applicable to Unit 3 (the second unit), and, hence, there is no such a risk for Unit 2 (the first unit).

For the list of Global Risks mapped to Critical Path Summary tasks, see Appendix D: Global Risks.

5.0 PROCESSING

The cost loaded Level 5 P6 Schedule from the JV was rolled up to be the Base Risk Schedule, which is a P6 XER format file. Based on the Base Risk Schedule, Summary Tasks were created for series Critical Path work and Non-Critical Path work to form four (4) P6 XER format files for 4 units.

These Summary Tasks which represent CWP Series Work (such as Pre-Requirements Prior to Containment Isolation, Feeder Removal, Calandria Tube Installation, Post-Requirements After Containment Isolation) are created in the risk models to roll up the costs and resource loading of activities. The cost and resource elements of the Summary Tasks enable the risk models to capture the effects on cost due to the change in the durations (risks and uncertainties) of the activities inside the Summary Tasks supported by time dependent resources, and to compute the probabilistic cash flow. Of course, the cost uncertainty also is an element to affect the cost in the risk models. In general, the Summary Tasks are divided into Critical Path Work and Non-Critical Path Work for the Series such as Pre-Requirements prior to Containment Isolation, to enable processing of risks on Critical Path such as Global Risks.

Indirect Cost items are represented in the P6 XER file as hammock tasks or normal tasks, depending on JV and OPG SMEs' common views on whether they are dependent on critical path contingency or not respectively. For SME input on critical path contingency dependency, see Appendix E: Critical Path Contingency

Dependency. Mapping for indirect and direct cost items that are schedule dependent is summarized in 0 Model Buildup.

The Risk Analysis parameters of PRA are using Latin Hypercube Sampling with the Random Number Generator seed set to 1 for speed and consistency. The Monte Carlo simulations are initially run for 500 iterations to gather consistent results. For Probabilistic Cash Flow results and final results, the Monte Carlo simulation is run for 3,000 iterations.

5.1 Schedule and Cost Relationship

Schedule is determined by the following in the risk models:

- Deterministic schedule duration values are entered.
- Deterministic values are overridden by Range Uncertainty, if applicable. Based on a random number generated in each iteration of the Monte Carlo simulation, a value within the alignment of the Range will be chosen to override the Deterministic value to be the schedule duration for that iteration.
- The duration is further imposed on by the Schedule Risks (both Global and Mapped Risks) and impacts applied in series (all risk impacts are incremental). The occurrence of each risk is determined first for each iteration by its probability of occurrence – Yes or No. If it is determined to occur (Yes), impact is established based on a random number generated in the current iteration of the Monte Carlo simulation within the alignment of the Range of the Risk Impact. If it is determined not to occur, the risk is not applied for the current iteration.
- If parallel paths are involved, a critical path will be determined from the longest path for each iteration. The critical path may be different for each iteration.
- The Summary task schedule in each iteration is determined by the individual durations of tasks inside each Summary task. Hammock task schedule in each iteration is determined by the Start Date of the Start-to-Start Predecessor task to the Finish Date of the Finish-to-Finish Successor task.

Cost is determined by the following:

- In each iteration, each Summary Task that carries costs will calculate its cost based on the duration established by the schedule (a combination of all tasks within the Summary Task) and the rate and loading of the resources assigned to the task, together with the resource rate (with applicable cost uncertainty).
- Hammock tasks can carry costs (level of effort) which will be determined via the links with the critical path tasks/milestones. The Indirect Cost Items that are dependent on critical path durations, such as PMT Site Labour (Item 3.1

as per the Cost Summary Table (Table 7) of the Class II Milestone Report [2]), are using Hammock tasks to link with the critical path tasks/milestones.

5.2 Rounding of Schedule Input Data

Rounding of Import

When the risk model is built for each unit, the Risk Schedule is imported into PRA in P6 XER format. This import process can be done in three choices of units for planned duration (Day, Hour, or Quarter Hour). Though the uncertainty and risk are estimated in days, it has been found that the planned duration unit must be hours in order to synchronize PRA data with other software such as Acumen used by the JV. Before August 31, 2015, the Monte Carlo Model was using “Day” as the unit for planning duration. A duration unit of hours has been used since August 31, 2015. This requires the Risk Register import and export to be in Hours, instead of Days.

Rounding of Data Entries

Even though the import and export file format allows for 2 decimal places, PRA only accepts the integer-valued part of the input values. Therefore, the risk probability (cost risk, global risk and mapped risk) are rounded to integers before entering into PRA. The schedule uncertainty 3-point estimates are rounded to 3 integers before entering them into PRA.

5.3 Rate of Labour and Rate of Expenses

For the Probabilistic Cash Flow to be collected and reported for OPG programmatic reporting, all cost elements are set to a standard rate of $100 per hour. The base budget of each normal task/summary task/hammock task is determined by the Class 2 Estimate and rolled up, if applicable. The set standard rate of $100 per hour means the loading of resources will be calculated by the PRA software to meet budget and duration of the rolled up of the P6 Level 5 schedule. This setup will not distort the calculation in P50 or other cost results.

A calculation is as follows:

$$Budget\ at\ Completion\ (from\ Class\ 2)$$
$$= Remaining\ Cost\ at\ the\ beginning\ of\ the\ Project\ (from\ Class\ 2)$$
$$= Duration\ (P6\ Schedule) x\ Units\ per\ period\ (the\ only\ variable\ that\ is\ tuned) x\ Rate\ (\$100\ /\ unit).$$

For example:

A task needs 50 days to complete with a deterministic budget of $4.8Million.

For rate of $100 / unit,

Units per period = $4,800,000 / $100 / 50 /24 = 40 resource units / hour

For rate of $80 / unit,

Units per period = $4,800,000 / $80 / 50 /24 = 50 resource units / hour

This arrangement of setting the rate arbitrarily may be different from other plans, but effectively there is no material change from other arrangements for the Monte Carlo perspectives, but it provides an efficient way to input the cost uncertainties and to collect and report Probabilistic Cash Flow by OPG requirements. The reason is that the risk models are focusing on Overall Schedule and Overall Cost of each unit.

In general, Indirect Cost Items in the risk models are considered to be “normal” loading (the total units of resources for the task increases with the task duration), or “spread” loading (the total units of resources is independent of the task duration). Cost Items which require “front” loading or “back” loading, such as OSM and Goods, are not included in the risk models. This means the cash flow is spread evenly within the duration assigned. As there is no particular requirement to distinguish Labour cost items and Expense cost items, all Indirect Cost Items are coded as Labour cost items in the risk models for the efficiency in entering input values and reporting Probabilistic Cash Flow.

5.4 Elimination of Double Counting

The entire Monte Carlo Model focuses on elimination of double counting:

- SMEs scrub – Basis Sheets and Risk Sheets are reviewed multiple times to ensure no double counting from JV/OPG SMEs
- Risk Register Reviews by JV and OPG management
- 3% Rework cost allowance will be reduced by the schedule driven Rework Risk cost amounts, using the method outlined in Section 7.5
- JV Risk Register has been synchronized with OPG Risk Register multiple times to avoid double counting of duplicate risks

6.0 OUTPUTS

Following Monte Carlo Model processing, this section presents the outputs of the risk models on cost, schedule and probabilistic cash flow.

6.1 Cost

The final cost summary for each Unit is shown in Table 1. The Deterministic Best Case (Base Cost) is shown for each unit along with the P50 Cost. 3% Rework is not included in P50 Cost, as 3% Rework is not included in Monte Carlo Model. For histogram summaries of all Monte Carlo simulations for each unit, see Appendix H: Simulation Histograms and S-Curves.

Table 1 – Cost Summary

	Deterministic Best Case (Base) [$ Millions]	P50 Cost [$ Millions]
Unit 2	[redacted]	
Unit 3		
Unit 1		
Unit 4		
Total		

The following table shows a comparison of the Indirect and Direct cost portions of the P50 Cost.

Table 2 - Indirect Cost and Direct Cost

	P50 Indirect Cost [$ Millions]	P50 Direct Cost [$ Millions]
Unit 2	[redacted]	
Unit 3		
Unit 1		
Unit 4		

6.2 Schedule

The final schedule duration summary for each unit is shown in Table 3. The Deterministic Best Case (Base Duration) is shown for each unit along with the P50 Schedule Duration. The P50 Contingency component is further broken down into Uncertainty and Risk components. For histogram summaries of all Monte Carlo simulations for each unit, see Appendix H: Simulation Histograms and S-Curves.

Table 3 - Schedule Summary

	Deterministic Best Case (Base) [Days]	P50 Target Schedule [Days]
Unit 2	[redacted]	
Unit 3		
Unit 1[1]		
Unit 4		

6.3 Cash Flow

As the project has uncertainty (and risks), there will be uncertainty about when money is spent and earned. Monthly Probabilistic Cash Flow is turned on in the PRA to record the cash flow for each iteration. The probabilistic cash flow data can then be extracted for further processing in OPG NR Program.

For the probabilistic cash flow (S-curves) for each unit, see Appendix H: Simulation Histograms and S-Curves.

7.0 RESULTS ANALYSIS

This section provides an analysis and discussion of the Monte Carlo Model outputs.

7.1 Probabilistic P50 vs Deterministic

The P50/Deterministic ratio is calculated to help understand the Monte Carlo Model output and provide justification to support the model results. The overall ratio of P50 schedule duration to most likely duration is shown in Table 4 to be approximately 11%.

Table 4 - P50/Deterministic for all Units

	Unit 2	Unit 3	Unit 1	Unit 4	Average
Deterministic Duration	[redacted]				
Most Likely Duration					
P50/Deterministic					
P50/Most Likely					

The following points should be noted when considering the above P50 Ratios:

[1] Unit 1 Deterministic Best Case has been adjusted by 1 day to align with August 31 submission.

- RFR Project is an EPC agreement with 3.5 years of Definition Phase to prepare for the Execution Phase. Measures and arrangements are planned to provide JV control such as Tools that are designed and delivered by JV, same team of experts from Definition Phase to Execution Phase, sourcing of reactor materials and components part of JV scope, and subcontracting part of JV scope. All these arrangements give JV the maximal control and independence in the Execution Phase.

- Significant front-end work has been completed in the Definition Phase. Mock up and Tool Performance Guarantee (TPG) are part of the Definition Phase work, with $1B spent. These efforts have helped reduce project risk and uncertainty.

- The contract has incorporated allowances such as Rework, Spot OT and Cost Escalation. Since these items would otherwise be captured in contingency, the allowances inherently reduce the overall contingency amount.

- RFR Project is using the Best Case as Base (Deterministic), instead of the Most Likely as Base. This means the P50 vs Deterministic ratio is expected to be significantly higher than other projects to cover the range from Best Case to Most Likely values.

- The Risk Management Process for the Class 2 Estimate is following the JV's Risk Management Plan [5] and performing the following tasks:

    - All risks identified and validated have been qualitatively analyzed with mitigation strategies to lower risk exposure of the project, which means less contingencies.

    - Many risks have been retired through application of mitigation strategies. Tremendous efforts on mitigation actions have been carried to reduce risk exposure and uncertainties.

    - Risks have been screened to ensure there are no duplicates by both JV SMEs and OPG SMEs.

    - Uncertainties have been identified and classified separately from risks in the risk register and three point / range estimates are captured for Schedule and Cost in the Basis Sheet and Cost Uncertainty table.

    - Risks classified as "business as usual", ambiguous risks, or risks past the time window are reviewed and approved by the Project Director prior to "retiring" or "closed" from the risk register.

- Opportunities are identified and analyzed with a goal to implement enhancement actions, once they have been approved to improve the chance of success of the project.

- Finally, the risks in the Risk Register and the schedule uncertainties and cost uncertainties have been confirmed and validated that they are included in the Monte Carlo simulation to derive the Contingency for Schedule and Cost of the Project.

7.2 Indirect Cost vs Direct Cost

The following table shows calculated Ratios of Indirect Cost vs Direct Cost in the Base and the P50 Cost. The results confirm that the risks and uncertainties have higher impacts on Direct Cost as on Indirect Cost.

Table 5 - Indirect / Direct Cost Ratios

	Base Indirect/Direct Cost Ratio	P50 Indirect/Direct Cost Ratio
Unit 2	[redacted]	
Unit 3		
Unit 1		
Unit 4		

7.3 P90

When examining the Schedule Duration output, it is observed that the P90 Schedule Duration is very close to P50 (average difference of approximately 35 days per unit, that is a 3% of the P50 durations, Figure 1). This indicates that the spread is very narrow, meaning the worst case durations may be overly aggressive, or overly optimistic, and the consequences and probabilities may be too narrow.

However, due to contractual arrangements, risks are transferred to OPG internal or transferred to JV internal. For example, Excusable Delay is a risk in OPG Risk Register, and Defective Work is a risk in JV Internal Risk Register. Some of these excluded risks may have the extreme worst case impacts which will not be shown in the Monte Carlo Model.

Figure 1 - Comparison of Base, P50 and P90 Schedule Duration

[redacted]

7.4 Uncertainty/Risk Split

The following table shows calculated Uncertainty/Risk Contingency ratios for each unit. On average the Uncertainty to Risk ratio is approximately 2.05 for cost and 2.4 for schedule.

Table 6 - Cost and Schedule Duration Uncertainty/Risk Ratios

	Cost Uncertainty/Risk Ratio	Schedule Uncertainty/Risk Ratio
Unit 2	[redacted]	
Unit 3		
Unit 1		
Unit 4		
Overall		

The Uncertainty component of the contingency calculation is significantly higher than the risk component. This is because the Best Case is used as Base, therefore the uncertainty makes up a higher portion when compared to risk, as the portion from Best Case to Most Likely is included as part of the uncertainty contingency. As the requirement of the Class 2 Estimate and Contingency Determination, JV and

OPG SMEs took multiple steps to ensure that no rework and no contingency were embedded in the Base.

7.5 Schedule Driven Rework Cost

The 3% Rework Cost is not included in the Monte Carlo Model. It is calculated separately with the Base Cost of the Labour portion (All items in 1, 2, and 3) from the Class 2 Estimate, as per the Cost Summary Table (Table 7) of the Class II Milestone Report [2], with the exception of items 1.2, 1.5, 1.6, 1.7, 3.5.

Rework Schedule Risks (also known as A La Carte Rework Risks) were clearly identified and marked by SMEs and management. The schedule risks were mapped to individual tasks in the risk models. To avoid double counting, the contingency value will have to be adjusted to remove the cost impact of the Rework Schedule Risks.

The following formula shows how the Contingency Amount is adjusted:

$$Adj.\,Cost\ Contingency = P50\ Contingency - \sum Schedule\ Driven\ Rework\ Cost$$

The schedule driven rework cost is calculated using two versions of the risk models - a prime version without schedule driven rework risks and a version with rework risks included. The difference in P50 cost between these two models is the schedule driven rework cost. This cost is shown in Table 7.

Table 7 - Cost Impact of Schedule Driven Rework

	Schedule Driven Rework Cost [$ Millions]	P50 Contingency (Cost) [$ Millions]	Adjusted Cost Contingency [$ Millions]
Unit 2	[redacted]		
Unit 3			
Unit 1			
Unit 4			
Overall			

Table 8 – Target Cost & Fixed Fees

[$ Millions]	Base	Rework	Contingency (adjusted)	Execution Phase Target Cost	Fixed Fee	Subtotal*
Unit 2	[redacted]					
Unit 3						
Unit 1						
Unit 4						

Note: * Escalation not included.

7.6 Risks Excluded From Risk Registers

As per the Agreement, certain risks are not allowed in the Risk Registers as input to the Monte Carlo Model. Due to contractual arrangements, risks are transferred to OPG internal or transferred to JV internal. For example, Excusable Delay is a risk in OPG Risk Register, and Defective Work is a risk in JV Internal Risk Register. These two risks are examples of risks not included in the Monte Carlo Model.

This implies that less contingency will be shown in this Monte Carlo Model, as part of the contingency shall reside with OPG and part remain with the JV. To assess overall contingency, all OPG and JV contingency needs to be considered.

7.7 Impact of Separate Unit Risk Models

The Monte Carlo Model has the 4 units run independently. As some of the units undergoing refurbishment at the same time (overlap) and some of units planned to be refurbished in series, it may appear that these separate risk models do not simulate the big picture. However, the Monte Carlo Model of independent runs is based on the assumption that OPG will make the informed decisions to optimize the breaker open dates for the Subsequent Units. With this assumption, the Monte Carlo Model is portraying the big picture with the contingency profiles of the individual units, .

8.0 REFERENCES

[1] NK38-REP-09701-10311-R000, Darlington RFR Class II Estimate Review Report

[2] 509407-0000-00000-33RA-0144 Rev 01, DNGS RFR Project – Class 2 – Milestone Report

[3] 509407-0000-00000-33RA-0165 Rev 01, DNGS RFR – Class 2 – Risk Report

[4] 509407-0000-00000-33RA-0145 Rev 01, DNGS RFR Project – Class 2 – Schedule Report

[5] 509407-0000-00000-30IM-0005, Risk Management Plan

Appendix A: List of Cost Uncertainties

Cost Uncertaininty

Cost Line Item	Per Unit Cost $m	FINAL WAR TEAM AGREEMENT Best Case	Worst Case	% Ranges		OPG SME Sign-off	JV SME Sign-off
DFL On-boarding Training - Uncertainty	[redacted]	- Lower than expected attrition rate (-1%) - Estimate Uncertainty - Lower than expected new to nuclear (-1%) - Estimate Uncertainty - Lower than expected testing failure rate (-1%)	- Higher than expected attrition rate (1%) - Higher than expected new to nuclear require training (2%) - Estimate Uncertainty - Higher than expected testing failure rate testing (2%)	-3	5	[signature]	[signature]
PMT On-boarding Training - Uncertainty	[redacted]	- Lower than expected PMT required (-1%) - Estimate Uncertainty - Lower than expected PMT Rates dictated in the table (-2%) - Lower than expected attrition rate (-2%)	- Higher than expected PMT required to meet expectations and higher than expected workload (2%) - Higher than expected PMT rates dictated in the table (2%) - Higher than expected attrition rate (3%)	-5	7	[signature]	[signature]

Cost Line Item	Per Unit Cost $m	FINAL WAR TEAM AGREEMENT Best Case	Worst Case	% Ranges		OPG SME Sign-off	JV SME Sign-off
Commissioning (Part of Target Cost) - Uncertainty	[redacted]	Commissioning scope/process being optimized (Less support may be required) (15%)	- Commissioning scope/process being optimized (More support may be required) (15%)	-15	15	[signature] Stephen Allen	[signature]
Project Management Team (PMT) - Uncertainty	[redacted]	Lower than expected PMT manpower (-5%)	- Higher than expected PMT rates dictated in the table - True escalation may be higher than escalation allowed by agreement +7%	-5	7	[signature] Stephen Allen	[signature]

Cost Line Item	Per Unit Cost $m	FINAL WAR TEAM AGREEMENT Best Case	Worst Case	% Ranges		OPG SME	JV SME	OPG SME Sign-off	JV SME Sign-off
Rework	[redacted]					Saumil	Seb W		

Cost Line Item	Per Unit Cost $m	FINAL WAR TEAM AGREEMENT Best Case	Worst Case	% Ranges		OPG SME	JV SME	OPG SME Sign-off
Subcontractors - Uncertainty	[redacted]					Samad K	Seb W	

Cost Line Item	Per Unit Cost $m	FINAL WAR TEAM AGREEMENT Best Case	Worst Case	% Ranges		OPG SME Sign-off	JV SME Sign-off
DFL Series Training - Uncertainty	[redacted]	Series training may be optimized with respect to course hours and course content from OPEX data and other projects and SME review of content (-5%). From efficiency format feedback during initial training runs.	Higher than expected DFL requiring training (+5%) - Estimate Uncertainty - Variablity in schedule starts is not included for in the series training estimate.	-5	5	[signature]	[signature]

Cost Line Item	Per Unit Cost $m	FINAL WAR TEAM AGREEMENT Best Case	Worst Case	% Ranges		OPG SME Sign-off	JV SME Sign-off
DFL - Uncertainty	[redacted]	All DFL estimates (CWP estimates) are task based. Optimization of DFL estimates were completed by war room teams during the rev 0 to rev 1 submission.	- manpower leveling will increase CWP DFL estimates as tasks for carrying crews from one CWP to the next have not been estimated in the Class 2 Rev 1 submission. - Non-critical path range 0-8%; Critical path range 0-15%; Aggregate 0-12%	0	12	S. [signature] Saumil Sabhaya	[signature]

Cost Line Item	Per Unit Cost $m	FINAL WAR TEAM AGREEMENT					
		Best Case	Worst Case	% Ranges		OPG SME Sign-off	JV SME Sign-off
Spot Overtime for DFL (4%) - Uncertainty	[redacted]						
Spot Overtime for PMT (2%) - Uncertainty	[redacted]						
Subsequent Unit(PMT) - Uncertainty	[redacted]	Other oppourtunities such as MP-090 and unit over unit revised methods.	Many elements of this estimate such as :work plans,asset suite,lessons learned (eng),unique scope(eng),3 unit procurement has not been executed as PMT or definition.Therefore there is potential to have additional unexpected efforts.	-5	10		

Cost Line Item	Per Unit Cost $m	FINAL WAR TEAM AGREEMENT					
		Best Case	Worst Case	% Ranges		OPG SME Sign-off	JV SME Sign-off
Indirect Field Labour TMO - Uncertainty	[redacted]	There is DFL estimate uncertainity for overestimation given the fact the manpower has not been leveled and not optimized between DFL/Indirect labour support (CSS) and TMO. (-10 %)	Higher than expected DFL manpower included in estimate resulting in a (+10 %) estimate uncertainty	-10	10	CSW	
Offsite Facilities - Uncertainty	[redacted]	0% based on best case P6 and month-to-month leases and quoted rates.	- Rates may be higher than expected due to limited facilities available, mainly contaminated storage facility. (10%). - Quantity of space required (contaminated/maintenance storage) may be more than expected (i.e. more tool failures, additional tooling and equipment). (10%) - monthly square footage ups/downs vary due to the requirements	0	20	CSW	

Appendix B: List of Cost Risks

COST RISKS

Risk ID	Risk Title	Risk Description	Unit 2				Unit 3				Unit 1				Unit 4			
			Consequence		Probability		Consequence		Probability		Consequence		Probability		Consequence		Probability	
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1.6	Forced work off site due to lack of site office space	If there is a lack of site office space it may cause work to be forced off site resulting in additional costs for building rentals.	$1M	$1M	0%	20%	$1M	$1M	0	10	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.8	Outage start date changes after target established	If the outage start date changes significantly it may cause the JV to incur costs that are not addressed by the provisions in the EPC agreement (Article 3.10 and 16.1) . Prolonged delay in start date may result in demobilization and remobilization that would adversely impact the JV's ability to retain staff and thus, adhere to the established targets. QUALIFICATION REQUIREMENTS SUBSEQUENT UNITS	$0M	$0M	0%	0%	$0M	$3M	20%	30%	$0M	$3M	10%	20%	$0M	$3M	10%	20%
8.112	Bankruptcy of key vendors and requalification	Bankruptcy of key vendors and requalification OSM RJ PL	$0M	$0M	0%	0%	$0.6M	$0.6M	10%	30%	$0M	$0M	0%	0%	$0M	$0M	0%	0%
17.14	Unavailability of adequate apprentices	Potential unavailability of adequate apprentices will cause the inability to achieve the 1:5 apprentice to experienced trade ratio resulting in future labour shortages and additional costs to hire fully qualified craft	$0M	$3M	0%	10%	$0M	$3M	0%	8%	$0M	$3M	0%	8%	$0M	$3M	0%	10%
29.14	Changes to logistic/transportation for contaminated tools	Lack of space/vendors to store contaminated tools in certain peak times may cause significant changes to logistics/transportation methodology and storage rates resulting in additional costs.	$0.6M	$1.2M	10%	30%	$1.2M	2.4M	30%	50%	$1.2M	2.4M	30%	50%	$0.6M	$1.2M	10%	30%

ONTARIO POWER GENERATION

Report

OPG Confidential	
Document Number: NK38-REP-09701-10320	Usage Classification: N/A
Sheet Number: N/A	Revision: R000

Title:

DARLINGTON RFR CLASS II ESTIMATE
MONTE CARLO MODEL REPORT

Appendix C: Mapped Risks

MAPPED RISKS - UPDATED 28AUG2015

CWP	CWP Description	Risk Form Name	Risk ID	Risk Title	Risk Description	Conseq. (days)		Prob. (%)		Risk Owner	Roy/Brian Comments 16-Aug-2015	Category	Future Actions	Action/ Mitigations to be completed	Response	U3 (% of U2)	U1 (% of U2)	U4 (% of U2)
2017	RTP Install	Risk Existing 3 - RTP Install	12.51.	Tritium levels in vault	Higher tritium levels can force one of the airlock doors to be closed, impacting the ability to freely move material through the airlock.	1	5	0	10	Jag Mohindra	What is the source of tritium?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide Justification for quantification	Potential leeching from concrete. Risk of an unforeseen tritium spill/event could drive up tritium levels which may result in the need to close airlock doors to ensure RAB tritium levels do not rise above 1MPCA. Mitigation would be to minimize activities that could generate spike in tritium.	100%	100%	100%
2017	RTP Install	Risk Existing 4 - RTP Install	4.54.	Hitting rebar/embedded steel during core drilling (Pressure boundary)	If a piece of rebar is hit in the ballscrew pits, then the area will have to be analyzed to ensure that the containment boundary is not compromised by the rebar being cut. Current approach is to scan, and avoid hitting rebar, limiting the possibility of cutting rebar. If a piece of rebar is cut, a PMOD will have to be processed, and OPG safety analysis approval to proceed in parallel with the PMOD completion will have to be received.	1	5	80	90	Greg Morandin	Pre-engineered solutions?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions	Engineering to develop plan to mitigate through pre-analysis - (GREG M)	Engineering to develop plan to mitigate through pre-analysis	Increased tolerance for anchor bolt placement may not adequately mitigate this risk. Further development of contingency plans required. Approval for a contingency PMOD should be sought to ensure the critical path impact is kept to a minimum. Estimate of engineering cost to develop contingency plans needs to be provided by Greg Morandin and Steve Rate by EOD Aug 25. These costs will be carried in Class 2 Rev01. Risk has been reduced on the assumption of these contingency plans being in place for execution. Initial mitigation is oversized holes. Secondary mitigation is 5" tolerance on hole relocation. Final mitigation is contingency PMOD scenario. Cost of mitigation required	100%	100%	100%
2017	RTP Install	Risk Existing 6 - RTP Install	4.39.	Hitting Rebar (Non pressure boundary)	If newly specified anchor requires further drilling it may hit rebar resulting in relocation of the anchors or qualifying another anchor.	1	5	80	90	Greg Morandin	Pre-engineered solutions?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions	Engineering to develop plan to mitigate through pre-analysis - (GREG M)	Engineering to develop plan to mitigate through pre-analysis	Increased tolerance for anchor bolt placement may not adequately mitigate this risk. Further development of contingency plans required. Approval for a contingency PMOD should be sought to ensure the critical path impact is kept to a minimum. Estimate of engineering cost to develop contingency plans needs to be provided by Greg Morandin and Steve Rate by EOD Aug 25. These costs will be carried in Class 2 Rev01. Risk has been reduced on the assumption of these contingency plans being in place for execution. Initial mitigation is oversized holes. Secondary mitigation is 5" tolerance on hole relocation. Final mitigation is contingency PMOD scenario. Cost of mitigation required	100%	100%	100%
2060	Replace Access Stairs		4.39.	Hitting Rebar (Non pressure boundary)	If newly specified anchor requires further drilling it may hit rebar resulting in relocation of the anchors or qualifying another anchor.	1	5	80	90	Greg Morandin	Pre-engineered solutions?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions	Engineering to develop plan to mitigate through pre-analysis - (GREG M)	Engineering to develop plan to mitigate through pre-analysis	Replacement anchors are larger and deeper than the existing. Increased tolerance for anchor bolt placement may not adequately mitigate this risk. Further development of contingency plans required. Approval for a contingency PMOD should be sought to ensure the critical path impact is kept to a minimum. Estimate of engineering cost to develop contingency plans needs to be provided by Greg Morandin and Steve Rate by EOD Aug 25. These costs will be carried in Class 2 Rev01. Risk has been reduced on the assumption of these contingency plans being in place for execution. Initial mitigation is oversized holes. Secondary mitigation is 5" tolerance on hole relocation. Final mitigation is contingency PMOD scenario. Cost of mitigation required	100%	100%	100%
2060	Replace Access Stairs		4.54.	Hitting rebar/embedded steel during core drilling (Pressure boundary)	If a piece of rebar is hit in the ballscrew pits, then the area will have to be analyzed to ensure that the containment boundary is not compromised by the rebar being cut. Current approach is to scan, and avoid hitting rebar, limiting the possibility of cutting rebar. If a piece of rebar is cut, a PMOD will have to be processed, and OPG safety analysis approval to proceed in parallel with the PMOD completion will have to be received.	1	5	80	90	Greg Morandin	Pre-engineered solutions?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions	Engineering to develop plan to mitigate through pre-analysis - (GREG M)	Engineering to develop plan to mitigate through pre-analysis	Replacement anchors are larger and deeper than the existing. Increased tolerance for anchor bolt placement may not adequately mitigate this risk. Further development of contingency plans required. Approval for a contingency PMOD should be sought to ensure the critical path impact is kept to a minimum. Estimate of engineering cost to develop contingency plans needs to be provided by Greg Morandin and Steve Rate by EOD Aug 25. These costs will be carried in Class 2 Rev01. Risk has been reduced on the assumption of these contingency plans being in place for execution. Initial mitigation is oversized holes. Secondary mitigation is 5" tolerance on hole relocation. Final mitigation is contingency PMOD scenario. Cost of mitigation required	100%	100%	100%
2100	Remove Reactor Area Bridge		4.52.	Remove roundways to remove elevator	If dowell set up is not as expected it will cause the roundways to be removed resulting in additional time for alignment during reinstallation.	2	4	30	50	Doug Fertile	Need more info? Have we asked fuel handling?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide Justification	Based on OPEX during TPG	100%	100%	100%
2124	Bulkhead Install		24.11.	Pressure equalization between Vault and Duct	Inability to equalize pressure between Vault and Fuel Duct - The ability to weld the root pass on the bulkheads may be affected due to the pressure differential causing loss of cover gas	1	2	80	100	Muhammad Naeem	Covered by uncertainty	Retire as this risk is covered by Uncertainty	Challenge Team (MIKE A)	Confirm whether it is part of range assessment and provide justification	Opportunity exists to apply sealant to catch containment trays between seal plate interface locations to mitigate negative pressure draw from fuelling duct, thus reducing the risk of weld failure.	100%	100%	100%
2124	Bulkhead Install		10.38.	APT breakdown	APT breakdown may cause critical path delays	1	5	20	30	Ziad Saad	What will breakdown?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	Currently no design. It remains an unknown at this time. Risk to be carried. Probability has been reduced to 20%-30%	90%	80%	70%
2125	Bulkhead Removal		10.38.	APT breakdown	APT breakdown may cause critical path delays	1	3	20	30	Ziad Saad	What will breakdown?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	Currently no design. It remains an unknown at this time. Risk to be carried.	90%	80%	70%
2166	PT Cut		4.72.	Contingency cut (Rework)	Rework	0	1	0	10		re-work	Rework	Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification	Agreed, rework Follow-up required on confirmation of successful cut	100%	100%	100%

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2169	PT Removal		12.1.	Loss of highly radioactive debris/particles	Highly radioactive debris escaping the designed flow path into the work areas may cause worker exposure to higher dose resulting in contingency plan for recovery and work stoppage.	0	2	10	30		pre-engineered plan? What is mitigation?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	Risk to remain The PT will be pulled into the flask, the garter springs may remain in the ouboard end of the Guide Sleeve (groove in GS flange). The integrity of the garter spring is in an unknown condition	100%	100%	100%
2169	PT Removal		18.11.	PT Cut contingency piece falls over	If a PT contingency cut piece falls over it may impede the PT gripper to engage to PT resulting in retrieval/removal of the bracelet	0	2	0	10		Roy concurs, can work process be changed to ensure ligament remains on PT stub on end fitting vs remaining on PT.	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	Risk to remain Currently, the design is such that if the ligament exists it will be potentially attached to the EF. A ligament resulting from a false negative primary cut has the potential to fall over regardless of the cut parameters/cut location.	100%	100%	100%
2169	PT Removal TRANSITION OUT		12.39.	Serapid chain exceeding safe working dose rate	If build up of contamination on serapid chain is higher than expected it may cause the serapid chain to exceed safe working dose rate resulting in replacement of a full palette	1	2	50	70		are the probablities realistic? Seem a little high.	Risk Agreed - although probabilities need to be re-visited		Provide justification for Probability	Chain is likely to become contaminated, requiring a pallet change out at the end of the series. Tool change out is faster than replacing the serapid chain.	100%	100%	100%
2169	PT Removal		4.95.	Dummy Bundle/FROB lost during PT removal process	Need to find the dummy bundle/FROB that was lost during the removal process	1	2	10	15		?? Need more info	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	Cosequence lowered, probablity lowered Mitigation is to have tracking form to identify what PT is in what FLASK. Previous: consequence (3-5), probablity (40-60) New: consequence (1-2), probability (10-15)	100%	100%	100%
2170	Bellows Replacement		5.46.	Damage to Bellows (rework)	If there is damage to bellows, repair/replacement will be required resulting in schedule delays	0	7	40	60	Todd Hamilton	Is this re-work category?	Rework	Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification		100%	100%	100%
2172	FC Install		4.87.	Weld Failure (Visual Inspection) (rework)	Bellows weld failure and resulting cut out could potentially affect critical path	0	2	0	10		re-work	Rework	Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification	Rework risk	100%	100%	100%
2172	FC Install		4.61.	Fuel channel replacement (Rework)	Based on Wolsong/Bruce OPEX, 1 SFCR may have to be performed during FC Install series due to quality issues (i.e., feeder port angle out of spec)	1	4	40	50		(only 3 have eveer been replaced during retubes (wolsong 2, bruce 1) - therefore probabilities are excessive and number of days should be 0 to 1 to represent a single SFSR Why is this not re-work?	Rework	Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification	Rework risk	100%	100%	100%
2173	New Fuel Load		4.43.	Broken Shim/Fuel Bundle Removal	Heavy fuel bundles may cause the shim to break off in the channel resulting retreival of the shim	0	1	5	10	Todd Hamilton	ok	Risk Agreed			Risk to remain Low probability and low consequence reflects improved process	100%	100%	100%
2173	New Fuel Load		9.41.	Lapping/Moulding of the EF Closure Cap sealing surface (rework)	If indications are found on the end fitting closure cap sealing surface during inspection it may cause lapping of the sealing surface	2	3	10	20	Todd Hamilton	re-work	Rework	Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification	Rework risk	100%	100%	100%
2173	New Fuel Load		4.100.	CNSC/ OPG Fuel Secure Requirements	A method needs to be developed and agreed upon to ensure Fuel Security requirements are being met.	4	5	5	10	Bryan Murdoch / Chris Doyle	Operators or fuel handling mechanics will assist in fuel loading and will look after CNSC requirements. JV will do leg work. This should not be a risk.	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	This should remain a risk, if the special initiative to allow 'NFL resequencing' is rejected, this critical path time will be incurred	0%	0%	0%
2176	CTI Removal		4.84.	CTI falls out of tubesheet into lattice tube	CTI falls out of tubesheet into lattice tube	1	2	10	20		what is the mitigation? Pre-engineered response? Is there any OPEx on this?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	This scenario occurred a total of 6 times during the Wolsong campaign.	100%	100%	100%
2176	CTI Removal		4.85	CTI warping (Rework)	reshock required, plus removal	6	8	0	10		re-work	Rework	Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification	agree, rework	0%	0%	0%
2177	CT Removal		15.11.	Additional force required to remove CT	If designed force does not successfully remove the CT is may cause reactor engineering to approve additional force above the tech spec resulting in schedule delays	2	3	40	60		pre-engineered solution as mitigation	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	agree, retire Before this can be retired, there needs to be engineering pre-approval for RTP loading up to 40000 lbs	0%	0%	0%
2178	Calandria Vessel Inspection		4.81.	Technical staff do not have jurisdiction to operate CVI tooling	Technical staff do not have jurisdiction to operate CVI tooling, resulting in camera cable entanglement	0	1	0	10		OPEX? 20% chance? Is this part of uncertainty?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Confirm whether it is part of range analysis and provide justification	Basis - previous Retube projects had experts running the tools (designers of the tools). Darlington will have trained trades (not designers) to run the tools. Mitigation - Jurisdiction markup shall include non-trade tool operators to eliminate risk for subsequent units	0%	0%	0%
2179	LT and Bellows Inspection		29.6.	Bellows cut not square due to tool failure (Rework)	If bellows cutting tool fails it may cause bellows not being square resulting in re-squaring bellows	1	2	0	10		re-work	Rework	Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification	Cost of mitigation required - SCADA sequence change to use laser on BCT to obtain adhoc squareness measurements in order to reduce consequence of this risk	100%	100%	100%
2179	LT and Bellows Inspection		4.8.	Helicoil replacement	May have to replace the helicoils when removing the TTs as the TT studs will need to be removed	0	2	10	20		re-work		Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification	Cost of mitigation required - mitigating activities to reduce likelihood of helicoils coming out. Assessed as not being rework on the basis that handling of helicoil is part of standard work process steps	100%	100%	100%
2180	CTSB Inspection		12.45.	Loss of Contamination Control resulting in work stoppage	High volume of contamination may cause loss of contamination control resulting in a work stoppage and initiating decontamination to recover	1	3	40	60		ok	Risk Agreed			No change to risk	50%	50%	50%
2180	CTSB Inspection		5.17.	Improper brushing and excessive as found deposits (CTSB)	Improper brushing and excessive as found deposits may cause damage resulting in additional brushing, swabbing or debris cleaning.	8	12	10	30		OPG will perform evaluation in Argentina. Use OPEX from Argentina and develop procedure to polish only. Use first unit as basis for remaining units.	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	This risk will remain for the first unit but will be eliminated by U2 OPEX for subsequent units	0%	0%	0%

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2180	CTSB Inspection		4.44.	CTSB Milling (Rework)	CTSB milling required due to JV human performance/tooling issue damaging tubesheet (Not concealed condition)	2	4	0	10		ok, possibly as found condition or damage by contractor	Rework			No change to risk - risk scoring is post-mitigation and is outside any concealed conditions	100%	50%	50%
2181	FME Inspection		4.48.	Hitting a reactor component during FME Debris Retrieval	If a reactor component is hit by the FME Debris Retrieval tool, a stand-down could take place and assessments of the component would be on critical path	1	3	0	10	Todd Hamilton	what is basis and is this on critical path? Is there any OPEX on this? Can repairs be performed off critical path?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	Risk to remain this happened at Lepreau with trained operators and a simulation. the tool is manually operated. The duration was reduced to reflect the time to inspect the component that was hit, and to assess tooling and simulation to ensure this does not happen again. The probability was reduced as OPEX was based on Lepreau tool that is different from the Darlington RFR tool Cost of mitigation required to ensure simulation and proper operator training is in place for this series. In addition, there should be a prepared pathforward on dispositioning any impacts with internal calandria components (i.e., adjuster rods, VFDs etc.) in the event that they occur during this series	0%	0%	0%
2183	CT Install		18.12.	Calandria tube replacement (Rework)	Tubes installed out of tolerance, requiring Rolled Joint to be shock-heated and tooling installed to remove tubes, and tube then reinstalled. This risk also captures contingency actions associated with RJ leak test failure	15	20	0	20		re-work	Rework	Agree to rework treatment (ROY/BRIAN)	Provide Justification for quantification	agree, rework Justification for duration: 1. Transition out of CT Install tools and IWT 2. Transition in, Install and commission of CTI Release tooling 3. Perform shock heat 4. Transition in CT Removal Contingency tools 5. Remove CT 6. Transition out of CT Removal Contingency Tools 7. Transition in CT Install tools 8. Re-Install CTs	100%	100%	100%
2183	CT Install		14.8.	FME loss during series	FME loss during production after FME inspection and retrieval series	1	2	10	20		ok	Risk Agreed			Risk to remain, agree	100%	100%	100%
2187	Bulkhead Containment Test		24.7.	An isolation point between units is missed (JV and OPG)	An isolation point in containment or an internal process system is missed this will require the test to stop, the isolation be corrected and the test to be restarted.	8	12	0	10	Ziad Saad	need basis for the duration; pre-planning & challenge, walkdown, independet reviews.	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	If a leak is encountered, leak searching must be performed to identify the source, TCB must be depressurized, repairs must be done, and test profile must be repeated Mistakes will be identified and rectified for subsequent units	0%	0%	0%
2227	Dummy Bundle Retrieval		4.97.	Hot fleas released	possibility that hot fleas are released on the RTP when the dummy bundles are removed	1	2	20	30		pre-engineered repsonse & challenge percentages	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	Risk modification Risk probability reduced from (20-40%) to (20-30%)	100%	100%	100%
0010	Waste EF Processing		26.20.	Recovery from an Outboard EF being dropped during the transfer from the Trough to the LLWC as a result of a Robot failure	Assumes recovery procedure is in place in case this risk happens	0	1	0	10	0.5	duplicate of 26.17	Reject - DUPLICATE			This is a measure of tooling performance and procedures. Additional post FAT Testing including dry cycling testing. Robot can be operated in manual mode if required.			
0010	Waste EF Processing		26.21.	Trolley not being able to rotate the RWC/DSO	Assumes recovery procedure is in place in case this risk happens	0	1	0	10	0.5	Is there a manual recovery plan? Basis of critical path impact?	Additional info/basis required from War Room Team. Risk to be re-assessed based upon suggested mitigations and/or suggested actions		Provide justification	This is a measure of tooling performance and procedures. Manual recovery mode is available. Switch to the second line and change out defective motor Rehearsals to perform motor change out and this is a planned contingency operation during PTP.			
2146	Lower Feeder Install		4.106.	Rework (Weld Repair, End Fitting Side Port and Feeder Coupling Hub Rework)	Poor feeder weld quality may cause high rejection rates, PAUT interpretation, higher dose uptakes, and additional time for repairs. In addition End Fitting side port and Feeder coupling hub may require repair.	8	12	30	50			Rework				100%	100%	100%
2145	Upper Feeder Install		4.107.	Delays associated with Rework	Poor feeder weld quality may cause high rejection rates, PAUT interpretation, higher dose uptakes, and additional radiography for repairs resulting in productivity losses. This duration includes nozzle height repair.	16	20	40	60			Rework				100%	100%	100%
2124	Bulkhead Install		4.108.	Rework	Poor access ability or human performance of bulkhead weld locations may result in failed weld and require repair.	1	2	80	90			Rework			Can apply CAT welding system to reduce incidents of failed welds	100	100	100
2124	Bulkhead Install		4.109.	Pressure equalization between Vault and Duct	Inability to equalize pressure between Vault and Fuel Duct - OPS has identified the potential issue of the VVRS having reduced capacity due to breathing air load and elevated tritium levels during bulkhead install resulting in reduced manpower levels to 10 people in vault for final welding.	2	6	40	70						Can apply CAT welding system to reduce number of mandatory welders	100	100	100
0010	Waste PT Processing		26.12.	Simultaneous dual-line failure	Simultaneous dual-line failure occurs resulting in press swap-outs. Recovery achieved with one line restored	~~0~~	~~14~~	~~0~~	~~10~~	~~11~~	duplicate	REMOVE (ROLLED UP TO GLOBAL).			Tool failure and unavailability is a measure of tooling performance and procedures. More Training for Press Changeout which should reduce the time taken Extra Testing post FAT and the ability to run in Burst Mode which will allow the system to catch up There is a possibility that the second Processing Line can go down while the primary line is being repaired			

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(DISCUSSED CHANGES WITH P. LEOKEFF).

2175	CTI Release		4.110.	ES Measurements require additional assessment due to unexpected readings	TS requires measurements to be provided to the Design Organization for every row of CTI released and CT removed for acceptance and approval to proceed. 10 sites can be released/removed prior to receiving approval to proceed from the Design Organization. Risk is the directive from the Design Organization to stop work if the values are outside the acceptance criteria range	1	3	0	10							Revise TS requirement to eliminate this risk (Cost of mitigation)	0%	0%	0%
2176	CTI Removal		4.110.	ES Measurements require additional assessment due to unexpected readings	TS requires measurements to be provided to the Design Organization for every row of CTI released and CT removed for acceptance and approval to proceed. 10 sites can be released/removed prior to receiving approval to proceed from the Design Organization. Risk is the directive from the Design Organization to stop work if the values are outside the acceptance criteria range	1	3	0	10							Revise TS requirement to eliminate this risk (Cost of mitigation)	0%	0%	0%
2183	CT Install		4.8.	Helicoil replacement	May have to replace the helicoils when removing the TTs as the TT studs will need to be removed	0	2	10	20							Cost of mitigation required - mitigating activities to reduce likelihood of helicoils coming out. Assessed as not being rework on the basis that handling of helicoil is part of standard work process steps	100%	100%	100%
2172	FC Install		4.8.	Helicoil replacement	May have to replace the helicoils when removing the TT studs and temporary PA hardware	0	2	10	20							Cost of mitigation required - mitigating activities to reduce likelihood of helicoils coming out. Assessed as not being rework on the basis that handling of helicoil is part of standard work process steps	100%	100%	100%
2177	CT Removal		4.110.	ES Measurements require additional assessment due to unexpected readings	TS requires measurements to be provided to the Design Organization for every row of CTI released and CT removed for acceptance and approval to proceed. 10 sites can be released/removed prior to receiving approval to proceed from the Design Organization. Risk is the directive from the Design Organization to stop work if the values are outside the acceptance criteria range	1	3	0	10							Revise TS requirement to eliminate this risk (Cost of mitigation)	0%	0%	0%
2181	FME Inspection		4.111.	Debris Retrieval (Rework)	If debris is introduced to the calandria vessel during CT install, it will have to be retrieved using FME tooling	1	3	40	60								100%	100%	100%

Appendix D: Global Risks

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GLOBAL RISKS - UPDATED 28AUG2015

Risk ID	Risk Title	Risk Description	Basis	Mitigating Actions	Mitigation Status	Rework (Yes or No)	New Conseq. (days)		New Prob. (%)		New Resultant PSO	Comments	JV/OPG Risk Register	Response	Unit 3	Unit 1	Unit 4
6.4.	Crane Breakdown	If the reactor building crane breaks down, it may cause disruption to material and equipment movements resulting in productivity losses.	Based on OPEX multiple crane failures occurred (PLGS)	None.	Proposed	No	2	4	50	70	1.8		JV		Cons 2 | 4 Prob 40 | 56 0.8	0.6	0.4
6.7	RWPB Crane Failure	If the RWPB crane breaks down, it may cause disruption to material and equipment movements resulting in productivity losses.	Flask Handling will take more time. Lower crane failing in the way of the upper crane.	None.	Proposed	No	0	2	10	30	0.2	No change to the New Conseq. Numbers.	JV		1	1	1
6.8.	Lack of Power for tools and supporting equipment (i.e. lighting, munters)	If there is a power loss in the station it will cause lack of power to tools and supporting equipment resulting in a work stoppage and additional activities to return to service	Best estimate. Assuming UPS starts off immediately and there is no disruption in shutdown sequence. Likelihood of interruption is low. Recovery is generally obtained within the same shift	None.	Proposed	No	0	2	80	100	0.9		JV	Accepted as 4-1. OPEX in PLGS - one incident.	0.8	0.6	0.4
7.1.	Unexpected Vault Equipment Airlock Malfunction	Poor reliability of the vault equipment airlock may cause an unexpected malfunction resulting in restriction for transferring equipment, materials and tooling in and out of the vault	Mechanical airlocks. Affects CP only during pre-req and post-req. Darlington OPEX: 5 hours recovery time on CP.	Ensure dedicated airlock support staff available. Spare parts on-hand in case. Use the alternate airlock for personnel entry/exit. Confirm with Conventional Safety if the access to vault will be restricted if the main airlock will be damaged - open/closed.	Proposed	No	0	2	80	100	0.9		JV	Mechanical lock with experienced operator attendants opening / closing to lower probability of risk events.	0.8	0.6	0.4
10.3.	Unexpected failure of RTP elevator mechanism	Unexpected failures of the RTP elevator mechanism may cause loaded flasks with radiated material to remain on the RTP resulting in additional dose and productivity losses	Design Improvements based on OPEX from LePreau and Wolsong	Contingency plan to be put in place to utilize Vault crane while RTP cannot be elevated.	To Do	No	8	12	0	10	0.5		JV	Rule of 4-1 applies	0.8	0.6	0.4
16.7.	Interference with RFR activities due to unexpected OPG Plant Operations activities (for flask transfer activities)	Unexpected OPG Plant Operations for adjacent units may cause interference with JV RFR flask transfer activities resulting in work stoppages and a backlog of flasks.	1. Frequent ERT announcements that occur (fire alarms (not drills), rescue etc), may result of stoppage of work in some areas of the plant to permit ERT unimpeded access or local evacuation area to be established. 2. Radiography occurring in some plant areas result in temporary barriers and obstructions (potential to interfere with material, tooling, flask and personnel movements) 3. Site security issues resulting in temporary closure of incoming traffic of people and/or equipment 4. OPEX concerns raised on equipment that is used generally across the plant and within RFR. For example- manufacturer's product notices causing temporary freeze on the use of some equipment until a recall inspection is done, use of Cranes generally across the plant resulting in a lock up of Cranes until inspected, PPE generic issues across the plant, etc.etc. OPG will issue blanket instructions For action to be taken 5. OPG or other contractors management of labour issues that spill over into the RFR project causing work delays, labour actions, or expectations of "same treatment" within the JV work force= increased cost 6. fire drills working through accounting processes, assembly all clear etc. where work must stop 7. Outdoor restrictions (lighting weather tornado etc.) may interfere with material, BWC shipments etc. 8. Re-alignment of electrical supplies on station side, maintenance outages on service water, exhaust stack, monitors etc. all of which support the RFR - Quiet mode declared on operating units resulting in evacuation of RFR vault	OPG to have interface protocol in place with Operations to minimise the impacts.	Proposed	No	2	4	30	50	1.2		JV		1	1	1
16.12.	Interference with RFR activities due to unexpected OPG Plant Operations activities (for in Vault Activities)	Unexpected OPG Plant Operations (i.e. Fuel Handling, Islanding, etc.) activities may cause interference with JV RFR activities resulting in critical path delays	1. Radiography (ESW) 0.5 day 2. HFD Replacement - 0.5 day 3. Fuel Handling - FM stuck under the Unit in once a month travel 4. B Cooler (1 unit) - 1 day 5. STOP - 0.5 day 6. SG - 0.5 day 7. PHT valves - 8. VVRS - 1 day	JV to establish protocols with OPG and other vendors, as per agreement	Proposed	NO	5	5	100	100	5	Unit to unit reduction. May need to be revisited for each unit.	JV	Radiography in the eavestrough pipe;	0.9	0.8	0.7
16.13.	Safety events caused by OPG or other contractors (occurences <3 days)	If OPG or other contractors doadhere to safety procedures it may cause a number of safety events less than 3 days resulting in an aggregate delay to critical path	Based upon OPEX i.e, Bruce RFR crane safety standown due to Bruce B incidents. Tied to OPG Safety Statistics as per millions of man hours worked.	OPG to reinforce safety culture amongst all contractors and OPG itself.	To Do	NO	0	4	40	60	1	Based on current outage OPEX	JV		1	1	1
24.10.	Ozone excursion into the vault	Ozone excursion into the vault will cause a stand-down in the work. Would be caused by Calandria losing negative pressure due to ventilation system disturbances.	Wolsong OPEX in place.	Ensure that the vessel is kept at negative pressure. Set up equipment in advance and put program in place for proper monitoring.	Proposed	No	2	4	30	50	1.2	Agreed Quantification	JV	Greater quantification suggested for subsequent units as the Thumb Tacks will be reused (possible seal failures)	20-40%	20-40%	20-40%
27.3.	Heat Stress	Higher than expected temperature in vault areas may cause heat stress resulting a higher number of craft turnover.	Confined spaces and areas of higher elevation will result in areas of higher heat stress. This is an aggregated event and not a single one.	Ice vests maybe worn Time would be limited to < 1 hour continuously/employee. Temporary Chillers/ACUs to be installed before work begins. More plastic suits might be demanded.	To Do	No	4	8	20	40	1.8	Vault area ACUs are to be rebuilt and may not be available. No changes to the new conseq.	JV	Planned dates in summer vs winter.	20-40%	10-20%	20-40%

PJD Aug.28,2015
30-Aug/15

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Risk ID	Risk Title	Risk Description	Basis	Mitigating Actions	Mitigation Status	Rework (Yes or No)	New Consequ. (days)		New Prob. (%)		New Resultant P50	Comments	JV/OPG Risk Register	Response	Unit 3	Unit 1	Unit 4
16.8.	Multiple empowered single points of contact within OPG space	Multiple empowered single points of contact within OPG space (i.e. Ops, project, construction, etc.) may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	***SEE DIRECTLY BELOW: Broken into 4 risks***								0						
19.26.	Multiple empowered OPG Operations	Multiple empowered OPG Operations may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	Work Protection: 12 swaps - 1/2 a shift per swap = 3 days Ops interference prior to escalation: one shift impact = 1/2 day	OPG to manage the interfaces	To Do		6	8	40	60	3.5		IV	Operations Quantification: - 25 days @ 50% for cost - 10 days @ 50% for schedule Rationale: - OPG operations will be focused on keeping operating units running - during pre and post vault turnover, interfacing activities with OPG operations will be predominant - OPG operations are not accountable for JV RFR activities - changes authorized made by the group not aligning with the OPG Contract	50-60%	30-40%	20-30%
19.27.	Multiple empowered OPG Engineering	Multiple empowered OPG Engineering may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	Very minimal impact on critical path as most activities are expected to be on parallel path. Not a lot of engineering activities completed during execution phase. Expectation is to have an engineering group specifically for RFR that can sign off on changes.	OPG to manage the interfaces	To Do		0	2	20	40	0.3		IV		20-20%	10-20%	10-10%
19.28.	Multiple empowered OPG Work Management	Multiple empowered OPG Work Management may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	Expected quantification same as engineering	OPG to manage the interfaces	To Do		0	2	20	40	0.3		IV	OPG Work Management Quantification: - 20 days, @ 50% Rationale: - Current OPG governance places OPG work management (Unit outage director) in position of authority to direct overall work program - OPG work management not accountable for RFR project activities	20-20%	10-20%	10-10%
19.29.	Multiple empowered OPG Construction Oversight	Multiple empowered OPG Construction may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	Less impact than Operations.	OPG to manage the interfaces	To Do		3	5	40	70	2.2		IV	Coristruction Oversight Quantification: - 10 days @ 50% Rationale: - Oversight roles not performed directly by OPG RFR project team have consistently provided instruction not alignment with OPG RFR project team (OPEX). - changes authorized made by the group not aligning with the RFR Contract	20-20%	10-20%	10-10%
4.76.	Personnel Injury/near miss	Personnel Injury/near miss	Target 3 near misses causing one standdown. 4 incidents per 200,000 manhours as standard. The DFL / SS has so many hours. Lepreau OPEX - Improper clamping as well as break in communication. Wolsong OPEX - Feeders dropped + Temp. shielding wall fell on personnel. Bruce OPEX - Electrictal panel dropped + RTP collision (4 week standown) Standown causing duration increases. Assuming procedures and prudent practices are followed.			No	8	12	0	20	1		IV		1	1	1
5.5.	Plant Equipment/Material Damage	Human performance incidents resulting damage to station equipment damage OR personnel injuries, resulting in standdown. This risk is the post-mitigated value after following prudent practices,.	The residual risk, after following prudent practices. Risk ID 11.1, 26.7 and 5.5 amalgamated. This risk includes activities such as flask transfer in station, waste reduction activities, large equipment transition movement in/out of the vault, hot welding activities.	Require confirmation from management that this is rework or not.	To Do	?	10	30	10	30	4	None	IV	A large volume of material/tooling/heavy equipment handling is greater in magnitude than during operation/outages. Also the material/tooling/heavy equipment is much larger. At PLGS and Wolsong, rails were used and still damaged surrounding equipment on several occations. The quantitative assessment encompases a lower consequence than past OPEX and takes into account lessons learned. The craft handling the movements are not "specialized"/dedicated trades. Risk team believes that there would be insignificant risk reduction from unit to unit.	Response Comment not accur	0.9	0.8
5.51.	Damage to existing common tooling i.e., HWT, pallet, IWT, RTP and related equipment, AGVs etc.	Human error during transitions may cause damage to existing common tooling resulting in craft being idle while the tool is repaired or replaced.	OPEX. Every refurb project including Darlington mock-up. Impact will reduce when there is a team ready to take action to transition into a new tool. HU related damages. Depends upon the severity of the damage.	Confirmation to be obtained on movement of panels. Rehearse transitions at the mock up (standby plan, if approved).	To Do	No	2	4	10	30	0.6	Tool Performance Guarentee reports provides great insight on improvements for such activity.	IV	Dropped shield plug in wolsong and damaged FCP ball screws, platform events (Retube platform damaged feeder platform in PLGS), shock heating tool that bent platform, collisions with RWC at Bruce, Positioning bar for rack on HWT). With the amount of lost time based on OPEX, quantification is based on improvement.	This is what mock up & training	0.4days	0.3 days

PL

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Risk ID	Risk Title	Risk Description	Basis	Mitigating Actions	Mitigation Status	Rework (Yes or No)	New Conseq. (days)		New Prob. (%)		New Resultant P50	Comments	JV/OPG Risk Register	Response	Unit 3	Unit 1	Unit 4
10.13.	Unavailability of Tools or Unexpected Tool Failure	Unexpected tool set reliability and/or incorrect tool set up/usage may cause the tool to unexpectedly fail resulting in additional work for tool troubleshooting/maintenance. This includes HU type error as well as tool unavailability	The residual risk, after following prudent practices. Risk ID 29.12, 6.6, 4.55, 26.12, 4.49, 10.33, and 10.13 amalgamated. Contingencies set at: - Waste processing, 10% of Best Case overall, 7 days - Bellows Cut, 2.5 days, - AISV , 1 day - General, 3% of Tool availability excluding the Bellows Cut For last 2 Units - Waste processing, 2% 2days - Bellows Cut, 1 days, - General, 2%	It is advised to go through each series to understand the likelihood of tool failure. Relook at the evolution of tooling and lessons learned from previous tooling	To do	No	21	21	100	100	21		IV	~375 day duration for tool availability. Based on current assessment, the P50 duration would only account for 8% of tool unavailability. The unavailability of tooling at any of the past refubs was significantly higher. Wolsong was also 2nd generation tooling.	Cons | Prob. 13 | 13 | 100/50 a/9, 100, 100 13d ~~More basis needed. Response~~ 13d	9d ~~8d~~	9d ~~8d~~	AJ
16.9.	Interference with RFR activities due to unexpected OPG RFR related activities	Unexpected/Unplanned/Currently Unknown OPG or other OPG Contractor Activities may cause interference with JV RFR activities resulting in critical path delays.	Reactor vault when it is under JV jurisdiction.	Changes might be required to contract for scope injection process. Create language that creates a remidiable delay for added non-JV scope in excess of the Level 5 execution phase schedule. 16.9.1. Work with OPG to determine appropriate time to complete PM activities. 16.9.2 Prepare Access Protocol agreement as per Article 2.16 (j) to coordinate work between contractors and OPG 16.9.3 OPG to provide an obligation in its 3rd party agreements to comply with Article 2.16 (j) to ensure cooperation between contractors and the JV	16.9.1. Proposed 16.9.2 To Do 16.9.3 To Do	NO	10	20	10	30	3	Agreed jointly.	JV	Could be mitigated by defining the Non-JV Unknown Scope as Excusable Delays. Quantification of risk is subjective. Get from Andre	8d	10d ~~8d~~	10d ~~10d~~	AJ
16.15.	OPG and/or other contractors will not be able to complete their critical path activities on schedule	If OPG and/or other contractors are not able to complete their critical path activities on schedule, this will impact JV target cost	Consequences being 0-30 days (The difference of total of most likely and total of worst case of OPG tasks before Airlock is Open). This risk has no impact on Target Schedule of JV, only Target Cost. 7 Interfaces are identified that JV tasks will be impacted directly by OPG / other contractors.	None	Proposed	No	0	30	20	40	4.5		JV	How is this a cost risk? It is a schedule (time dependent) risk that will inherently affect the Target Cost since most activities are outside the target outage duration	0.8	0.8	0.6
4.118.	Calandria Seal Leak Test	May have extra duration on critical path, due to results of Calandria Seal Leak Test					0	0	0	0	0				8-12 days (40-60%) AJ	0	0
											54.9						

ONTARIO POWER GENERATION

Report

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Appendix E: Critical Path Contingency Dependency

Model Buildup

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign off	JV SME Sign-off
Onboarding - PMT	No	No	No change	NA	NA	Majority of training cost is driven by PMT attending the training. There are a set number of courses and set number of hours per course. This effort is not schedule dependant. There is a role for JV to manage the training courses.	[signature]	[signature]
Onboarding - DFL	No	No	No change	NA	NA	majority of training cost is driven by DFL manpower attending the training. There are a set number of courses and set number of hours per course. This effort is not schedule dependant. There is a role for JV to manage the training courses. Agree, however there is a component of variability of the scheduled start of each series (and thus variability in the cost of each training series)	[signature]	[signature]

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign off	JV SME Sign-off
Rad Work Allowance	Yes	Yes	No change	Reactor Shutdown Breaker Open	Feeder Removal Finish	Costs are directly proportional to duration.	[signature] Jordan Allen	[signature]

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign off	JV SME Sign-off
Support Services	Yes	Yes	No change	U2-Pre Req Start /De-fuel Complete	Unit Mechanical Completion	Costs are directly proportional to duration.	[signature]	[signature]
Subcontractors (PAUT)	Yes	Yes	No change	Upper Feeder Installation Start	Lower Feeder Installation Complete	Costs are directly proportional to duration.	[signature]	[signature]
Subcontractors (Other than PAUT)	Yes		Remove the hammock. No more driven by duration.	NA	NA	Only 2% (860k) of the cost of the Subcontracts (other than PAUT) is applicable to duration variation. Currently this task is not on CP therefore currently it not part of the model. No further action is required.	[signature]	[signature]

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign off	JV SME Sign-off
[illegible] Rework	No		No change	NA	NA			

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign off	JV SME Sign-off
Series Training	No	No	No change	NA	NA	Vast majority of training cost is driven by DFL manpower attending the training. There are a set number of courses and set number of hours per course. This effort is not schedule dependant. There is a role for JV to manage the training courses. Trainers (DFL and PMT) can easily be reallocated to support Critical Path activities and bolster efforts to recover schedule Agree, however there is a component of variability of the scheduled start of each series (and thus variability in the cost of each training series)	[signature]	[signature]

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign off	JV SME Sign-off
DFL	Yes	Yes	No change	Critical Path Tasks	Critical Path Tasks	Costs are directly proportional to duration. Included for all CP items. Included for all non CP where range analysis was compelted (ex Upper Feeder Install is included)		

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign-off	JV SME Sign-off
DFL Spot Overtime	No	No	No change	NA	NA	This is a commercial issue.		
PMT (Engineering)	Yes, included in PMT	Yes, included in PMT	No change Separate cost item for Cash Flow purpose	Reactor Shutdown Breaker Open	Unit Mechanical Completion	Costs are directly proportional to duration.		
PMT (other than Engineering)	Yes	Yes	No change	Reactor Shutdown Breaker Open	Unit Mechanical Completion	Costs are directly proportional to duration.		
PMT Spot Overtime	No	No	No change	NA	NA	This is a commercial issue.		
Subsequent Unit	No	No	No change	NA	NA	Work is not driven by duration of DFL work. P6 Level 5 schedule shows that Subsequent Unit work occur ahead of the exact execution work.		
Subsequent Unit (Engineering)	No	No	No change Separate cost item for Cash Flow purpose	NA	NA	Work is not driven by duration of DFL work. P6 Level 5 schedule shows that the Engineering (SU) work occur ahead of the exact execution work.		

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign-off	JV SME Sign-off
TMO	Yes	Yes	Split TMO into 2 parts (30%/70%). One is dependent on critical path and grows and shrinks with it (30%). One is independent of the critical path (70%).	Reactor Shutdown Breaker Open ---- NA	Unit Mechanical Completion ---- NA	Vendor support is not schedule dependant Offsite crew based work can be adjusted by management to mitigate any schedule variations.	OSW	
Offsite Facility	Yes	Yes	No change	Reactor Shutdown Breaker Open	Unit Mechanical Completion	Agreement Obtained.		

Appendix F: Duration Ranges – Critical Path Activities

Duration Ranges - Critical Path Activities - August 27

Series order and list	Team	Unit 2 (Aug 20 2015)			Unit 2			Unit 3			Unit 1			Unit 4			Justification (for multi-unit and focus areas)
		Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	
Establish GSS (OPG)	OPG	[redacted]															
Defuel (OPG)	OPG																
FM Crane and Hoist Well Crane maintenance (OPG)	OPG																
EF Seal cap install	Remove/Inspect																Range is already narrow
Containment Leak Rate Test (-15kpa) (OPG)	OPG																
[redacted]	TMODs																Subsequent unit increase in best case duration is due to a 50% productivity factor as opposed to 83% applied to Unit 2 because of Unit 1 Outage alignment with Bulkhead installation for Unit 2. Learning curve, OPEX, increased trade experience, revised and improved process/procedures, and interface with OPG OPS will result in Unit over Unit improvement
VVRS to achieve appropriate vault air dew-point (OPG)	OPG																
Containment Test	TMODs																Test profile remains consistent for Units 2, 3, 1 and 4, thus duration reduction is not expected
[redacted]	TMODs																Currently, worst case is based on incomplete shielding design. Learning curve, OPEX, increased trade experience, revised and improved process/procedures, and interface with OPG OPS will result in Unit over Unit improvement
Vault vapour recovery config for negative airflow (OPG)	OPG																
Comission bulkhead shielding (OPG)	OPG																
Airlock Doors open (OPG)	OPG																
Bulk Interferences and PDS installation	TMODs																Multiple CWPs are embedded into this basis. Reactor vault congestion and coordination contributes to the worst case duration.
[redacted]	TMODs																
RTP Install	TMODs																Partial validation testing performed at mockup. Greater confidence in best case and most likely. OPEX gained from Unit 2 and Unit 3 will result in improved efficiency for Units 1 and 4
Feeder Cabinet Removal	Feeders																Reduction 2nd Unit (Material Handling Logistical OPEX, craft retention plus, Off Gassing times requirements) Additional reduction 3rd and 4th Units(craft retention minimal scope known, Material Handling
Install Feeder Platform	Feeders																Reduction on 2nd Unit: Installation OPEX, craft retention, 0 % reduction 3rd and 4th Unit due to component handling quantities and in situ installation environment .
[redacted]	Remove/Inspect																Changed WC U2 from 12 to 10 For subsequent units, there are a lot of parallel activities happening simple manual tasks and lots of heavy lifting. Little room for improvement in uncertainty
Transition IN Feeder Coupling Disconnect	Feeders																Already narrow range
Feeder Coupling Disconnect	Feeders																Reduction 2nd Unit Craft retention, OPEX and lessons learned. Additional reduction on third Unit (OPEX and craft retention 0 % reduction on 4th Unit series dialed in
Transition OUT Feeder Coupling Disconnect	Feeders																Already narrow range
[redacted]	Feeders																Improvement due to better understanding/management of logistics involving multiple crews. Less uncertainty due to unknowns. Possible 25% opportunity reduction for 2nd unit (by using alternative tooling and process logic for feeder cutting and volume reduction). Opportunity not included in range
Transition IN Dummy Bundle Retrieval	Remove/Inspect																Range is already narrow
Remove Dummy Bundles	Remove/Inspect																Range is already narrow
Transition OUT Dummy Bundle Retrieval	Remove/Inspect																Range is already narrow
Transition in PT Severing Tool	Remove/Inspect																Range is already narrow
PT Severing	Remove/Inspect																Range is already narrow, this is an automated series with minimal manual activities
Transition out PT Severing Tool	Remove/Inspect																Range is already narrow
Transition in Bellows Severing tool	Remove/Inspect																Range is already narrow
[redacted]	Remove/Inspect																Changed WC U2 from 40 to 32 Assume machine cycle time improvments and tool reliability between units
Transition out Bellows Severing	Remove/Inspect																Range is already narrow
Transition in End fitting Removal tool	Remove/Inspect																Changed WC U2 from 5 to 4 Subsequent units will have learnings from U2, therefore shorter WC durations
End Fitting Waste Processing	Waste/Volume Reduction																harvesting of Efs for Annulus Spacers is only for U2
Transition out End Fitting Removal	Remove/Inspect																Range is already narrow
Transition in PT removal	Remove/Inspect																Range is already narrow

Duration Ranges - Critical Path Activities - August 27

Series order and list	Team	Unit 2 (Aug 20 2015)			Unit 2			Unit 3			Unit 1			Unit 4			Justification (for multi-unit and focus areas)
		Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	
[redacted]	Remove/Inspect	[redacted]															Changed ML U2 from 30 to 28 Changed WC U2 from 44 to 38 Assume that ML will remain the same for all units, based on 30 min flask change time. For WC, assume that flask change may improve to 45 mins in subsequent units compared to the 60 mins assumed in U2
Transition out PT Removal	Remove/Inspect	[redacted]															Range is already narrow
Transition in CTI Release	Remove/Inspect	[redacted]															Range is already narrow
[redacted]	Remove/Inspect	[redacted]															Changed ML U2 from 9 to 10 Changed WC U2 from 18 to 16
Transition out CTI Release	Remove/Inspect	[redacted]															Range is already narrow
Transition in CTI Removal	Remove/Inspect	[redacted]															Range is already narrow
[redacted]	Remove/Inspect	[redacted]															Changed ML U2 from 14 to 11 Changed WC U2 from 16 to 13
Transition out CTI Removal	Remove/Inspect	[redacted]															Range is already narrow
Transition in CT Removal	Remove/Inspect	[redacted]															Range is already narrow
CT Removal	Remove/Inspect	[redacted]															Changed ML U2 from 27.3 to 28.7 Changed WC U2 from 35 to 39
Transition out CT Removal	Remove/Inspect	[redacted]															Range is already narrow
Calandria Vessel Inspection (includes transition in and out)	Remove/Inspect	[redacted]															Vessel conditions is unknown from unit to unit. Concealed conditions
Bellows Replacement and End Shield leak Repair	Remove/Inspect	[redacted]															N/A
Transition in Tubesheet bore cleaning and inspection	Remove/Inspect	[redacted]															
Tubesheet bore cleaning and inspection (5 sites each face)	Remove/Inspect	[redacted]															
Transition out Tubesheet bore cleaning and inspection	Remove/Inspect	[redacted]															
Transition in CT install	Remove/Inspect	[redacted]															
CT Install (5 sites)	Remove/Inspect	[redacted]															
Transition out CT install	Remove/Inspect	[redacted]															
Transition in Tubesheet bore cleaning and inspection	Remove/Inspect	[redacted]															Range is already narrow
[redacted]	Remove/Inspect	[redacted]															For subsequent units, reduced uncertainties around QC subjectivity and dose levels on brushes, vacuum lines, tool heads. Mitigation strategies will be in place to deal with contamination spread. In subsequent units, BC duration is 25.16 due to elimination of requirement to do 5 sites of CT Install prior to finishing CTSB Inspection
Transition out Tubesheet bore cleaning and inspection	Remove/Inspect	[redacted]															Range is already narrow
Transition in CT Installation tools	Install	[redacted]															Range is already narrow
[redacted]	Install	[redacted]															U2 was not altered. For subsequent units, ML was lowered from 94 to 85, and WC was lowered from 113 to 100. This is expected due to gained efficiency unit-over-unit with trades experience and procedural optimization
FME Inspection	Install	[redacted]															Assume debris retrieval is rework. Not included in basis - removal of 1 day
Transition out CT Installation	Install	[redacted]															Range is already narrow
Transition in Bellows Inspection	Install	[redacted]															Range is already narrow
[redacted]	Install	[redacted]															Changed WC U2 from 22 to 21 all justifications from basis sheet apply (dual table coordination, periphery sites, feeder lifts) from unit to unit, but can be improved from U2
Transition out Bellows Inspection	Install	[redacted]															Range is already narrow
Transition in FC Installation	Install	[redacted]															Range is already narrow
[redacted]	Install	[redacted]															U2 was not altered. Subsequent units will benefit from process OPEX from previous units. Improvements are also expected due to increased trades experience and procedural optimization over subsequent units. **Cost of mitigation required - dedicated technical experts required in field to improve productivity**
Transition out Fuel Channel Installation	Install	[redacted]															Range is already narrow
Remove Feeder Platform	Feeders	[redacted]															Reduction 2nd Unit (Material Handling Logistical OPEX, craft retention and lessons learned) Plus Opportunity reduction (anodize aluminum surfaces that are exposed to high risk of contamination to reduce in vault decontaminate 0 % reduction 3rd and 4th Unit due to material handling quantities and in-situ environment .
Lower Feeder Installation	Feeders	[redacted]															5% Reduction for 2nd Unit (craft / welder retention, logistics OPEX ,installation lessons learned. 5% Reduction for 3rd and 4th Units (craft /welder retention and additional installation OPEX
Transition out Lower Feeder Installation	Feeders	[redacted]															Already narrow range
Transistion in CP,SP New Fuel Load tools	Install	[redacted]															Range is already narrow
[redacted]	Install	[redacted]															U2 ML duration is aggressive based on OPEX (Bruce/Lepreau). WC is much smaller than all other retube NFL times achieved. The WC is 8 days better than achieved at Lepreau (pro-rated). The U2 duration is based on allowing fuel loading without the requirement to immediately close channel with reactor-grade SP and assumes there is no PT swab or full-length PT ID FME inspection

Report

OPG Confidential		
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Title:
DARLINGTON RFR CLASS II ESTIMATE MONTE CARLO MODEL REPORT

Duration Ranges - Critical Path Activities - August 27

Series order and list	Team	Unit 2 (Aug 20 2015)			Unit 2			Unit 3			Unit 1			Unit 4			Justification (for multi-unit and focus areas)
		Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	Best Case	Most Likely	Worst Case	
Transition out CP,SP install and New Fuel Load	Install	[redacted]															Range is already narrow
[redacted]	Feeders																Reduction 2nd Unit (Logistics OPEX ,insulation integrity OPEX ,and Craft retention) Reduction 3rd Unit (additional OPEX and Craft Retention Reduction 4th Unit (Craft Retention)
[redacted]	TMODs																RTP removal has not yet been validated at the mockup. Opportunity exists to inject this validation into the Standby Plan. OPEX gathered from Unit 2 and 3 will result in a net reduction over Units 1 and 4.
[redacted]	TMODs																Opportunity exists to train for this activity on Unit 2; however training not possible on subsequent Units as RTP will be installed at the mockup. Opportunity exists to create a mockup to simulate this activity in order to train for subsequent units.
[redacted]	TMODs																OPEX generated from Unit 2 install will result in reduced durations on subsequent Units
[redacted]	TMODs																
Airlock Doors Closed (OPG)	OPG																
Containment Test	TMODs																Test profile remains consistent for Units 2, 3, 1 and 4, thus duration reduction is not expected.
Negative Pressure Containment Logic Restoration (OPG)	OPG																
[redacted]	TMODs																Learning curve, OPEX, increased trade experience, revised and improved process/procedures and interface with OPG OPS will result in Unit over Unit improvement. WC remains the same since Bulkhead components are contaminated at this point in time
Final Vault Clean-up	TMODs																No justification for increase of best case duration. Based on electrical tasks
ATC (OPG)	OPG																
Low Power Testing and Heat-up (OPG)	OPG																
Power Escalation (OPG)	OPG																
Run-Up and Synchronization (OPG)	OPG																
High Power Testing and Turbine Testing (OPG)	OPG																
Figures To be Deleted																	
Global Risks																	

Appendix G: Model Buildup

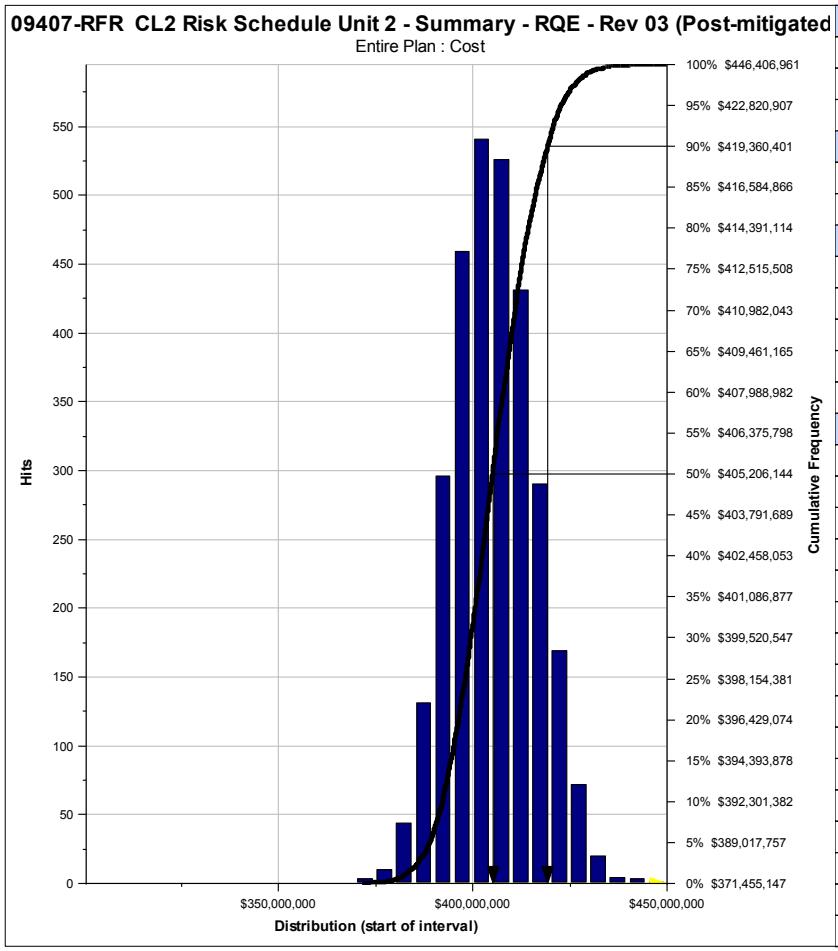
Model Buildup

Elements of the Estimate	Is it included in Contingency Calc (August 31)?	Is it included in Contingency Calc (September 24)?	Changes Since August 31st?	Applicable Period From	Applicable Period To	Final SME Agreement	OPG SME Sign off	JV SME Sign-off
TMO	Yes	Yes	Split TMO into 2 parts (30%/70%). One is dependent on critical path and grows and shrinks with it (30%). One is independent of the critical path (70%).	Reactor Shutdown Breaker Open ----- NA	Unit Mechanical Completion ----- NA	Vendor support is not schedule dependant Offsite crew based work can be adjusted by management to mitigate any schedule variations.		
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
DFL	Yes	Yes	No change	Critical Path Tasks	Critical Path Tasks	Costs are directly proportional to duration. Included for all CP items. Included for all non CP where range analysis was compelted (ex Upper Feeder Install is included)		
Series Training	No	No	No change	NA	NA	Vast majority of training cost is driven by DFL manpower attending the training. There are a set number of courses and set number of hours per course. This effort is not schedule dependant. There is a role for JV to manage the training courses. Trainers (DFL and PMT) can easily be reallocated to support Critical Path activities and bolster efforts to recover schedule Agree, however there is a component of variability of the scheduled start of each series (and thus variability in the cost of each training series)		
Onboarding - PMT	No	No	No change	NA	NA	Majority of training cost is driven by PMT attending the training. There are a set number of courses and set number of hours per course. This effort is not schedule dependant. There is a role for JV to manage the training courses.		
Onboarding - DFL	No	No	No change	NA	NA	majority of training cost is driven by DFL manpower attending the training. There are a set number of courses and set number of hours per course. This effort is not schedule dependant. There is a role for JV to manage the training courses. Agree, however there is a component of variability of the scheduled start of each series (and thus variability in the cost of each training series)		
Offsite Facility	Yes	Yes	No change	Reactor Shutdown Breaker Open	Unit Mechanical Completion			
Support Services	Yes	Yes	No change	U2-Pre Req Start /De-fuel Complete	Unit Mechanical Completion	There is a role for JV to manage the training courses.		
Subcontractors (PAUT)	Yes	Yes	No change	Upper Feeder Installation Start	Lower Feeder Installation Complete	Costs are directly proportional to duration.		
Subcontractors (Superheat)	Yes	Yes	No changes	Vault Turn Over to JV	WTS Start	Costs are directly proportional to duration. The closest milestones were used in the model - Reactor turn over to JV thru Waste tooling in-service.		

Subcontractors (Other than PAUT)	Yes	No	Remove the hammock. No more driven by duration.	NA	NA	Currently this task is not on CP therefore currently it not part of the model. No further action is required.		
Rad Work Allowance	Yes	Yes	No change	Reactor Shutdown Breaker Open	Feeder Removal Finish	Costs are directly proportional to duration.		
DFL Spot Overtime	No	No	No change	NA	NA	This is a commercial issue.		
PMT (Engineering)	Yes, included in PMT	Yes, included in PMT	No change Separate cost item for Cash Flow purpose	Reactor Shutdown Breaker Open	Unit Mechanical Completion	Costs are directly proportional to duration.		
PMT (other than Engineering)	Yes	Yes	No change	Reactor Shutdown Breaker Open	Unit Mechanical Completion	Costs are directly proportional to duration.		
PMT Spot Overtime	No	No	No change	NA	NA	This is a commercial issue.		
Subsequent Unit	No	No	No change	NA	NA	Work is not driven by duration of DFL work. P6 Level 5 schedule shows that Subsequent Unit work occur ahead of the exact execution work.		
Subsequent Unit (Engineering)	No	No	No change Separate cost item for Cash Flow purpose	NA	NA	Work is not driven by duration of DFL work. P6 Level 5 schedule shows that the Engineering (SU) work occur ahead of the exact execution work.		

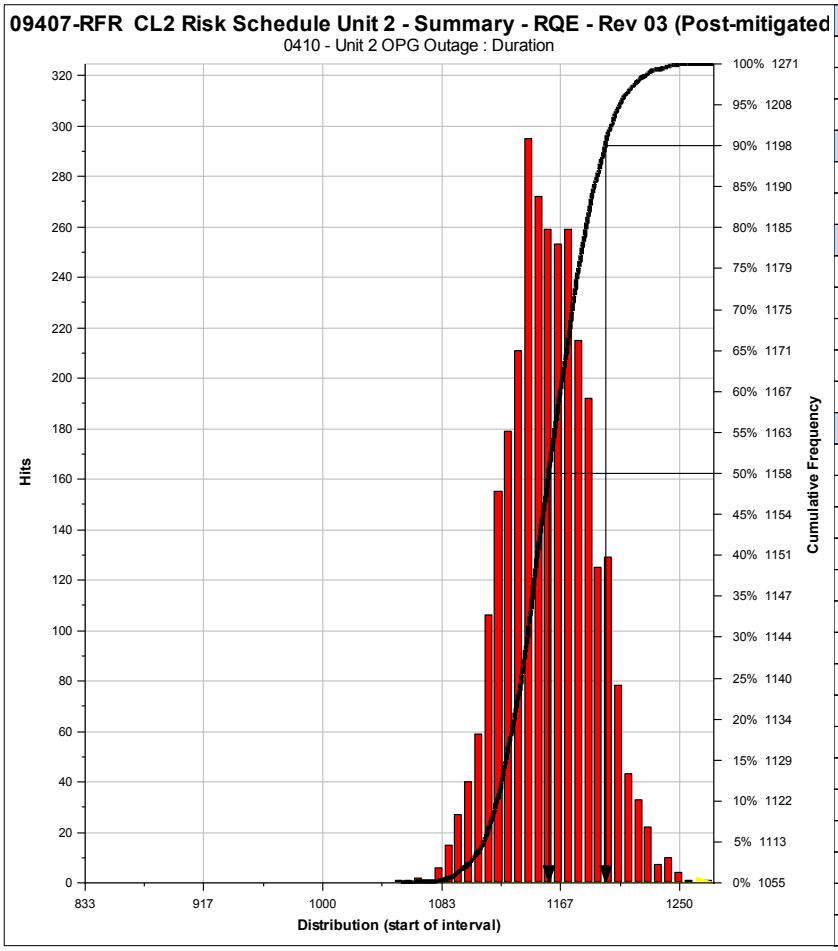
Appendix H: Simulation Histograms and S-Curves

Unit 2 – Cost Histogram



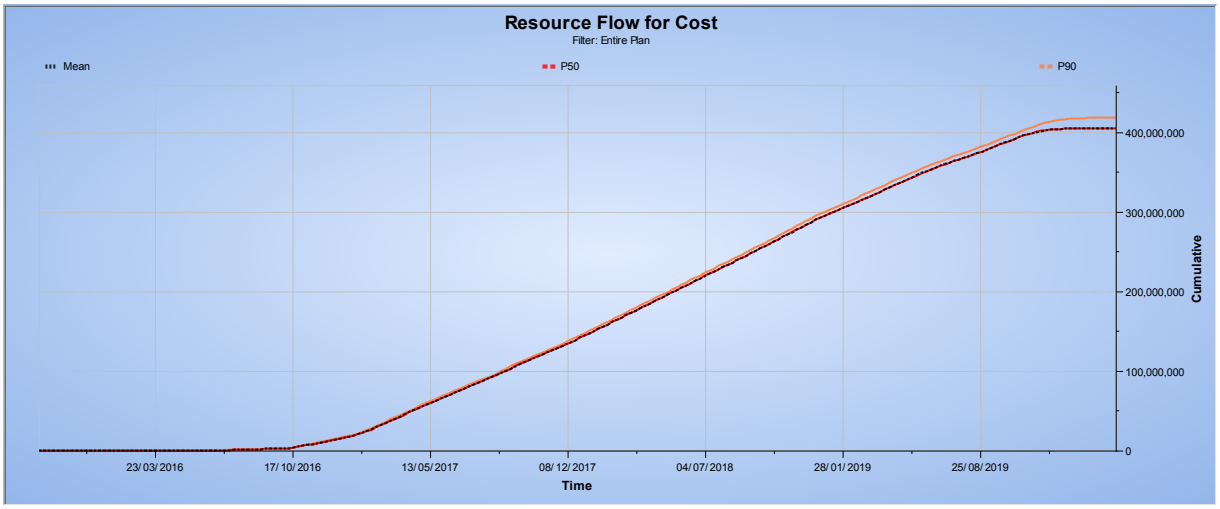
Data	
Cost of:	
Entire Plan	
Analysis	
Iterations:	3000
Statistics	
Minimum:	$371,455,147
Maximum:	$446,406,961
Mean:	$405,462,339
Bar Width:	$5,000,000
Highlighters	
Deterministic ($300,487,040)	<1%
50%	$405,206,144
90%	$419,360,401

Unit 2 – Schedule Histogram

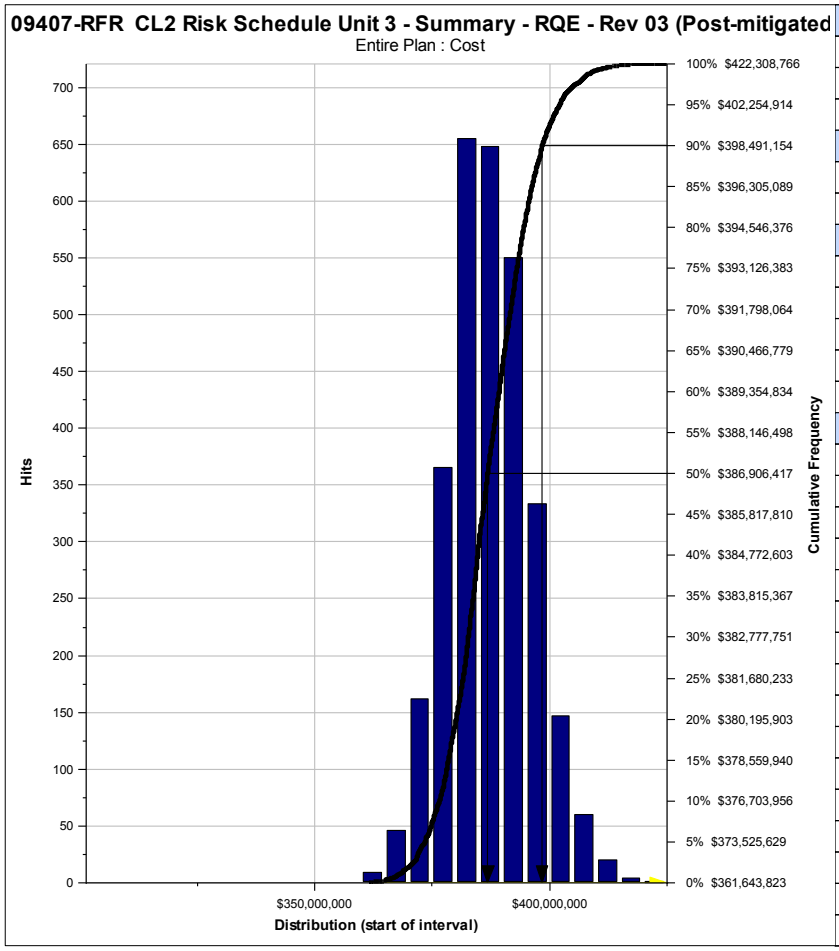


Data	
Duration of:	
0410 - Unit 2 OPG Outage	
Analysis	
Iterations:	3000
Statistics	
Minimum:	1055
Maximum:	1271
Mean:	1159
Bar Width:	week
Highlighters	
Deterministic (834)	<1%
50%	1158
90%	1198

Unit 2 – S-Curve for Cash Flow

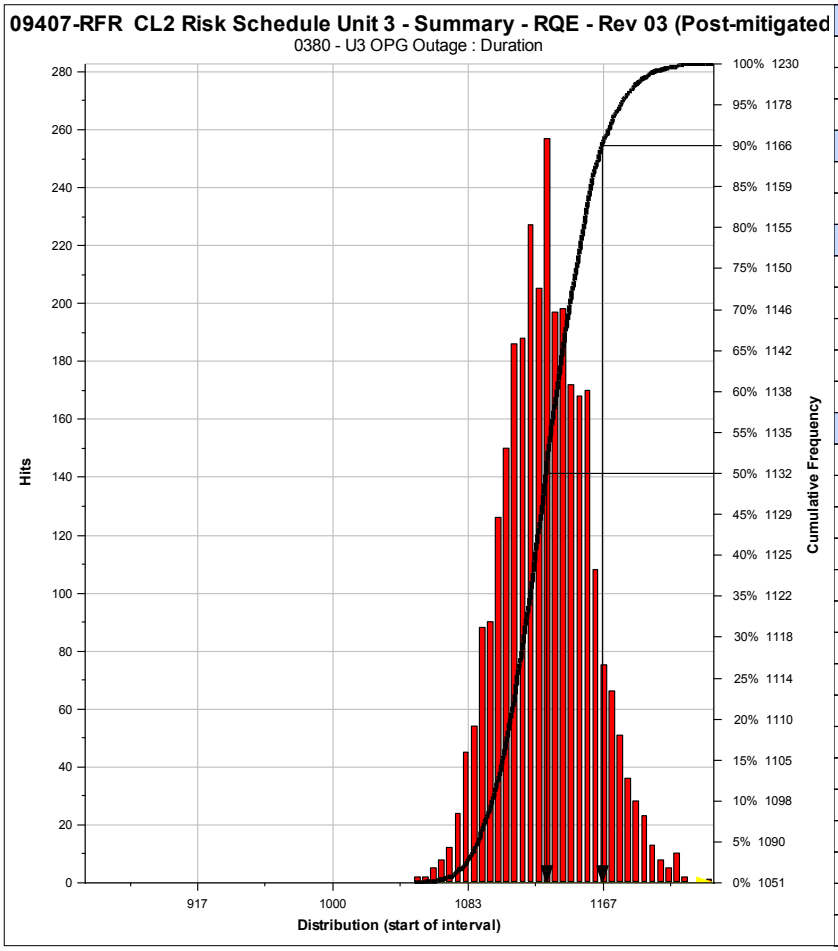


Unit 3 – Cost Histogram



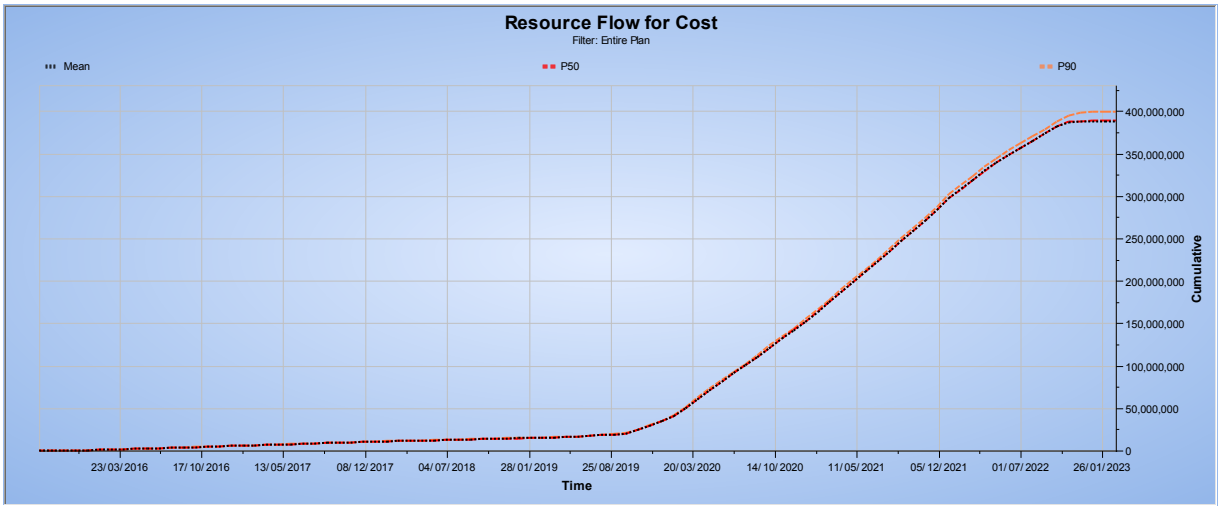
Data	
Cost of:	
Entire Plan	
Analysis	
Iterations:	3000
Statistics	
Minimum:	$361,643,823
Maximum:	$422,308,766
Mean:	$387,412,709
Bar Width:	$5,000,000
Highlighters	
Deterministic ($301,409,802)	<1%
50%	$386,906,417
90%	$398,491,154

Unit 3 – Schedule Histogram

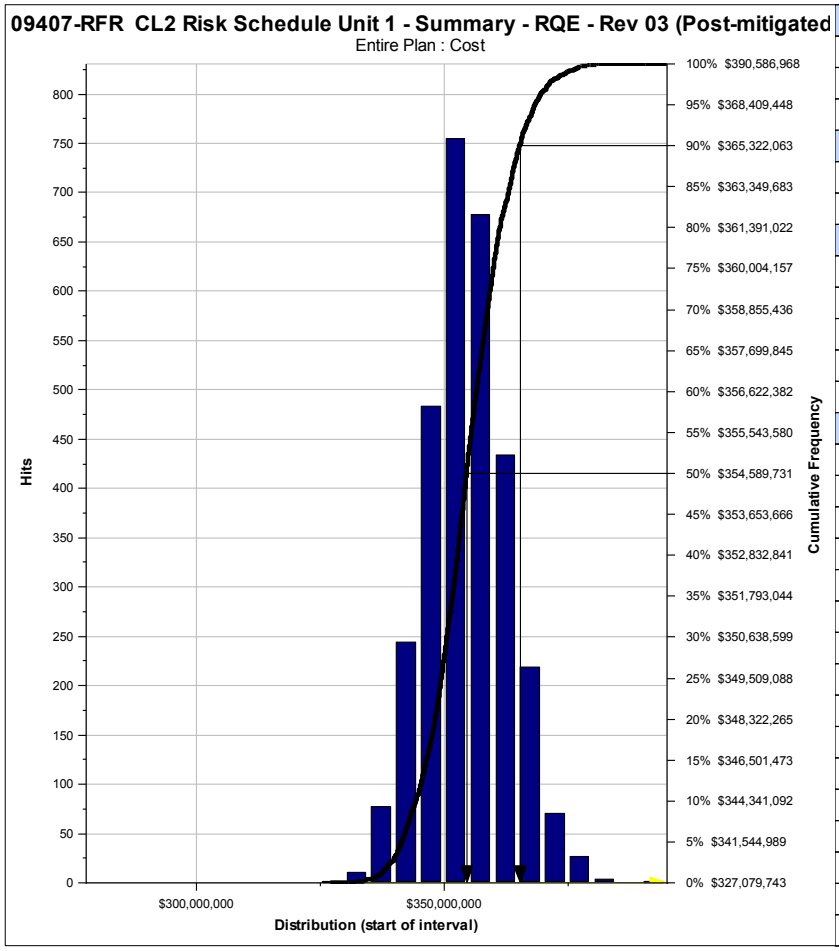


Data	
Duration of:	
0380 - U3 OPG Outage	
Analysis	
Iterations:	3000
Statistics	
Minimum:	1051
Maximum:	1230
Mean:	1132
Bar Width:	week
Highlighters	
Deterministic (847)	<1%
50%	1132
90%	1166

Unit 3 – S-Curve for Cash Flow

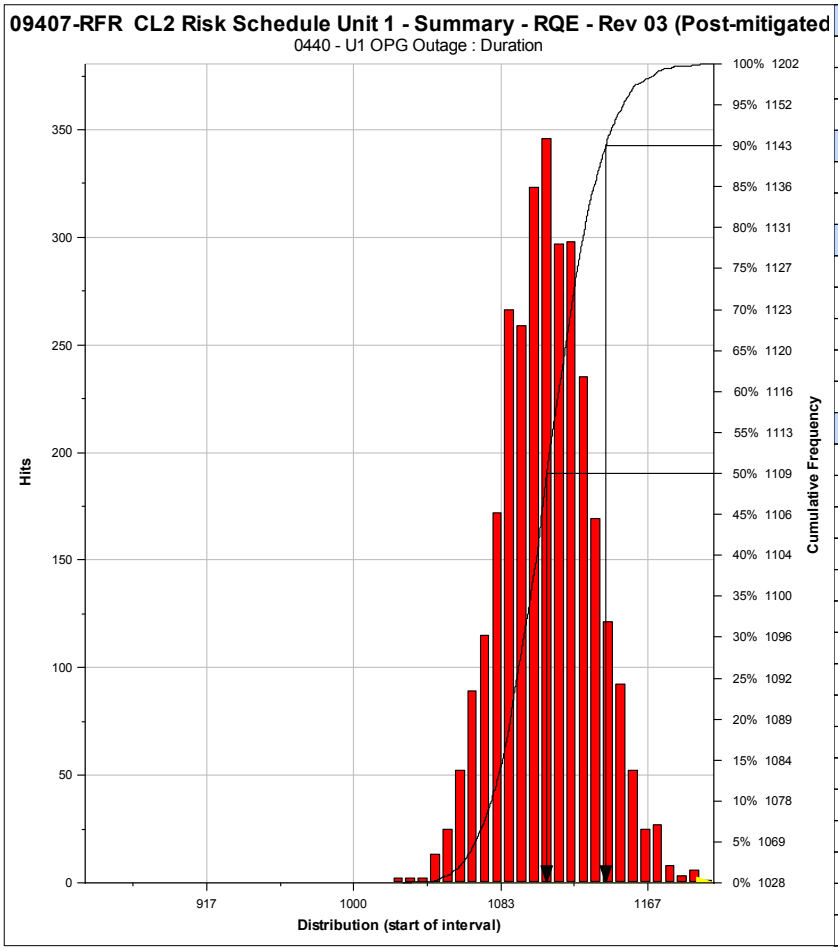


Unit 1 – Cost Histogram



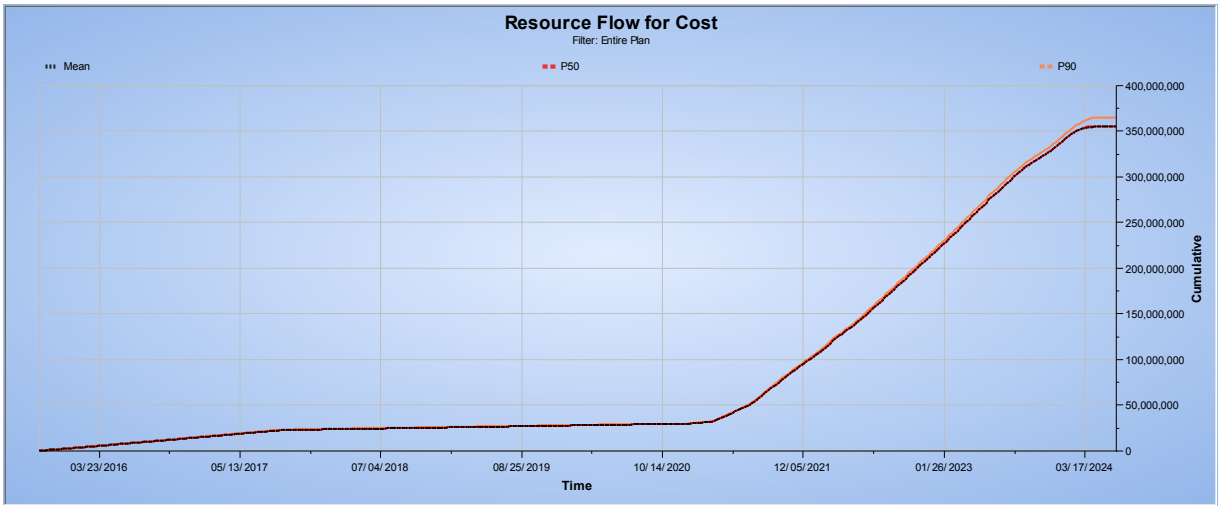
Data	
Cost of:	
Entire Plan	
Analysis	
Iterations:	3000
Statistics	
Minimum:	$327,079,743
Maximum:	$390,586,968
Mean:	$354,857,588
Bar Width:	$5,000,000
Highlighters	
Deterministic ($277,857,968)	<1%
50%	$354,589,731
90%	$365,322,063

Unit 1 – Schedule Histogram

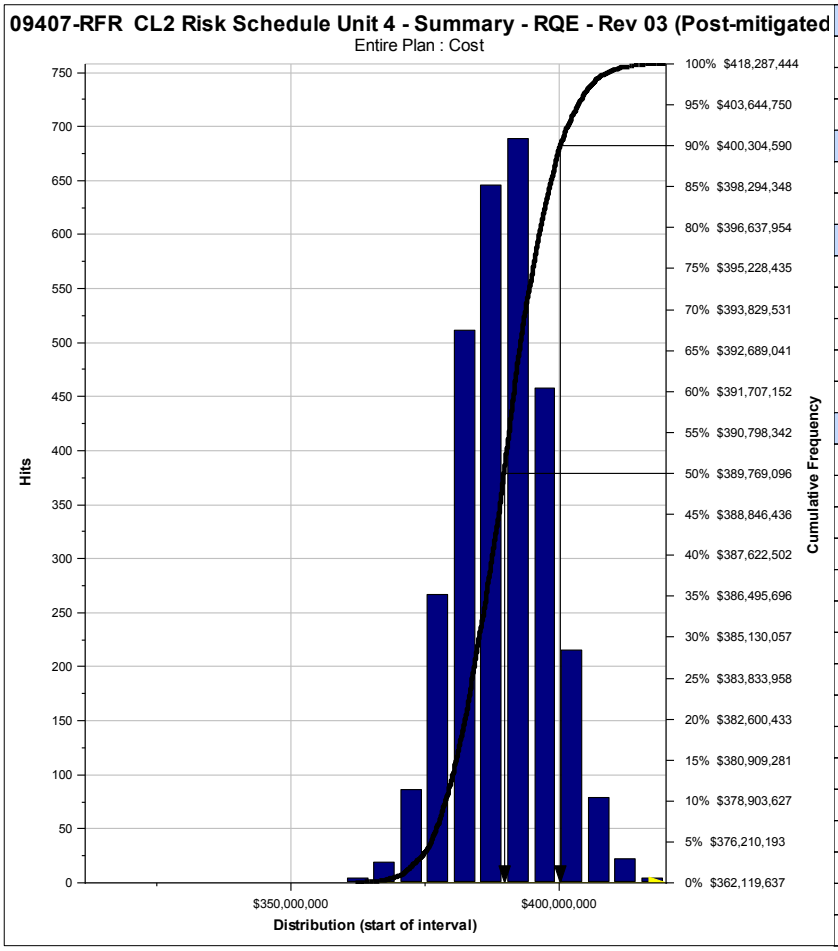


Data	
Duration of:	
0440 - U1 OPG Outage	
Analysis	
Iterations:	3000
Statistics	
Minimum:	1028
Maximum:	1202
Mean:	1110
Bar Width:	week
Highlighters	
Deterministic (848)	<1%
50%	1109
90%	1143

Unit 1 – S-Curve for Cash Flow

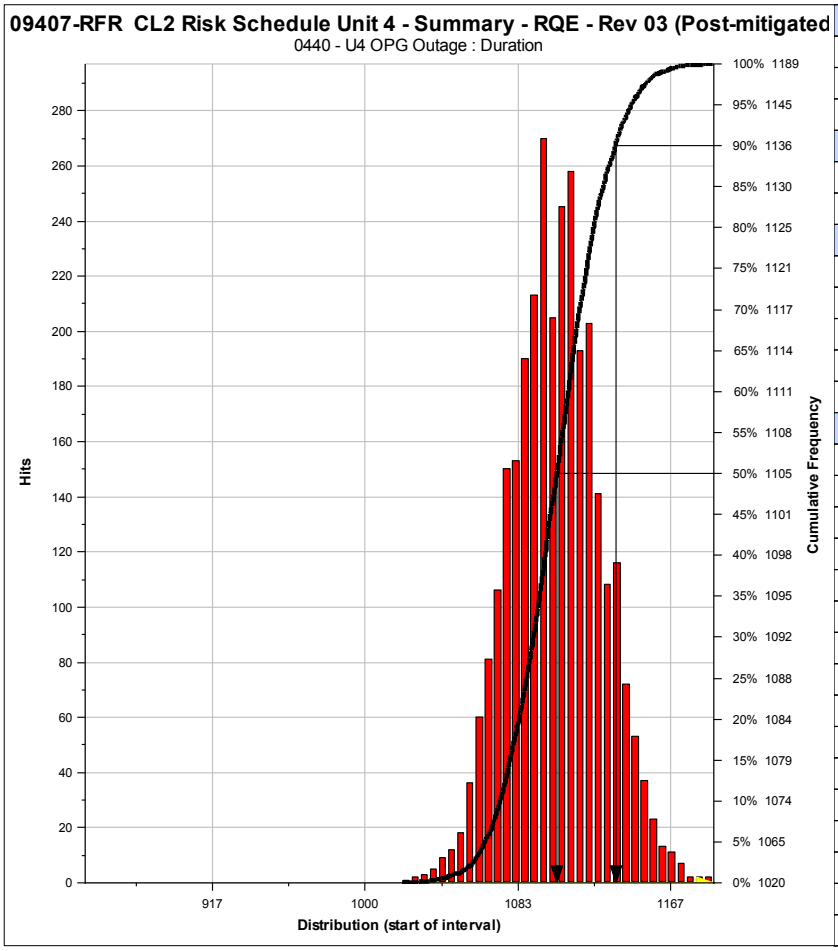


Unit 4 – Cost Histogram



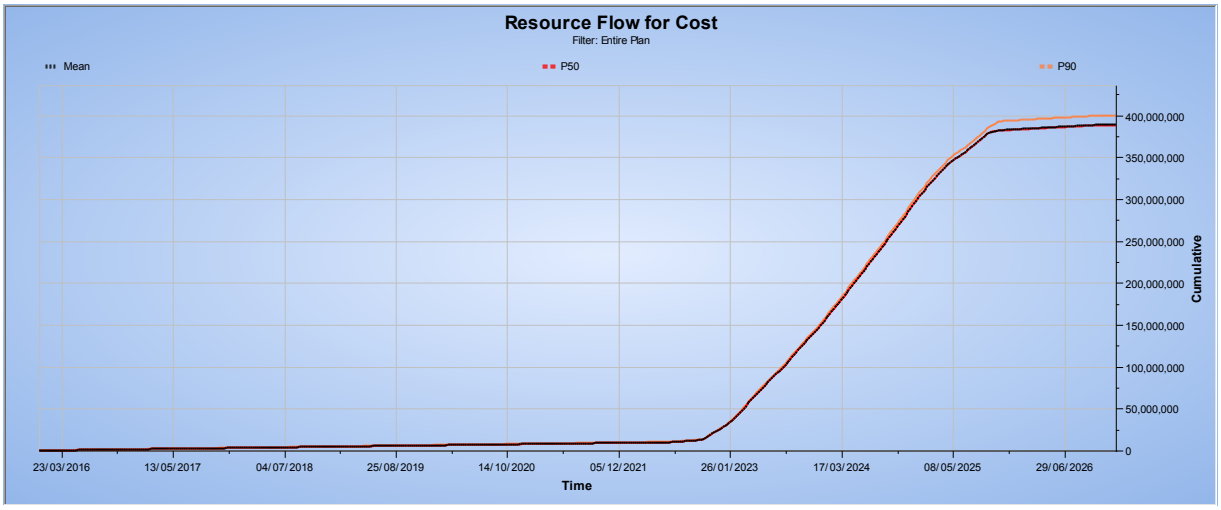
Data	
Cost of:	
Entire Plan	
Analysis	
Iterations:	3000
Statistics	
Minimum:	$362,119,637
Maximum:	$418,287,444
Mean:	$389,671,669
Bar Width:	$5,000,000
Highlighters	
Deterministic ($311,534,055)	<1%
50%	$389,769,096
90%	$400,304,590

Unit 4 – Schedule Histogram



Data	
Duration of:	
0440 - U4 OPG Outage	
Analysis	
Iterations:	3000
Statistics	
Minimum:	1020
Maximum:	1189
Mean:	1105
Bar Width:	week
Highlighters	
Deterministic (847)	<1%
50%	1105
90%	1136

Unit 4 – S-Curve for Cash Flow



Appendix I: Target Cost & Fixed Fee Calculation

Target Cost / Fixed Fee Calculation							
$M	Factor	Execution Phase Target Cost	Overheads		Profit		Fixed Fee
Unit 2		$	%	$	%	$	$
[redacted]							
Note: * Escalation not included							
Note: ** The Contingency is adjusted to remove double counting of A La Carte Rework Schedule Risks (Rework in $)							

Target Cost / Fixed Fee Calculation							
$M	Factor	Execution Phase Target Cost	Overheads		Profit		Fixed Fee
Unit 3		$	%	$	%	$	$
[redacted]							
Note: * Escalation not included							
Note: ** The Contingency is adjusted to remove double counting of A La Carte Rework Schedule Risks (Rework in $)							

Target Cost / Fixed Fee Calculation							
$M	Factor	Execution Phase Target Cost	Overheads		Profit		Fixed Fee
Unit 1		$	%	$	%	$	$
[redacted]							
Note: * Escalation not included							
Note: ** The Contingency is adjusted to remove double counting of A La Carte Rework Schedule Risks (Rework in $)							

Target Cost / Fixed Fee Calculation							
$M	Factor	Execution Phase Target Cost	Overheads		Profit		Fixed Fee
Unit 4		$	%	$	%	$	$
[redacted]							
Target Cost + Fixed Fee	Unit 4	**$ 515.10**					
Note: * Escalation not included							
Note: ** The Contingency is adjusted to remove double counting of A La Carte Rework Schedule Risks (Rework in $)							

Glossary

1) Acronym List:

Acronym	Meaning
AACE	Association for the advancement of cost engineering
CWP	Comprehensive Work Package
DFL	Direct Field Labour
DNGS	Darlington Nuclear Generating Station
JV	Joint Venture
NR	Nuclear Refurbishment
OPEX	Operational Experience
OPG	Ontario Power Generation
OSM	Owner Specified Materials
PMT	Project Management Team
PRA	Primavera Risk Analysis
PT	Pressure Tube
QA	Quality Assurance
RFR	Retube and Feeder Replacement
SME	Subject Matter Expert
TBD	To be determined
TPG	Tool Performance Guarantee

2) Definition List

Cost Uncertainty Range	Represented by triangular distributions assessed by JV and OPG SMEs. Inputs to the risk models are 3-point cost estimates.
Deterministic Best Case	Calculated based on the deterministic best case for both duration and cost.
Global Risks	Global Risks are risks applicable to multiple tasks, or to the entire Unit.
Hammock task	A schedule or project planning term for grouping tasks that “hang” between end dates it is tied to.
Indirect Cost Item	Represented in the P6 XER file as hammock tasks or normal tasks, depending on JV and OPG SMEs’ common views on whether they are dependent on critical path contingency or not respectively.
Mapped Risk	Mapped Risks that are risks mapped/“linked” to specific CWP level tasks.
Monte Carlo	Mathematical technique that allows user to account for risk in quantitative analysis and decision making.
Monte Carlo Model	Risk simulation model using Monte Carlo sampling method.
Primavera Risk Analysis (PRA)	A tool that helps model risks and performs analysis of cost and schedule impacts (previously known as Pertmaster).
risk model	Refers to a Unit specific risk simulation model.
Single Point Estimate	Estimating technique that uses the average of each set of a minimum value and a maximum value.
Schedule Uncertainty Range	Represented by triangular distributions assessed by JV and OPG SMEs and Input to the risk models as 3-point duration estimates.
Summary task	A summary task is a task in P6 schedule that contains subtasks and summarizes their information.
Uniform Distribution Range	A distribution that has a constant probability range.

AMPCO Interrogatory #45

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-3 Attachment 1 Page 7

Preamble: The Summary of EPC Contract for RFR with SNC/Aecon JV indicates that a certain amount of typical rework is to be expected on a project of this nature.

a) Please explain the basis for a 3% rework.

b) Please provide the value of the allowance and show the calculation.

Response

a) Studies completed by the Construction Industry Institute (CII 2005) have concluded that rework contributes to approximately 5% of construction costs. Other studies have concluded that rework can range from 2% to as high as 7%, and in some cases up to 12%. OPG reviewed this information against the complexity of the RFR work and determined that it was too high for items such as engineering and other non-industrial work. Additionally, OPG considered that a significant portion of the trade work is removal, under which there will be no rework. OPG determined that 3% was reasonable based on the nature of the work and the unique nature of the project.

The 3% fee was a point of negotiation during the Request for Proposal where both proponents felt it was too low, but both ultimately accepted the figure.

b) [redacted]

AMPCO Interrogatory #46

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-3 Attachment 1 Page 10

Preamble: The evidence states "The agreement requires that ownership of the physical tooling be transferred to OPG as such tooling is completed".

a) Please confirm that all the tools have been manufactured and tested.

b) Please provide a listing of Major Tools and their projected useful life.

c) Please explain the role of SNC/AECON JV in the non-performance of the tools during the execution phase.

d) Please explain what role SNC/AECON JV has in the repairs of the tools during the execution phase.

e) Please explain the cost of disposal of the tools and where/by whom the disposal costs are to be borne.

f) Are the disposal costs included in the cost of the DRP?

Response

a) Please refer to L-4.3-2 AMPCO-63. In short, with limited exceptions, the tooling was delivered and commissioned as part of the Definition Phase by mid-2016.

b) Major Tools include:

- Tools for the removal of the reactor components and hardware
- Tools for removal of the reactor face insulation and feeder cabinets
- Tools for the installation of the new reactor components
- Inspection Tools
- Drainage and drying tools and equipment
- Tooling required for waste management & processing
- New Fuel Loading Tools

Although the useful lives of the tools are not spelled out explicitly in the Retube and Feeder Replacement (RFR) contract, the tools must meet or exceed the required standards in the scope of work and tooling design requirements, which includes tool testing, commissioning, training and execution of all four units.

c) The performance of the work in regards to tooling is found in section 2.2(a)(1) of the RFR contract and, at a minimum, the tooling must meet or exceed the requirements of the tooling design requirements, the RFR scope of work, the tooling performance guarantee and the contractor/owner interface requirements (EPCIR) set out in the contract. That standard continues through the Execution Phase. Additionally, under section 4.8 of the RFR contract, the contractor has an obligation to design tooling that will perform satisfactorily under the full range of predicted conditions.

d) In addition to the above tooling requirements, the contractor has an overriding obligation to ensure the entire work is completed in a timely manner as part of their functional scope for the project, irrespective of tool break-downs or delays. Under section 3.2 of the RFR contract, the contractor must adhere to the target schedules and give OPG notice for deviations in schedule. Additionally, under the tooling design requirements, the contractor must also have contingency tooling for all major tool sets to reduce overall project risk for tool breakdowns. For example, where some tools have a shorter life by design, contingency plans may include obtaining higher quantities with a planned replacement or swap-out of a tool.

e) Under s. 2.2(a) of the RFR contract, the contractor must remove and dispose of the tooling appropriately. The contractor has specified the removal procedure and estimated waste categories and volumes in the tooling life cycle plan. The disposal costs were included in the Execution Phase target price. OPG will pay for the actual costs incurred in respect of the disposal costs.

f) See part e) above.

AMPCO Interrogatory #47

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-3 Attachment 1 Page 12

Preamble: The Summary of EPC Contract for RFR with SNC/Aecon JV states that the agreement permits OPG to suspend the work at any time.

a) Please provide examples of circumstances that would require OPG to suspend the work.

b) Please provide details of the circumstances that result in certain types of direct damages payable by OPG to the contractor.

Response

a) Suspensions of the work may occur for a variety of reasons, including due to significant safety or quality issues on the project, other potential requirements related to operation of other units of the Darlington facility that interfere with the contractors' scheduled work, or changes to the schedule as a result of prerequisite activities being delayed.

b) Under s. 16.1 of the Agreement, OPG would be responsible to pay reasonable direct damages to the contractor, except to the extent that the suspension was caused by the contractor. Where the suspension was not caused by the contractor, if the suspension is less than one week, the contractor receives only actual costs. If the suspension exceeds one week, the contractor also receives the related profit and overhead.

AMPCO Interrogatory #48

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-3 Attachment 3 Page 7

Preamble: The Summary of EPC Contract for Turbine Generators with SNC/Aecon JV indicates the agreement includes an allowance equal to 4% of the labour portion of the execution phase target cost for the first unit to be refurbished and 3% of the labour portion of the execution phase target cost for each subsequent unit for rework.

a) Please provide the $ value for the 3% and 4% rework.

b) Please explain why for this contract, a higher allowance for rework is agreed to for the first unit. For the RFR contract a 3% rework allowance was agreed to.

Response

a) Unit 2 - $855,275 4%
Unit 3 - $991,791 3%
Unit 1 - $962,952 3%
Unit 4 - $1,108,949 3%

The difference in values between the units is due to escalation and unit-over-unit scope differences.

b) Rework value of 4% was derived for the first unit due to the fact that the nature of the Turbine Generators work was specialized work and first-in-a-while work, which did not include repetitive task and large scale removal of components. Subsequent units would have the 3% rework rate applied as a measure of efficiencies gained from the first unit.

AMPCO Interrogatory #49

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-4 Page 2

a) Please provide the total spend to date.

Response

a) The life to date actual costs for the Definition Phase is $2.183 Billion at December 31, 2015. The life to date actual costs for the Darlington Refurbishment Program, including both Definition and Execution Phases, is $2.900 Billion at September 30, 2016.

AMPCO Interrogatory #50

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-4 Page 3

Preamble: With respect to meeting key Definition Phase milestones, OPG indicates that regarding Scheduling, OPG developed an integrated Level 2 schedule for the Program and an integrated and resource-loaded Level 3 schedule for the Unit 2 preparation and Execution Phase.

a) Please explain what OPG means by resource-loaded.

Response

a) A resource loaded schedule means that the type of trades (e.g., boilermakers, pipefitters, millwrights, etc.) required for each activity in the schedule, as well as the hours required for each type of trade, have been loaded into the scheduling tool. This allows not only accurate scheduling of the correct trades to show up to each job, but also allows detailed analysis of the schedule to identify resource peaks and potential conflicts in the demand for resources, which can then be addressed through a resource-levelling exercise. Resource-loaded schedules also allow detailed costing of each activity and earned value reporting through interface with the costing and reporting systems (see: L-4.3-1 Staff-57).

AMPCO Interrogatory #51

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-4 Page 3

a) Please confirm the party that undertook the independent assessment of the RQE.

b) Please provide the key updates that were made to the DRP Business Case Summary.

Response

a) The party that undertook the independent assessment of the RQE was KPMG. Their report is filed as Ex. D2-2-8, Attachment 3.

b) The Darlington Refurbishment Execution Phase Business Case Summary is filed in Ex. D2-2-8, Attachment 1. The key updates to the DRP Business Case Summary compared to the November 2013 Business Case Summary (previously filed in EB-2013-0321 at Ex. D2-2-1, Attachment 5) are as follows:

- The costs of the DRP were updated to be consistent with the RQE.
- The schedule for the DRP was updated to be consistent with the RQE high confidence schedule.
- The post-refurbishment cost assumptions (cost to operate, maintain and fuel the station) were updated to OPG's latest outlook.
- All Levelized Unit Energy Cost calculations were updated from 2013$ to 2015$.
- Narrative descriptions of progress in Project Planning, Major Projects, Pre-requisite Projects (including the Facility and Infrastructure Projects), Regulatory Projects and Safety Improvement Opportunities were updated to reflect progress to the Fall of 2015.

AMPCO Interrogatory #52

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-4 Page 4 Chart 1 Key Lessons Learned

a) Please provide a summary of all of the reference documents that OPG reviewed.

b) For each of the past CANDU and other nuclear refurbishment projects reviewed, please provide the technical similarities and differences of these projects compared to the DRP and the key lessons learned by project.

c) Please provide the specific operating experience and lessons learned from each of the non-nuclear mega projects: Niagara Tunnel, Lower Mattagami River projects, London Olympics, Alberta Oil Sands, Toronto Union Station Redevelopment, and Heathrow Airport Terminal 5.

d) Please describe the benchmarking visits that OPG conducted.

e) Please describe the new benchmarking and collaborations that are planned.

f) Please explain how the lessons learned discussed in b) and c) were incorporated into the DRP.

Response

a) OPG declines to answer this question. The question does not recognize proportionality considerations which underlie the interrogatory process, in that it is overly broad and all encompassing. The question contemplates the production of every reference document that OPG reviewed over a period of more than five years in compiling operating experience and lessons learned for DRP.

   Please refer to L-4.3-1 Staff-053 for a list of information that OPG staff reviewed from certain megaprojects. Please see parts b) and c) below for summary lessons learned reports.

b) Please see L-4.3-1 Staff-052 which provides a summary of the similarities and differences of the DRP to previous refurbishments. Attachments 1 and 2 provide summary lessons learned reports for 2013 and 2014, respectively and include lessons

learned from other nuclear projects. Attachment 3 provides a summary of the lessons learned library from the Risk Management and Oversight (RMO) tool for 2014-2015.

c) See part b). Specific lessons learned from the Niagara Tunnel and Lower Matagami River Projects are provided in Attachment 4.

d) OPG performed benchmarking visits to other utilities during the development of the Release Quality Estimate. These visits focused on utilities undertaking similar projects in terms of scale, cost, or technology, such as the Tennessee Valley Watts Barr project. The onsite benchmarking included interviews with site staff, reviews of plans and processes the utility was undertaking, and understanding of lessons learned and best practices. The objective of the benchmarking was to integrate this knowledge into the plans and processes for the DRP.

e) OPG is continuing to collaborate with Bruce Power in order to leverage the planning and execution expertise in both organizations. Benchmarking and collaboration visits and related activities are an expectation of all the senior staff at the DRP. There is no specific schedule of these visits which OPG can provide as they are conducted as part of a normal part of doing business. See L-4.3-2 AMPCO-100 for the Memorandum of Understanding regarding collaboration with Bruce Power.

f) Lessons learned were key drivers of all of OPG's Definition Phase planning activities. OPG's evidence, in particular, Ex. D-2-2-4 explains how these were incorporated into the DRP.

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Document Number: NK38-REP-09701-0491208	Usage Classification: N/A
Retention: LOF10	Revision: N/A

Title:
2013 DARLINGTON REFURBISHMENT PROGRAM OPEX/KEY LESSONS LEARNED (KLL) REPORT

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2013 Darlington Refurbishment Program OPEX/Key Lessons Learned (KLL) Report

NK38-REP-09701-RN/A LOF10

2014-01-29

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Internal Use Only

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Executive Summary

Successful organizations develop systems to share information from past successes and failures as part of their knowledge management practices. Darlington Refurbishment Program (DRP) defines these "key lessons learned" as knowledge or understanding gained by experience. Sharing these lessons learned can reduce risk, improve efficiency, promote processes, and improve performance during all phases of the refurbishment program.

The DRP OPEX adheres to and supports the authority of the fleet N-PROC-RA-0035, which incorporate and shares lessons learned gathered through INPO, WANO, COG, OPG internal operating and projects experiences. The DR program has established N-MAN-00120-1001 which increases its range to include project management key lessons learned through benchmarking visits, project reviews, including benchmarking of non-CANDU NPPs and non-nuclear mega projects. Both programs together collect and share information to enable continuous learning for the DRP.

1.0 INTRODUCTION

The DR program describes knowledge project management as "the methods our organization will use to retain and share knowledge produced by its workers, industry and past refurbishment and other projects. Effective project management activities foster an environment in which the right information gets to the right people at the right time in ways that measurably improve performance.

Since 2007, the DR organization has identified 3 primary goals for its OPEX and Lessons learned systems and processes:

1. Sustain OPG's knowledge across the program;
2. Organize, train and share refurbishment project existing knowledge; and
3. Generate SCR and/or Risks as needed.

OPEX/Key Lessons learned preserve institutional knowledge and communicate experiences that can potentially reduce risk and improve efficiency and performance. These lessons may come from a variety of project management areas, including safety, engineering, operations, procurement, management, and managed systems oversight.

KEY Lessons learned are to be general statements that describe good practices or innovative approaches that are shared to promote repeat application. They may also be descriptions of challenges, risks or areas for improvement that are shared to provide continuous improvement.

2.0 2013 DARLINGTON REFURBISHMENT OPEX METRICS

Group	Program Element	Metric	Measure	Score	Green	White	Yellow	[illegible]
Fleet	Incoming OPEX	Fleet OPEX SME Disposition Rate	Monthly %Submittted[1]	**89%***	< 90% of reports	80 reports	70 reports	< 60 reports
Refurbishment	Incoming Project OPEX	OPEX SME Disposition Rate	Monthly % Submitted[1]	**100%***	> 90% of reports	80 reports	70 reports	< 60 reports
	Key Lessons Learned (KLL) Risks	Assigning Risk to KLL	Total	**22***	Trend reports	Trend reports	Trend reports	Trend reports
	Key Lessons Learned (KLL) Closed Risks	Assigning Risk to KLL	Total	**11***	Trend reports	Trend reports	Trend reports	Trend reports
	Adding Value Assigning SCR	Number of OPEX that generated an SCR	12 Month Rolling Total[2]	**2***	Trend reports	Trend reports	Trend reports	Trend reports
	Adding Value Assigning Risk	Number of OPEX that Generated a Risk	12 Month Rolling Total[3]	**11***	Trend reports	Trend reports	Trend reports	Trend reports

[1]month-end submission deadline = OPEX Received divided number dispositioned (10 business days) in time

[2]of OPEX SCRs with Status > = OPEX that generated an SCR, in-progress.

[3]of OPEX Risk created Status > = OPEX that generated a Risk, in-progress.

***All data is from Jul1st – Dec 31st**

An explanation of the colour codes are described below.

GREEN

- Excellent meeting the requirement of the metric.

WHITE

- Good there is room for improvement. The organization should review their process and see what can be done to improve to green status.

YELLOW

- Fair metric is indicating that there are problems with governance or execution of the OPEX process. Corrective actions may be required to improve the effectiveness of their OPEX process.

[illegible]

- Poor the OPEX process is not fulfilling its obligation to share information to the broader industry. Corrective actions are required.

3.0 EXECUTIVE SUMMARY ON KEY LESSONS LEARNED

This report covers the period of Jan. 1, 203 to Dec. 31, 2013. The key lessons learned are summarized below along with associated Risks and SCR's generated.

3.1 The Darlington Refurbishment (DR) Organizational Structure is independent from Darlington Station

OPEX from multi-unit sites has shown that large scale refurbishment projects can negatively impact plant performance. A review of Brown's Ferry OPEX showed that the construction organization should be independent from the operating organization.

As an organization we've learned early through project quality management that an independent refurbishment organization, established early to minimize impact on plant operation was the best approach. Today we are a separate organization, which is centre-led program team (i.e. matrix organization) with functions providing governance, standards and expertise to each of the program pillar projects of refurbishment.

Risk 82: Resources optimized for station operations rather than refurbishment program

Status: Closed

Risk 315: Inability to establish adequate project organization

Status: Closed

3.2 The Engineer, Procure and Construct (EPC) Contracting Model has been implemented

OPEX from benchmarking trips to Luminant Power Company at Comanche Peak, Southern Nuclear Operating Company at Vogtle, and New Brunswick Power at Pt. Lepreau, as well as Lessons Learned from Pickering "A" Restart and Bruce A Restart all confirmed the EPC model as the most effective and commonly used model for nuclear refurbishments.

We've learned it was prudent and good business, establishing an effective contract business management strategy early and established our Engineer, Procure and Construct (EPC) contracting model and oversight. This approach clearly defines accountabilities, allocates risk where best managed, encourages performance, and minimizes handoffs between the owner and contractor. This model has been proven to result in fewer delays and promotes an owner-contractor environment of teamwork, trust and transparency.

Risk 37: Procurement and Contract Management

Status: Closed

Risk 58: Input from regulatory bodies interferes with contract negotiations.

Status: Closed

Risk 312: Ineffective owner/ contractor relationship or alignment

Status: Closed

3.3 Front End Planning has been implemented

OPEX statistical information, based on review of 318 megaprojects, identified insufficient front-end planning as a primary source of megaproject failures.

We've learned by adopting the Construction Industry Institute (CII) Front End Planning (FEP) through our quality procurement management approach, it ensured our program is ready to progress to the next phase through an objective stage-gate decision process.

Risk 106: Contractor involved too late

Status: Closed

3.4 Full Scale Reactor Mock-up for training and tool development has been built

OPEX shared during the refurbishment efforts at Bruce Power and New Brunswick Power, is that delays and cost impacts were incurred as a result of tooling incompatibility and a lack of worker training and task familiarity at the work face.

We've learned early in the Refurbishment to include in the scope the construction of a full scale reactor mock-up to assist in the training of personnel and development and the testing of tools and work plans. This will ensure worker familiarity with tasks and tooling compatibility when the execution phase begins.

3.5 The Regulator is engaged early and consistently throughout each phase of the project

OPEX form Pickering 'A' Restart assumed that the regulatory approval process could be completed in 3 months and did not anticipate having to prepare a formal Environmental Assessment (EA). The regulatory approval process ended up taking more than 2 years.

We've learned establishing early engagement of the CNSC enabled the DR Project to submit and obtain acceptance of the process and scope for the Integrated Safety Review (ISR) and EA at the initial stages of the assessments.

Risk 11: CNSC resource availability to review documents

Risk Status: Active

Risk 44: Regulatory uncertainty with regards to contractors

Risk Status: Active

Risk 133: Licensing requirements change during and/or after refurbishment

Risk Status: Active

Risk 59: CNSC does not approve modification of containment to allow opening of airlocks as required for movement

Risk Status: Closed

3.6 Operations and Maintenance (O&M) is a member of the DR Organization

OPEX during commissioning activities and a Foreign Material Exclusion (FME) at Brown's Ferry, Bruce 'A' and Pickering 'A' showed a lack of involvement of dedicated O&M organization.

We've learned from our past experiences andestablished an Operations and Maintenance organization with considerable working experience at Darlington Station has been embedded in the DR Program to ensure optimized integration and streamlined interfacing with the operating station throughout the refurbishment effort and provide oversight for ongoing maintenance activities.

Risk 125: INACTIVE - Non-conforming components or inspections

Risk Status: Closed

Risk 477: Inadequate commissioning/RTS process

Risk Status: Closed

3.7 Project Management processes and controls is implemented throughout each phase of the project

OPEX concerning Management activities at Pickering 'A' Return to Service determined early in the project that Project Execution Plan (PEP) was unnecessary.

We've learned early it was important to adopt processes and controls from the Project Management Institute (PMI) to administer the core project elements at the outset of the Initiation Phase and have maintained these throughout the current development phase in Project Management Plans (PMP). Project Management governance and processes established early to support alignment and efficiency.

Risk 39: Poor governance and process management

Status: Active

Risk 184: Ineffective communications leading to misunderstanding of desired business outcomes during Definition Phase

Status: Active

3.8 The Scope definition is defined early through a control process

OPEX from Pickering 'A' Return to Service work began without a complete and comprehensive determination of scope resulting in considerable schedule delays and cost overruns.

We've referenced past scope identification from past CANDU refurbishment projects and were used to assist in the development of our scope. A scope review board process has been set up to control and manage scope growth. The Integrated Safety Review, Environmental Assessment and Integrated Improvement Plan provide regulatory certainty for scope.

Risk 309: Unforeseen or unexpected regulatory upgrades required after project work scope freeze date.

Status: Active

3.9 Integrated Multi Level Scheduling and Standardization has been implemented

OPEX from Pickering 'A' Return to Service project discovered that a lack of integrated schedule resulted in contractors and suppliers performing work without knowing how it would contribute to the overall timing of project.

We've learned integrated schedules developed to support a coordinated planning approach across the project organization are imperative to our success. Contractors are expected to use the industry standard Primavera planning software and OPG coding to ensure integration is easily achieved. Improved cost management IT tools and associated workflows are being configured and implemented in advance to assist in work efficiency.

Risk 300: The Campus Plan schedule developed, but may not be fully integrated with the refurbishment schedule.

Status: Closed

Risk 303: Project schedule uncertainty due to limited planning by RQE

Status: Closed

3.10 Work will be planned separately for each of the refurbishment units

OPEX from Bruce Power discovered that work was not scheduled by each unit. This resulted in an inability to clearly determine costs to complete each unit and a degraded ability to efficiently capitalize major portions of work, resulting in greater interest costs.

We've learned while work is being planned the schedule has to be populated by each nuclear unit or project, wherever possible, to ensure optimal cost efficiency and traceability.

3.11 Risk and Contingency Management process is implemented throughout each phase of the project

OPEX gained from Pickering 'A' Return to Service showed inadequate risk management practices resulted in missed milestones and unfavourable variances relative to forecasting and reporting.

We've learned that it was imperative for refurbishment to establish a robust program for the identification and management of risk. Contingency allowed for projects is to address residual risk required after mitigation plans have been developed. Utilization of contingency is controlled through a managed change process. A focus has been placed on identifying and managing risks and their impacts at the point of discovery.

Risk 337: Ensure the risk is at an appropriate level in which confidence in the program estimate is not achieved, leading to insufficient or too much contingency

Risk Status: Active

3.12 Cost Management and Earned Value processes are incorporated in Program Reporting

OPEX from Pickering 'A' Return to Service Project identified that it lacked the necessary processes and reporting in place to effectively monitor progress or outlined costs by discernible groups and had no reliable measure of earned value that could be determined.

We've learned by using standardized metrics and reporting at the department level early in the program established control, understanding and alignment within the program and with external stakeholders. This will provide timely and accurate cost information resulting in greater cost predictability. An Earned Value Management system will be utilized to track project cost and schedule performance. Targeted metrics will be established at each phase of the project to monitor and control OPG and vendor cost performance.

Risk 661: The risk is that ineffective and/or inappropriate management decisions are made due to deficient processes, flawed metrics or uncontrolled/unverified source data.

Risk Status: Active

3.13 DR Safety Program has been implemented for OPG and Contractors

OPEX from previous outages have shown instances where safety procedures were violated, resulting in increased employee injuries, regulatory surveillance and involvement, schedule non compliance, and reduced cost performance. Any item that involves negative safety trending analysis or safety management system failures in relation to construction or maintenance activities should be included in this KLL.

We've learned by using standardized metrics and reporting established early for control, understanding and alignment with project members and external stakeholders alike. Safety is our core value in Refurbishment. Serious and critical injuries are a risk to the project with regards to work delays and cost overruns. OPG NR and its vendors understand the importance of measuring safe acts and behaviours on the prevention of injuries and reduction of worker risk. As the Constructor we are ultimately responsible for the safety of all workers on the project, both vendors and our employees.

Risk 550: Risk of significant construction event may impact cost and cause delay to schedule.

Risk Status: Active

3.14 Radiation Protection Management process has been implemented

OPEX from various radiation protection events from other refurbishment project indicated a high quality management of Radiation Protection (RP) is required to ensure that the refurbishment is completed in a safe, quality, and economic manner.

We have a strong strategy that is in place to develop and ensure Service Protection RP oversight is provided to the EPC Contractor by performing Nuclear Refurbishment activities within the refurbishment island

Risk 564 : Airborne Alpha Radiation Emitting Contamination Hazard May Result in Worker Uptakes During Refurbishment activities, similar to Bruce Power Alpha exposure event.

Risk Status: Active

3.15 Contracted services and manufactured Items are procured from qualified vendors

OPEX observed from Bruce Power identified on several occasions that manufactured items did not meet the product quality or specification, which generated rework.

We've learned early that NR Supply Chain has to be engaged with OEMs process of any major components prior to a contract award. Once the EPC contract has been

awarded, information is transferred to the successful contractor. Performing oversight on procurement activities executed by the EPC contractor is a must for Nuclear Refurbishment. Specific oversight activities such as review of RFP process, contract award is already in progress. Subsequent oversight on downstream activities are planned to address any potential non-conformances.

3.16 Return to Service process is implemented

OPEX gained from previous Return to Service programs revealed many lessons learned to be considered for future RTS projects.

We've learned by having the "Return to Service" process developed early and developed by Nuclear Refurbishment will lead to efficient turnover of the station from Refurbishment to Operations.

Risk 477: The risk is that current commissioning/ RTS processes may not meet the needs of Refurbishment

Risk Status: Active

3.17 Stakeholder Relations and Communications plan is implemented

OPEX concerning project communicated showed instances where project related information was not communicated to key stakeholders such as the grid operator, contractors, and/or regulators.

We've learned early that our Communications plan established early describes how we will manage and determine how program information will be distributed to meet the needs of project stakeholders (both internal and external).

Risk 184 : The risk is that expectations across stakeholder groups in OPG or Nuclear industry are not managed, resulting in misunderstanding regarding Darlington Refurbishment Business Case during Definition Phase.

Risk Status: Active

3.18 Skilled Worker Training Program has been implemented

OPEX identified key training and qualifications were identified as critical in the Industry Refurbishment (or New Build) Projects.

We've learned, due to the unique requirements associated with a refurbishment outage (Multi-Employer, Owner Only Islanding & Owner/Constructor configuration, the large scope and duration of the project) it is recognized that a structured refurbishment training plan is required. The NR Project Training Work Plan NK38-PLAN-09701-10007 "Darlington Refurbishment – Project Training Work Plan" details the activities and tasks necessary to fulfill the training requirements of the entire NR Project. As the

NR Project advances through various phases of completion, and more OPEX becomes available, this document will be reviewed and revised as required.

3.19 NR Engineering Organization has implemented proper design and modifications evaluations

OPEX from the Bruce showed a lack of proper design and packages reviews lead to an increased risk of improper operation conditions.

We learned early we needed to simplify our work process, guides and governance to become more efficient, nimble to optimize work performed in the Engineer, Procure and Construct (EPC) work environment and not compromise on standards or quality.

4.0 SCR'S GENERATED FROM OPEX

SCR #N-2013-01589: Increase in Refurbishment Modification Definition Package Costs

SCR #N-2013-0169: Refurb Supply Chain: Quality Group of Nuclear is Supply Chain received same disclosure note via AVON Valve (distributor for Swagelok) and working through the SCR (SCR # N-2013-01692) for investigation and corrective action (M.K - Supply Chain).

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Document Number: **NK38-REF-09701-0506878**	Usage Classification: **Internal**
Sheet Number: **N/A**	Revision: **R[000]**

Title:
Nuclear Refurbishment OPEX/Lessons Learned RQE Report

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Nuclear Refurbishment OPEX/Lessons Learned RQE Report

NK38-REF-09701-0506878
2015-01-19

Order Number: N/A
Other Reference Number:

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R[000]	2015-01-19	[TBC]

1.0 EXECUTIVE SUMMARY

Every successful organization learns from the past and improves for the future. The idea is to gain direct knowledge from our experiences and use our OPEX and Lessons Learned libraries and these reports in moving forward until program completion.

A program of this magnitude is positioned to benefit not only from the lessons of the past, but also to present a whole new slate of experiences that emerge from its trailblazing nature. The purpose of this report is to summarize important lessons learned from 2014. All of these lessons have come directly from the Nuclear Refurbishment (NR) staff and partners.

The Nuclear Refurbishment Program has sought out, gathered, and incorporated a significant amount of industry knowledge and experience pertaining to the planning and execution of major nuclear refurbishment and other mega projects including Bruce A and Point Lepreau rehabilitation projects.

2.0 PURPOSE

The OPEX process is guided by N-PROC-RA-0035 which brings the DR program in compliance with CSA Standard “N286-05: "**Management System Requirements for Nuclear Power Plants**”. In accordance with the procedural requirement; this report summarizes the status of OPEX and Lessons Learned in Nuclear Refurbishment.

3.0 OVERVIEW

The OPEX and Lessons Learned teams actively seeks out OPEX and Lessons Learned through benchmarking visits, project and peer reviews, industry working groups (i.e. COG, CII), and involvement in WANO activities at Bruce Power, NB Power, Pickering A NGS, Pickering B NGS and Wolsong. Additional OPEX and lessons learned have been incorporated from benchmarking of non-CANDU NPPs and non-nuclear mega projects and incorporation groups such as the Project Management Institute, INPO’s Project Management web sites and others.

Formal program communications is strategically presented through designated OPEX Lessons Learned meetings, web site, reports including metric’s, and other project employee activities such as emails, newsletter articles, pre-job briefings, monthly lunch and learns, including having an effective OPEX/Lessons Learned electronic library for all employees and contractors to use.

This is our second annual report and we focus on 3 sections: Program Lessons Learned, Internal Lessons Learned and OPEX/Lessons Learned Metrics.

- **Program Lessons Learned:** In 2014 there were 2 Program Lessons Learned (PLL). Over the course of the Program we have captured 21 PLL’s). These lessons learned were learned from nuclear, industry related or project management OPX. When incorporate they significantly impacted the structure, philosophy and business model.

- **Internal Lessons Learned:** In 2014 there were 31 Lessons Learned captured by department or projects. Each department and project has gained knowledge through experience, incorporating these lessons into procedures, plans or behaviors. They can

come from a variety or resources such as: benchmarking trips, reports, SCRs, and even staff interviews, but all have been selected to be shared throughout our organization.

- **OPEX/Lessons Learned Metrics**: In 2014 there were 198 COG OPEX that were sent to multiple department/projects to be dispositioned by subject matter experts this was at 98% completion rate. Over 500 OPEX captured by other industries and project management were archived to the OPEX library as a resource to Refurbishment. Having an effective and consistent metrics tracks the progress of the OPEX and Lessons Learned program throughout the life span of the NR program. Many improvements have been seen but the major ones captures are: the disposition percentage rates, increase in Lessons Learned and web site visits from staff. Improvement plans are

This report covers the period from January 1, 2014 to December 31, 2014

4.0 PROGRAM LESSONS LEARNED (PLL)

Below are the 2 PLL's and Risks associated with them as well as the scoring metrics in which shows our success rate in implementing the program. To date the NR Program has 21 Program Lessons Learned that can be found in Passport and our Lessons Learned Library.

1. ID# 20 – NR Engineering Design oversight requirements clearly defined
   OPEX from Point Lepreau shows a trending relationship between engineering oversight and the quality of work from the contractors. The OPEX suggests that a much greater level of success would have been achieved had there been oversight right from the beginning of the project.

   In response to this Lesson Learned, the Engineering has developed procedures in support of N-STD-MP-009, as well as supporting documents to communicate Engineering Management expectations to make sure that there is adequate engineering oversight.

   Risk 656: Engineering error or omission made goes undetected requiring significant time and cost to rectify

   Risk 693: Increasing cost of engineering may result in pricing the DNR projects beyond current budgets
   Status: Closed

   Risk 561: Project leadership and specialized resources are not in place when required

   Risk 687: Vendor CWP's are late and/or of poor quality impacting field execution with delays, cost over

   Risk 688: Owner significantly involved in the all phases due to the ES MSA Vendor's inability to meet contractual commitments.
   Status: Active

2. ID# 21 – Electronic Document Management Solution has been implemented
   NR will process and store large volume of OPG intellectual assets such as document, drawings and records in structured, semi- structured and unstructured information sources. Through OPEX from The Bruce, Point Lepreau, Engineer Businesses and the London Olympics it was discovered that each organization had a few different methods on

documenting and recording were done at the beginning, changed in the middle and at the end.

What we learned is that we need one system that was sustainable over the years. The new EDMS is a key component that supports many elements of the Modernizing Work. The implementation of an Electronic Document Management System will provide increased visibility of information as it is stored in a central location and increases in efficiencies relating to the processing and sharing of information internally and externally, especially with vendors.

Risk 557: Information security during transfer of information

Risk 11540: Supplier Document Hub
Status: Closed

Risk 692: Lack of an integrated process to onboard contractor staff
Status: Active

5.0 INTERNAL LESSONS LEARNED STATEMENTS

Below are the individual lessons learned statements, which are high level summaries of what Refurbishment groups have learned from OPEX. These reports are linked to the full reports and are organized below by department or project. The report is presented as nine main categories that break down into a number of lessons within each topic area. The Program lessons we've learned over the years are summarized below.

5.1 Engineering

5.1.1 Design Engineering

5.1.1.1 ID# 128 – Electrical Transient Analysis Program Model Update and Analysis

In order for Refurbishment Design Engineering to efficiently produce quality products, experienced Subject Matter Experts must be retained and should be available to provide guidance. Having essential tools and resources should be available for the project when they are needed. For any project to be successful, it is critical that project leads and project managers proactively foresee issues and resolve them quickly.

5.1.1.2 ID# 119 – Modification Definition Package

The intent of various deliverables prepared under the modification definition package (MDP) was to establish a preliminary set of design basis requirements for newly established engineering change (EC) packages. Challenges were encountered during the execution of the MDP contract which was observed by the Darlington Refurbishment Engineering organization, the Darlington Refurbishment Projects Execution organization, and the OSS Partners. See entry #91 in the NR Lessons Learned Library for a set of issues encountered during the execution of the 2013 MDP Program, along with recommendations that the Nuclear Refurbishment team can implement to improve, mitigate, or eliminate similar issues from occurring in the future.

5.1.1.3 ID# 143 – Safety Margin and Conservatisms in Design Engineering

We learned that reports should contain explicit descriptions of the conservatisms and non-conservatisms made in the calculations. Further the report should be explicit in the intended use; a statement such as 'the use of the report for applications other than originally intended should be confirmed to be fit for purpose on the basis of the assumptions applied' is required. This will allow for a margin of safety in calculations and any other work done based on the calculations.

5.1.2 Human Factors Engineering

5.1.2.1 ID# 115 – Human Factors Engineering

One cannot discount the importance of Human Factors Engineering (HFE) in large nuclear refurbishment projects. HFE should be included in the design process, upfront planning, stakeholder communications, and procurement of new and non-identical components, field changes, and Engineering Change Control (ECC). Ensuring HFE is considered in these areas increases the likelihood that the Darlington Refurbishment Program will be executed successfully.

5.1.3 Nuclear Safety Integration

5.1.3.1 ID# 114 – CCA Recovery Plan

Project management must ensure that adequate resources and support are committed to a project in order to complete scheduled activities on time. Additionally, communication with the vendor (with kickoff and periodic meetings) is critical when it comes to clarifying scope and addressing issues in a timely manner. In the CCA recovery project, a lack of essential station support led to project delays, and scope changes were frequent due to missing rigor in project controls. On the other hand, collaboration with the vendor was done well, especially at the end of the project when they were given direct contact with OPG reviewers. This kind of direct relationship helps improve efficiency and produces a better product in the end; it should be used in any project where possible.

5.1.4 Quality Engineering

5.1.4.1 ID# 110 – Workshop on Collaboration and Active Management

Four lessons learned were synthesized from this meeting:
There must be active management and collaboration in all engineering projects. Poor OPG understanding of contractor commitments, including their work on other projects, can hinder progress and lead to cost increases. (2) The resident engineer role and interfaces must be better understood. Areas that need more attention are communication and the need to keep the RE, PM, DSM up to date on progress and decisions. (3) Collaborative front end planning (CFEP) in projects should always be used. (4) The proposed Observation and Coaching (O&C) card can be used for focused observations of OPG-Contractor interface transactions. This is a simple method for dealing with issues and coaching.

5.1.4.2 ID# 127 – Lessons from Inadequate Communication Practices

Ensure that all personnel understand the importance of communication in a project. This will make certain correct actions are taken based on discussions. Without proper communication

between right channels key information can be lost resulting in delays, confusion, and down time which will ultimately lead to waste of funds.

5.1.5 System Engineering

5.1.5.1 ID# 140 - Shutdown Cooling System Project Lessons

As a result of the OPEX trip to Watts Bar, improvement areas identified in scheduling, construction, engineering and the Release Quality Estimate have either been implemented or are under review. In addition, the OPEX trip resulted in Watts Bar staff visiting the Refurbishment organization to provide further detailed analysis & recommendations that will be tracked to completion by the Refurbishment Work Control organization. Resources have been reallocated to better support RQE and strategic planning to ensure budget approval.

5.2 Environmental Assessment (EA) and Licensing

5.2.1.1 ID# 118 – Environmental Assessment – Refurbishment and Operation of DNGS

Based on the Project Description for the DNGS Refurbishment, an Environmental Assessment (EA) process under the Canadian Environmental Assessment Act (CEA Act) was initiated. The contracted work for the EA involved the completion of five major work tasks: (1) field studies, (2) project description, (3) technical support documents, (4) environmental impact statement, and (5) support for review and hearings. Lessons learned were documented following areas: contract and contract management, coordination and communication, schedule and work logic, interface with the regulator and other stakeholders, decision making process and strategic planning, documentation and records management, and hearing preparations.

5.3 Nuclear Execution

5.3.1 Balance of Plant

5.3.1.1 ID# 125 – Export License Compliance

Ensure all regulatory procedures are followed and licenses are acquired beforehand when dealing with controlled nuclear documents and drawings. Process to acquire Export License should be initialed early on as the CNSC may take 3-4 weeks to provide the license. This will avoid any delays that arise from the inability to share information with vendors.

5.3.1.2 ID# 137 – Lightning Protection – Configuration Management in Design

We learned by using questioning attitude in Balance of Plant - Design Engineering work is built on conditions that must be verified and compared with documentation. The questioning attitude results were that no modifications were required. Confusion can result in lack of clarity around the effort which would affect scope, schedule and cost of the project.

5.3.1.3 ID# 141 – Lessons from Watts Bar Nuclear Station

To ensure collaboration and alignment between different vendors Related Design Scope released to multiple vendors needed to be integrated as part the OPG design engineering strategy. While escalation process should be used to resolve evolving project concerns and ensure relevant stakeholders are engaged. This will avoid the existence of a scope overlap between vendors and work to provide clarification of scope while avoiding duplication of work.

5.3.2 Fuel Handling – Defuelling Lessons Learned

5.3.2.1 ID# 131 – Nuclear Execution Defuelling Strategy

By outsourcing the fuel handling work to an experienced contractor we were able to mitigate unnecessary risk that may arise from a lack of knowledge within OPG. If the project was to be entirely completed by OPG a significant amount extra work would be needed to compensate for the lack of experience which would require additional workers that would only be hired temporarily since the project is short term and to be executed only once. The awarded contractor has performed the tasks required for scope of the fuel handling project multiple times and has the understanding required to successfully complete the project.

5.3.3 Islanding

5.3.3.1 ID# 144 – Islanding Project Lessons

Increase no-fuel windows and reduce interaction between Bulkhead installation and Fueling activities to address the delays in Bulkhead install/removal due to fueling activities. Next a strategy must be implemented for Airlocks to address preventive maintenance, spare parts, and qualified resource availability. This will be done to help reduce delays to critical path due to airlock failures. Lastly, an analysis needs to be completed on the Vacuum Building setpoint if 2 units are simultaneously isolated as overlapping unit outages may require a Vacuum Building setpoint change. In conclusion all of these actions provide the opportunity to reduce critical path or eliminate risks to critical path durations.

5.3.4 Prerequisite Project

5.3.4.1 ID# 107 – Prerequisite Projects

Actions are needed to initiate improvement in six key areas of the Nuclear Refurbishment (NR) Facilities and Infrastructure Prerequisite Projects: (1) understanding of oversight, (2) ensuring scope of work is detailed, (3) explaining transfer of risk to EPC contractors, (4) ensuring integrated schedule is understood, (5) clearly defining project estimates, and (6) using teamwork as a business model. Deficiencies in these areas have caused the prerequisite projects to experience substantial cost growth and schedule delays. If the actions recommended in this log are undertaken, we will be better able to stay on schedule, within our budget, and ultimately more prepared for the NR execution phase when the time comes. If the actions recommended in this report are undertaken, we will be better able to stay on schedule, within our budget, and ultimately more prepared for the NR execution phase when the time comes.

5.3.5 Retube and Feeder Replacement Project

5.3.5.1 ID# 109 – Mock-Ups Project

Up-front requirements and specifications need to be more detailed and incorporate input from future users. This addresses problems that come from poor collaboration and lack of consistent understanding of scope, and ensures party alignment early on in the project. As a result, it will be easier to stay on schedule, avoid the need for recovery, and keep a common end goal in mind.

5.3.5.2 ID# 113 – Tooling Schedule Management

Integrated schedules are imperative to our success, as they support a coordinated planning approach across the project organization. Collaborating on the quality product schedule aims to provide clear objectives, deliverables and milestones. Recognizing objectives early on and managing the schedule proactively allows us to execute the project in a controlled manner, which is where we always want to be.

5.3.5.3 ID# 123 – RFR Procurement for Long Lead Materials Secured

Securing long lead materials ahead of time is a proven way to save on the cost of mega-projects. Given OPEX this a critical to the success of the program to order, deliver on time and meet the required quality and standards. Giving our vendors sufficient lead time of our material needs, allows them to optimize their manufacturing and to pass on to us more favourable pricing, achieving our schedules, and provide on-hand stock prior to the start of work.

5.3.5.4 ID# 124 – RFR Tooling Detail Design Complete

Ensure early vendor alignment with the project vendor(s) and remain in continuous contact with them as the project progresses. This helps to keep deliverable expectations clear and communication lines open between all parties involved. Failure to stay aligned can lead to a breakdown in schedule, and risks the vendor having a poor understanding of the product expected of them.

5.3.5.5 ID# 142 – RFR Project Lessons

The full size Mock-Up was created for training of workers and testing new tooling equipment these were lessons learned from other refurbishment projects. These ensure workers have sufficient training with the Mock-up, their tools and a realistic schedule. This will reduce impacts to schedule and refurbishment cost.

The tooling was designed with significant OPEX input from past campaigns and a systematic process was applied for final design selection to ensure the best OPEX was applied. Furthermore, both OPG and the Joint Venture aggressively staff their tooling organizations with industry experts with significant refurbishment experience. The core strategy was: To build the best tooling system, you need the best tooling people. Due to the criticality of the toolset, OPG could not afford to not have strong knowledgeable oversight. This was a lesson learned adopted where in past projects in OPG and in the nuclear industry that the owner tried to "home grow" its oversight and PM team with experienced staff but inexperienced in the area that they were required to oversee and manage.

In the area of purchasing reactor components, one of the key lessons learned has been to expand the vendor base through the use of a Pre-Purchase Qualification process whereby a few vendors are evaluated on a small quantity of components prior to the award of the full quantity. This addresses the issue of being beholden to only one vendor and also potentially having a lack of vendors due to market demands especially when in 2012 the possibility of Bruce Power starting their refurbishment outage in 2016 was a possibility.

5.3.6 Turbine Generator Project

5.3.6.1 ID# 108 – Overspending in D1321 Outage

Work must be assigned early enough for the vendor to provide a proper estimate and gain ownership over hours and schedule, and (2) oversight and communication must be improved. In this scenario the vendor was unable to assess and take accountability for the estimate, their hours had already been input into the Passport system, and issues in ONCORE prevented them from getting paid. Further, project teams were not made aware of the maintenance overflow contracting process or the need for additional project team involvement once the work was contracted out. Better planning and oversight would have greatly improved performance in many aspects of this outage.

5.3.6.2 ID# 134 – Turbine Generator Incorporates OPEX from Industry

All NR projects should conduct thorough evaluations using tools such as benchmarking and self assessments before awarding major contracts to vendors. This will ensure vendors have the resources, knowledge, and experience necessary for the completion of the project on time and on budget.

5.3.6.3 ID# 145 – Heavy Lift work including Main Stator lift and Crane Overhaul

The Turbine Generator team should continue researching heavy lift scenarios to ensure they are making enough precautions and investigations to mitigate risks associated in the lift. With this knowledge, the team will be able to diligently plan, and execute the stator lift in a confident and safe manner. The consequences of a lift failure could be devastating to workers, the refurbishment project and company, therefore, careful and persistent effort is required.

5.4 Operations and Maintenance

5.4.1 Conventional Safety

5.4.1.1 ID# 97 – Benchmark Trip - Union Station Project

It is important to correctly understand the "Owner Only Role" when leading a project that involves vendors. Metrolinx is not comfortable with this role for numerous reasons. The result of this is that there are a number of players in the Metrolinx Organization in an ‘Acting’ role at a time when Metrolinx is undergoing a huge revitalization program over southern Ontario.

5.4.2 Radiation Protection

5.4.2.1 ID# 139 - Benchmarking at Davis Besse Nuclear Power Station

We learned by having a standard Radiation Protection (RP) service contract strategy of a central RP contractor should continue. This will provide a more complete RP service where a central RP Tech group is utilized, rather than RP Techs reporting to individual project contractors. This strategy is in line industry best practice for radiation protection.

5.5 Planning and Controls

5.5.1 Estimating

5.5.1.1 ID# 135 – RFR Estimating Plan

Establishing an accurate that is clear and concise estimate that properly represents the project total cost is imperative in managing the any project. Inaccurate estimates of the RFR project

would have great impact to cost and schedule performance to the entire Refurbishment Program. We learned by having accurate class 2 estimates along with an effective estimating plan the Nuclear Refurbishment is better able to align issues including actions with our contractors early in the program.

5.5.2 NR Infrastructure

5.5.2.1 ID# 105 – Improving the OPEX and Lessons Learned (LL) Program

Capturing Internal Lessons Learned (ILL) successes can be difficult. Developing a Lesson Learned template, metrics and a monthly lesson learned report could generate ideas to improve the effectiveness of the program. This would improve consistency and value in our lessons learned documentation, allowing information to be extracted in a more efficient manner.

5.5.2.2 ID# 121 – Selecting Project Management Software

In projects you always have to plan with the end in mind. It doesn't matter if you're building a house or building an IT tool to support your business. Either purchased or built must support the tools for communicating objectives, deliverables and milestones. Always review your business requirements to see if the products you purchased, trained and communicated are still being leveraged and required.

5.5.2.3 ID# 122 – SharePoint Data Migration

Ensure that all groups adhere to a scheduled and well-communicated timeline for any data migration project. When done successfully there is minimal impact and down time, for both the data sharing software and its users. Lack of a schedule results in confusion, disorganization, and the potential loss of valuable information.

5.5.2.4 ID# 129 – Reporting Schedule is Managed - Reporting Lessons Learned

An integrated process and timeline for reporting requirements needs to be developed for Refurbishment and Projects and Modifications. Alignment between these two groups is lacking. An integrated reporting approach will facilitate a more streamlined process and help ensure alignment.

5.5.2.5 ID# 130 – Forecasting Process Established - Forecasting Lessons Learned

The inaugural Program forecasting exercise pointed out issues that reflect a need to improve operational processes, particularly delivery financial management systems. This requires both systematic and cultural changes. The organization will need better program and project management approaches for all significant pieces of work, including formal change protocols and timely communication.

5.5.2.6 ID# 126 – CIO-Electronic Document Management System (EDMS) Implementation

The business recognized the need to develop a vendor document control process to support project execution for the Refurbishment Program. The Electronic Document Management System (EDMS) was purchased to replace existing information technology that was not capable of providing all the functionality necessary to support traceability of document exchanges, document storage and electronic review and acceptance of vendor submissions. Always review your business requirements to see if the software purchased and implemented supports the required processes and meets the objective of the business case.

When implementing Electronic Document Management System (EDMS), the organization had to create or adapt processes that support electronic management of in-process or transient documents before fully developing a set of defining rules and accountabilities for electronic document control. These processes, when in draft, were not fully tested with stakeholders prior to launching the information technology. This was a significant gap. Develop document exchange rules/standards and test application of the rules and supporting processes with stakeholders prior to implementation.

The easiest way to get people to adopt new information technology such as EDMS is to show the employees the benefits of using it both on a personal level (which is often the first thing they will want to know) and on an organizational level. There were many forms of communication used, but experience showed that making time for more face -to-face meetings throughout the project and provision of continuous training post implementation is important. Use a combination of both informal and formal training throughout the project. Management, stakeholder and user buy-in are of vital importance for future software implementation to ensure a smooth transition to a successful system.

5.5.2.7 ID# 132 – Proliance Software Phase 1 Implementation

We've learned early in the Nuclear Refurbishment Program and Projects & Modifications required an effective financial software tool to assist in managing both large and small capital projects. With Proliance there is no limit-this software provides project visibility and oversight; clearly projects size bring major challenges if you don't have similar processes, usability and functionality of the tool.

5.5.2.8 ID# 133 – 2014 Top 10 NR Common Lessons Learned

We've learned that having an effective Lessons Learned Program one that crosses functional and project boundaries allows our organization to learn from both its mistakes and its successes. An effective Lessons Learned program prevents us from repeating our mistakes and allows us to repeat our successes. We must continue to make this program instrumental part of our organization's overall "continuous improvement" process.

5.5.3 Reporting

5.5.3.1 ID# 120 – Business Intelligence (BI) Tools

Any new software must be well understood and tested by key users before it is implemented on a wide scale. Poor planning can lead to not having a clear product vision, technical issues, and lack of appropriate training, poor support structures, continuous modifications, and insufficient software capabilities. These problems must be avoided to ensure new software is rolled out smoothly and fulfills its business requirements.

5.5.4 Project Management

5.5.4.1 ID# 111 – Transparency and Communication in Project Management

Transparency, business relationships, and communication are all critical aspects of project management and must be maintained to stay on schedule and budget. If any of these areas deteriorates, there is a risk of the project becoming increasingly convoluted, leading to issues not being identified or addressed in a timely manner. Avoiding this problem helps keep the project team aligned and on track, making it easier to reach the final goal.

5.5.5 Risk Management

5.5.5.1 ID# 117 – Successfully Identifying Risks

Informing and educating your organization on what the risk criteria is and how to properly identify risks is crucial. Failure to do so could lead to an undesirable event, wasted time and costs to the organization. By reducing the number of poor risks, you will have a smaller, concise list of risks, which improves the efficiency and quality of the risk management process.

5.5.6 Release Quality Estimate (RQE)

5.5.6.1 ID# 112 – Benchmarking to Improve the RQE

Numerous actions need to be taken to ensure a successful Release Quality Estimate (RQE), including full definition of scope, streamlined processes, improved risk management and contingency planning, and accurate documentation of assumptions. These address several problems that were present with the Watts Bar DESP (WBNP) document (their equivalent of OPG's RQE). The team will ensure management of RQE deliverables is improved and that known issues from WBNP are not duplicated.

5.5.7 Space Planning

5.5.7.1 ID# 116 – Space Planning

For space planning to be effective at every stage of a project the team must establish clear expectations, strong methods for communication and collaboration, and a well defined long-term plan. These make all aspects involved – ranging from short term office space requests to long term requirements – much easier to manage in a coordinated way. A poor plan for space can lead to disorganization and eventually schedule delays as a project grows and increasing strain is placed on available space.

6.0 OPEX/LESSONS LEARNED METRICS

On page 16 is the 2014 OPEX/Lessons Learned Metric Final Report. This report totals the 12 monthly reports sent to CARB, Webpage and Contractors. On page 17 are the individual departments peroformances that impacts this report. Below is a summary of the metric report. The first page is divided up in to manageable areas to report on.

1. The first area is where the DR Program contributes to the OPG Nuclear (Operation) fleet metrics report. In 2014 COG OPEX, Darlington Refurbishment targeted 193 OPEX Events that could impact on the Program. Those 193 OPEX Events were sent to either one or a number of departments and projects Subject Matter Experts (SME's) to be disposotioned (state they have a plan if impacts or for information if not). This was at a rate of 98 per cent "green" with overall timeliness (10-business days).

2. External Project OPEX Events is proactively sought out by the DR OPEX SPOC in areas of Project, Contract and Construction Management. In 2014 there were 263 OPEX Events archived in the library as a resource and measured in terms of numbers at "white" colour grade.

3. Received Contractor OPEX Event is new to the DR OPEX metrics and started in November with a poor number of 4 events shared and marked as the only "red" colour grade.

4. Received Darlington Refurbishment employees OPEX Event is new to the DR OPEX metrics and started in October with "green" overall grade.

5. Internal Lessons Learned metric captured 31 lessons that the individual teams learned from OPEX gathered or received and impacted their individual work program this was measured as sheer total numbers.

6. Program Lessons Learned metric captured 2 lessons that were promoted to this level by CARB since these lessonsapply across the DR Program. This is a trend report.

7. Finding OPEX and #8. Lessons Learned are measured on how many individual visitors by employees. A employee can visit the libraries numerous times a monthbut only counted once in this metrics at a "green" colur grade in both libraries.

9. "Adding Value to SCR" received from OPEX Events generated 11 SCR's within the Program and #10. "Adding Value to Risk" received from OPEX Event generated 1 Program Risk both of these are trend reports until more data is captured.

Appendix A: NR 2014 OPEX/Lessons Learned Metrics

The Annual Metrics contains statistics and scores for the different areas of OPEX and LL. This report captures all the metrics of 2014 and presents the final results.

Group	Program Element	Library Total #	Metric	Measure	Yearly	Score	Green	White	Yellow	Red
COG	Incoming COG OPEX	2281	Fleet OPEX SME Disposition Rate	Yearly % Submittted[1]	368/374	98%	> 90% of reports	76-89% of reports	60-75 % of reports	< 60 % of reports
Refurbishment	External Project OPEX		External OPEX Total Entries	Yearly Total Submitted	263	263	> 360 reports	252-360 reports	120-252 reports	< 120 reports
	Received Contractor OPEX		Received Contractor OPEX	Yearly[6] Total Submitted	4	4	> 30 reports	24-30 reports	18-24 reports	< 18 reports
	Received NR OPEX		OPEX Received	Yearly[7] Total Submitted	22	22	> 20 reports	16-20 reports	12-16 reports	< 12 reports
	Internal NR Lessons Learned	83	Internal NR Project Submissions	Yearly Total Submitted[5]	31	31	> 30 reports	24-30 reports	12-24 reports	< 12 reports
	Program Lessons Learned	21	Program Lessons Learned	Yearly Total Submitted[5]	2	2	Trend reports	Trend reports	Trend reports	Trend reports
	Program Lessons Learned (PLL) Risks		Assigning Risk to PLL	Total	34		Trend reports	Trend reports	Trend reports	Trend reports
	Program Lessons Learned (PLL) Closed Risks		Assigning Risk to PLL	Total	9		Trend reports	Trend reports	Trend reports	Trend reports
	Finding OPEX		Employee visits to OPEX NR Library	Yearly Total[4]	1714	1714	> 1800	1200 - 1800	600 - 1200	< 600
	Finding Lessons Learned		Employee visits to the NR Lessons Learned Library	Yearly[8] Total[4]	890	890	> 1050	700 - 1050	350 - 700	< 350
	Adding Value Assigning SCR	11	Number of OPEX that generated an SCR	Yearly Rolling Total[2]	11		Trend reports	Trend reports	Trend reports	Trend reports
	Adding Value Assigning Risk	1	Number of OPEX that Generated a Risk	Yearly Rolling Total[3]	1		Trend reports	Trend reports	Trend reports	Trend reports

[1] Month end submission deadline= OPEX received divided by number dispositioned in time (10 business days).
[2] of OPEX SCR's with status > = OPEX that generated an SCR, in-progress
[3] of OPEX Risk created Status > = OPEX that generated a Risk, in-progress.
[4] per employee per 'visit' to library and not 'hits'
[5] May be discreprencies between department total and recordable total
[6] Numbers cumulated from creation of field in October (3 Months)
[7] Numbers cumulated from creation of field in November (2 Months)

[8] Numbers cumulated from creation of field in June (7 Months)
[9] First number represents the total number of individual COG events, the second number represents the total number of COGs sent out.

An explanation of the colour codes are described below.

GREEN
- Excellent meeting the requirement of the metric.

WHITE
- Good there is room for improvement. The organization should review their process and see what can be done to improve to green status.

YELLOW
- Fair metric is indicating that there are problems with governance or execution of the OPEX process. Corrective actions may be required to improve the effectiveness of their OPEX process.

RED
- Poor the OPEX process is not fulfilling its obligation to share information to the broader industry. Corrective actions are required.

2014 OPEX/Lessons Learned Department/Project Annual Report

Impacted Organization	COG OPEX /Disposition Summary (Sent, Received, Dispositioned on time)			Received NR Lessons Learned Submission
	Sent Year to date	% Completed	Not Completed	
Balance of Plant Project	14	14		1
Construction	10	10		0
Fuel Handing Project	18	18		1
Islanding Project	9	9		0
RFR Project	14	14		4
Shutdown/Layup/Services	10	10		0
Steam Generator Project	14	14		0
Turbine Generator Project	14	14		2
NR Facilities and Infrastructure	4	2	2	1
Nuclear Execution	0			0
Contract Management	0			0
Corporate Relations and Communications	0			0
Engineering/Nuclear Safety	89	89		6
Planning & Controls	8	8		14
Managed Systems Oversight	3	3		0
Ops & Mtce and Safety	139	139		1
Regulatory Affairs/EA and Licensing	10	10		1
Supply Chain	14	14		0
Work Management	4	0	4	0
Totals	**374**	**368**	**6**	**31**

NK38-REF-09701-0568709
N02-0049, T10* October 15,2015

RMO TOOL OPEX LIBRARY 2014-2015				
ID	**Title**	**Date Identified**	**Source of Event**	**Specific Lessons Learned**
00002633	Post Vacuum Building Outage Human Performance Adverse Trend	2015/10/07	COG # 15 October 7, 2015	The appropriate level of risk recognition and conservatism was present during the VBO but once this was completed successfully, human performance declined as workers transitioned from outage to normal routine duties.
00002632	Potential Check Catches Live 120V Source Of Power Within Isolation Boundary	2015/09/30	COG # 7 September 30, 2015	A questioning attitude and execution of a thorough field walkdown (to verify the contents within the panel were identified as barriers that could have caught the error earlier.
00002631	Live Low Voltage Control Cable Cut During Instrument Air Compressor Replacement Project	2015/04/22	COG # 5 September 30, 2015	Cable detection should always be treated as a critical step when planning to cut and remove old low-voltage cables from station systems. By doing this, staff are better able to identify, evaluate, and manage all risks associated with cable cutting and can apply appropriate defenses before proceeding with any task
00002630	During a Reactor Building Crane Preventive Maintenance Carried Out by a Contractor, an Unexpected Crane Hook Descent Occurred	2015/09/30	COG # 4 September 30, 2015	All major tasks must have a work plan approved. Plant supervision ownership is needed to oversight contractors.
00002629	Individual Working on Bus Contacted Energized Equipment Resulting in an OSHA Recordable	2014/03/03	COG # 3, September 30, 2015	· Ensure clearance orders are established with sufficient detail to verify energy is isolated at the component level. If unique equipment identifiers are not available for the subject component, then additional actions, including thorough walkdowns and drawing reviews, should be used to verify energy will be isolated by the clearance order. · A live-dead-live test should be conducted immediately before performing or resuming electrical work. The test should be performed each time electrical work is started even if clearance orders are in place and have not changed.
00002628	OPEX Report In Support of EPGS PROJECT (DNGS EPS AVAILABLITY IMPROVEMENTS)	2015/09/25	Powersearch	See full report attached for details of the collected lessons learned.
00002627	OPEX Report in Support of EPG3 Project DNGS EPS Availability Improvements	2015/09/25	Powersearch	Over the years, there have been numerous SCRs documenting inadequate compressor maintenance, inadequate breathing are capacity, lack of spare parts, breathing air and compressor intake air quality, appropriate regulatory approvals, relief valve and compressor set points leading to inadequate supply of breathing air in the event of loss of power and inadequate supply pipe sizes. Both internal and external OPEX has illustrated some important lessons learned to be used when implementing this modification. To avoid similar errors/omissions, as specified in the OPEX gathered for this report, the following is recommended during implementation of this modification: • Need to ensure appropriate relief valve settings, as to not affect the existing designed system configuration. • The need for a maintenance strategy should be evaluated based on OPEX that indicates proper preventative maintenance will increase equipment reliability and provide a longer lifespan of the compressors. • Ensure similar Maintenance activities will be conducted on the new compressors as that of the existing compressors at Darlington. • The period of time that breathing air is required after a loss of Class IV power needs to be re-
00002626	Less Than Adequate Prepration for Installation of a Spare Heat Transport Bleed Condenser Tube Bundle	2015/09/23	COG # 12 September 23, 2015	· There was an incorrect mindset of "self-limiting cracking" of the Unit 1 tube bundle during the planning phase, which resulted in a perception of a low probability of replacement. This mindset was not properly challenged due to the low adherence of Pre-Outage milestones.
00002625	Damaged Electrical Hoist Trend	2015/09/23	COG #6 September 23, 2015	Lessons Learned: The common element among these events was the need to ensure that all work is conducted in compliance with Ontario Power Generation (OPG) governance and safety standards, and that a safe work environment is maintained, with safe work practices used during execution of all field work.
00002624	Notification of Critical Error Issues in Structural Analysis and Design Software STAAD.PRo	2015/09/24	COG #1 September 23, 2015	To provide preliminary notification to CANDU stations and other nuclear facilities that there are potential impacts on engineering design arising from the recent notification of deficiencies in the structural analysis and design software STAAD.Pro by the software supplier, Bentley Systems Inc. SNC-Lavalin Nuclear is taking actions by assessing and identifying the potential impacts from use of the STAAD.Pro software in services provided to CANDU station and other nuclear facilities.
00002623	Gap Sheet Process Implemented for Contactor Safety Program Reviews	2014/12/10		A new process (Gap Analysis Sheets) had to be created to ensure contractors meet the requirement outlined in Safety Management Essentials guide.
00002622	Pickering A Unit 2/3 Safe Storage Lessons Learned	2015/09/03	As7	Many good areas to review and learned from especially on Controls, OPS, MTCE and Engineering areas. For details please review the attached document.
00002621	Unit Turbine Trips on Loss of Generator Excitation	2015/08/31	COG #14 Sep 2, 2015	· The Excitation System logic was not operating as it should have due to several instances of incorrect cabling connections. Insufficient installation practices by the vendor and insufficient station oversight of vendor maintenance practices led to this event.
00002620	Unit Turbine Trips on Loss of Generator Excitation (Repeat)	2015/08/31	COG #12 Sep 2, 2015	Reactor Safety was challenged by this event. The turbine tripped and both shutdown systems (SDS1 and SDS2) actuated in response to the loss of the high power heat sink. A nine day unplanned outage was experienced. This event was declared an equipment reliability clock reset and classifies as a manual scram..

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002619	Level 1 Work Protection Event During Unit 4 Outage	2015/07/31	COG #5 Sep 2, 2015	Failure of workers to use HU Tools including Procedure Use & Adherence, Self-Check with Verbalization, Effective Communication and Stop. When Unsure when executing the CO resulted in the incorrect removal and installation of the East crane disconnect.
00002618	Accounting board at the DEC not updated by staff	2015/08/10	Amec FW	see attached
00002617	Deficiency in neutron-cross-section library in software code, ORIGEN Version 4.2	2015/08/21		The lessons learned from this event highlight the need to better understand, document, and communicate the applicability, limitations and risk of the use of design methodology and tools as stated below: 1. Understand design calculation methodology and the inputs: It is important to understand the applicability and limitations of design calculations, tools and input data used, taking into account available OPEX regarding independent testing and validation of such methodology. 2. Comprehensive testing of the design tools: a comprehensive testing and validation program incorporating all applicable scenarios for testing of codes/software used in design calculations when they are revised. 3. Comprehensive documentation: informing all stakeholders of the assumptions and simplifications made during the design calculation; and limits of the methodology, any OPEX that might indicate potential non-conservatisms in calculations and intended use of the information contained in the report. 4. Articulate the risks: If limitations or gaps in the qualification/validation of a particular methodology are known, the risk of such gaps poses to the design process should be documented and communicated to all stakeholders.
00002616	Turning Black Swans White	2015/08/11	KPMG	Spending valuable resources and energy trying to predict black swan events will only lead to a lot of sleepless nights. However, there are valuable lessons we can draw from many of Taleb's black swam concepts, uch as not being a trukey and understanding how much of an impact the viewpoint of the observation has on the persception of events. By first understsanding how and why projects fail, we can better understand how certain evetns may be misinterpreted as random black swan events as opposed to a series of failures that can be avoided. We have also learend how important it is to incoporate tools and technigques designed to prevent these failures, as well as introducing triggers to alert us early on if these failures are starting to happen. If the focus is ensuring the flow of independent and transparent information, then no matter how complex or challenging a project, management and project stakeholders will ahve the opportunity to turn the black swamsn white and avoid castastropic project failure.
00002615	Benchmarking Visit by Darlington Nuclear Refurbishment to Plant Vogtle , Waynesboro, Georgia May 2015	2015/07/30	VP NR Engineering	Integration of the the Corrective Action Programs of the Owner and ContractorsMandatory Oversight of Sub Contractors in their fabrcation shopsContractors make mistakes with wrong version of cades and standardsWeld Quality was an issue for the modules being shipped to siteSNC team is about 460 strong and divided into 2 groups, an Operational Readiness Group and a Construction Project Group
00002614	Darlington Boiler Blow Down Nozzle Inspection Stategy folling OPEX Evaluation of Pickering Unit 1 Nozzle Failure	2015/07/27	OPG	It is recommended to add inspection of the Darlington boiler blow down nozzles prior to the refurbishment on opportunity and in the post refurbishment outage inspection scope.
00002613	Potential Impact Determination On Operating Plants Due To Construction Activities	2015/07/29	INPO	Find attached the following documents: Interface group guidelines Impact and Hazard Evaluation Potenial Impact Dermination on operating plants due to construction activities Potential Impact Determination On Operating Plants Due To Construction Activities procedure
00002612	Vogtle 1 & 2 Interface Group Guideline activities that impact Operating Units from Construction activities	2015/07/28	VP NR Engineering	see attached for more details
00002611	5 Ways to Improve Your Project's Lessons Learned	2015/07/28	MPUG	Here are five ways you can improve your project lessons-learned practices. 1. Start Lessons-learned Collection from Kick Off A best-practice technique starting to gain popularity is collecting lessons-learned information during the life of the project. starting from the kick-off meeting, capture and store the lessons-learned information in a central repository for everyone to review. As the project progresses, use the project's status meetings to capture and review lessons gained since the previous meeting. This is the best time to collect it because you and your project team members can provide the week's lessons-learned information while you're reviewing it — everyone is present to discuss what is happening or did happen during the week. While collecting the lessons-learned information, enter the data into a central location, such as a database, document, collaboration tool such as SharePoint or even a social enterprise program such as Yammer. 2. Add Lessons Learned to Your Agenda When developing your weekly status meeting agenda, add a lessons-learned agenda item. As the meeting progresses to the point where you're ready to collect lessons-learned information, ask each team member about his or her
00002610	(BA)-Addition of 1500 SCFM breathing air (50 plastic suits), is not enough for Darlington Refurb. Project	2015/07/27	OPG NR HULL	Initital assumptions made were reevaulated once new information arrived. More communication between projects in the future would also help to minimixe delays and verify assumptions.

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00002609	Tornado Missile Protection	2015/07/27	COG #1 July 29, 2014	· Since 1983, the NRC has accepted license amendment requests (LAR) using Probabilistic Risk Assessment (PRA) methodologies to assess compliance with tornado missile requirements, including the NRC accepted EPRI TORMIS computer code. Licensees may decide to use other PRA computer models, and those new methodologies should be submitted for approval.
00002608	Owner was informed by its Engineering vendor about the USNRC 10CFR 21 notification issued	2015/07/24	Amec Foster Wheeler - Nuclear Canada	Owner and Engineering Vendors using critical design and analysis software should determine if they have a notification method (ex. subscription method) with the software vendor. This will help determine if there is an issue with past or current analysis produced by the software.
00002607	Production Loss due to Turbine Speed Probe Failure	2015/07/22	Darlington	Poor task scheduling and coordination resulted in a production loss of greater than 250 MW-hours.
00002606	Unit 6 Fuel Plug Damage	2015/07/22	COG #7 July 22, 2015	A mispositioned C-Clip on the Fuel Handling Outlet Isolation Plug resulted in damage to the Outlet Isolation Plug and FME inside a fuel channel.
00002605	Plant Status Control Issues involving Work Plans	2015/07/20	COG # 1 July 22, 2015	Operations was found to have an inacurate mental model regarding Plant Status Control aspects of Work Plans. Audit observations revealed that throughout Operations, it is a common belief that a work plan can be considered a document which controls the status of Systems, Structures and Components (SSCs) when they are manipulated away from normal position for more than a shift without work protection or Status Control Tags (SCTs)/Temporary Change Records (TCRs). During Auditor-observed rounds, an Operator noted eight open blocking switches. These were later determined to be opened for longer than one shift without the required TCR. The Control Room Operator (CRO) stated that these switches were part of a Vacuum Building Outage-related work plan that was in progress. The CRO was unaware why the switches in question were not tagged, as per Nuclear Procedure 'Temporary Change Records', and initiated an investigation. A review of the field and CRO log did not include the as-found status of the switches. The 'Temporary Change Records' procuedure requires that the recording of off-normal operational changes, when the change away from and back to normal is performed
00002604	Pretreatment Engineering Platform Lessons	2015/07/17	OPEXShare	Review the attached document for many lessons learned.
00002603	Are You Focused on Issues and Risks at the Expense of Assumptions and Dependencies?	2015/07/16	OPEXShare	A lack of focus on any one of these areas is a risk itself and can result in a negative affect and take a project off course. 2. If there are actions that can be taken to avoid the consequences of an assumption not being true then it should be considered (and managed) as a risk. 3. If an assumption cannot be changed then it should be considered (and managed) as a constraint If an assumption uses words like 'relies' or 'depends' then it should be considered (and managed) as a dependency which in itself should be managed as a risk.
00002602	Stockpile Program Hardware Shipment Delay	2015/07/10	OPEXShare	Occurrence prevention can be accomplished with greater rigor of planning and preparation. Scope and schedule, laid out and integrated alongside stakeholders and their relative workloads, would produce a more holistic approach to delivering said product.
00002601	Improving Construction Productivity	2015/07/01	Web	Review the attachment which will have more information and lessons. Below are just a small sample of them. Human factors such as worker motivation, worker boredom and fatigue, worker attitude and morale, worker's physical limitations, worker absenteeism, worker learning curve, worker experience, and worker skills as well as the team spirit of crew. External factors such as union rules and influences, adverse weather conditions, noise, dust, radiation, congested work area, change in drawings and specifications, changes in contract, demand for over- quality work, and the nature of project (size and complexity). Management factors such as protective gear, unrealistic schedules, overtime, multiple shifts, excessive shift length, disrespectful treatment of workers, parking facilities, salary and benefits, site layout, necessity to re-do work, discontinuity in crew makeup, failure to use worker's skill, incompetent personnel, overcrowded work areas, poor inspection programs, unsafe working conditions, inadequate equipment, inadequate supervision, crew composition, constructability, out of sequence survey work, interruption and disruption, adequate site facilities for workers, lack of co-operation between crafts,
00002600	VenDM benchmarking trip to the Bruce	2015/07/16	VenDM	Review the attached presentation on details of the benchmark trip.
00002599	Loss of Shutdown Cooling due to Spurious Trip of Reactor Protection System Division 1	2015/07/13	COG # 4, July 15, 2015	Engineering change to revise the overvoltage set-point. Engineering change to eliminate the potential for the field flash cards to cause RPS trips. Preventative Maintenance work orders revised to incorporate the new overvoltage set-point. Review modifications installed on high critical components or high probabilistic risk systems to identifiy a potential for margin loss.
00002598	Oversight of Conterfeit, Fraudulent and Suspect Items in the Nuclear Industry	2015/07/13	COG # 1 July 15, 2015	Any organization or individual who provides counterfeit or fraudulent material to an NRC-regulated entity in violation of the NRC's requirements may be subject to inspection, investigation, enforcement, and possible criminal prosecution

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00002597	Project Change Management: Minimize Risks. Maximize Rewards.	2015/07/10	Web	Key to Success: Effective practices for project change management must Incorporate and address the two (2) primary types of change: Reactive Change: When changes are necessary to respond to project problems (i.e. delays, technical failures, funding shortages, resources issues, etc.). In all likelihood, reactive changes are not optional as long as you wish to sustain or salvage the project. Requested Change: When changes to project requirements, scope, deliverables or related management plans are requested by end-users or other project participants. These changes can arise from new ideas, new information, or new perspectives, and usually are requested by project customers (i.e. your end-users) (stakeholder-analysis.html). In any event, requested changes are usually discretionary, and therefore, are difficult to control. While certain changes can enhance and improve a project, if left uncontrolled, excessive change can lead to multiple, varied problems (troubled-projects.html). Excessive project changes can overwhelm a project to the point where original benefits are lost, and the project can no longer be completed as expected. The trick to change control is to continually balance
00002596	Managing Process Project Scope	2015/07/10	Web	Accurately Define ProcessThe problem is not related to what we do but rather, what we don't do. It all begins with how organizations define business processes. Most analysts will define process as a set of activities that take inputs and create outputs according to policies, procedures, and rules utilizing people, facilities, and technology. There are variations on the exact wording, but conceptually, this is how most analysts will describe a process. There are two characteristics of process that rarely, if ever, get mentioned. First, all processes are cross functional. Second, all processes connect or interface with other processes. So, if your project encompasses a "process" that is contained within one functional area, there's a very good chance that your original project scope only encompasses a portion of the process however, as a result of discovery, eventually it will encompass the entire process as well as those that having a negative impact on the performance of the process in focus
00002595	Failure to get proper approval for PSF fire safety system could have been costly	2015/07/10	Pacific	
00002594	Lessons Learned from Past and Ongoing Construction Projects	2015/07/10	U.S. NRC	Ongoing construction projects show similar deficiencies identified in NUREG-1055. for example; Poor communication between design and construction organizations overconfidence in personnel ineffecive problem ID, reporting and corrective action unrealistic and aggressive schedules inadequate assignment of responsibilies and authority vendor issues subcontractor issues
00002593	Calibrate Analog Outputs Prior to Testing	2015/07/10	OPEXSHARE	It was determined that previous knowledge and experience were used in the work order instead of using vendor recommendations of resetting and calibrating the new module prior to use. This contributed to the confusion and delay of work completion. Reviewing vendor instructions for installation of new hardware to prevent erroneous indications and delays in turnover is essential. Even though work was delayed a proper questioning attitude was demonstrated when an unexpected result occurred. Work was stopped and the issue resolved prior to continuing work.
00002592	Health Hazards of Prolonged Sitting	2015/07/09	U.S. Department of Energy	If your job requires sitting for extended periods of time, consider the following activities:Walk more at work -- Park your car farther away from your building; use stairs not elevators; take a long route tothe restroom or cafeteria. When you are working in front of a computer, get up and walk around every hour.Stand up when you talk on the phone. Don’t send e-mails if the recipient is near; walk over and talk to him or her.Stand or exercise while you watch TV, or just stand and move around during commercial breaks.When you get up to have a glass of water or for a meal, walk around the house or office
00002591	The Importance of Radiological Characterization at Depth	2015/07/09	DOE	Deactivation and Decontamination (D&D) of the Off Gas Cell (OGC) of the West Valley Demonstration Project (WVDP) Main Plant Process Building (MPPB) was among the final scopes of work intended for completion in the MPPB D&D Project, OH-WV-0040.C1 & OH-WV-0040.R1.1. The OGC is a tall but narrow cell to which MPPB vessels were vented when the building contained the only commercial nuclear fuel reprocessing facility to operate in the United States. To perform this function the cell contained 13 vessels and about 2,800 linear feet of process piping. Foremost among the challenges in performing D&D of the cell was its high external dose, coming from both its floor and Northwest corner walls. The dose was the result of a leak that had occurred 40 years before when the MPPB was reprocessing used nuclear fuel. This leak resulted in highly radioactive contaminated acid solution being deposited in the Northwest corner and adjacent walls of the cell, as well as the cell floor. Monitoring performed in the cell almost 40 years before D&D showed exposure rates at the corner floor level as high as 50R/hr near the floor and as little as 9R/hr near the ceiling. To compound the challenge of working in the

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00002590	Project Management Good Practice Norms	2015/07/07	OpexShare	50 Project Management Lessons Learned (LL)Good Practice Norms from the EM projects in the PARS II database. These PM items were transmitted by an ARRA PMLL Questionnaire to all EM sites and rated by responders that had experienced the LL. The top rated LL items/norms that were experienced and rated as highly important to project success are addressed in the analysis section below. A list of all 50 PMLL norms is included in the attached file under six subgroups: Planning, Staffing, Documentation, Reviews, Contingency and Management Reserve, and Administration.
00002589	Use of Mockups in Demolition Planning	2015/07/07	OpexShare	The use of mockup in preparing to cut into insulated housing may have indicated the obstruction of vulnerable lines.
00002588	Design Engineering Inadequate Determination of Facility Configuration = Design Errors	2015/07/07	OPEXSHARE	Ensure that field verification efforts for modifications to existing contaminated facilities are sufficient to fully understand pre-job facility conditions. Inadequate verification at ORNL facility led to inadequate modification design. As a result, a significant amount of field re-design was required.
00002587	Commissioning Program Knowledge Base - N-MAN-09340-10000	2015/07/06	Engineering	
00002586	Cost Control Organization - Industry for Megaproject	2015/07/02	Deloitte Canada and MetroLinks	1 Senior Cost Change Management person assigned to a 2 billion project. A senior cost manager is equal to 12 years experience in this field. The Metrolinks project last year was 30 billion dollars world wide. There were 15 Senior Cost Change Management person and 3 junior personal to assist with inputs but also to transition to senior roles as part of job preperation for the future of the businss. Junior Cost Change personal are equal to 6 yrs or less.
00002585	Project Management & Risks in mega projects Conference	2015/07/06	Google Alerts	The Municipality reviewed the main risks associated with the construction projects of various infrastructures of the city and stressed the need of developing a Risks Management Plan that identifies such risks and then assesses their scope & impact on the project in terms of time and quality cost. Afterwards corrective measures have to be taken to cope with the risks along with their potential impacts and a surveillance mechanism to monitor the e results of these procedures at the present time and over the long run. The Municipality stressed that its operations are governed by a specific & strict risks management model to realize its objectives as a trendsetter of security, safety and environmental standards in all municipal projects. The paper narrated the key risks associated with different projects classifying them as technical, strategic, contractual and planning risks, and touched on the latent risks of each project in the fields of health, safety and environment during the project construction as well as operation & maintenance at a later stage. The Municipality set the key features of the roadmap detailing the way of coping with risks before their onset, during construction phase of infrastructure
00002584	Lessons must be learned from the high-speed rail fiasco	2015/07/06	Google Alerts	The Mass Transit Railway Corporation has already come under fire for misleading the government and the public on the project's progress last year. It had previously revised the budget from HK$65 billion to HK$71.5 billion and delayed the opening from this year to 2017. That the cost has shot up by again in less than year - this time by nearly HK$14 billion - is baffling. The rail giant has again cited unforeseen technical problems and rising labour costs. One has to wonder why these had not been taken into account earlier.
00002583	Guideliness for a Successful Contruction Project	2015/07/03	The Associated General Contractors of America	All parties must work throughout the project with an eye towards the final completion and acceptance by the owner. As a result, Project Closeout procedures must be integrated into all phases of the work beginning at contract award Reveiw attachment for more information.
00002582	Issue Management Guideline	2015/07/02	Georgia Technology Authority	Issue Management begins when someone suggests a matter should come to the attention of the project management team through the Project Change Request with issues as an identifier. Management may conclude the matter is not a concern – but will more often decide otherwise. The matter might be a "real" issue worth monitoring, or may represent a need to bring change to the project. This procedure is therefore a method for gathering information at the front end of the general change control process. It also allows for escalation to a risk.
00002581	Towards a Contingency Theory of Enterprise Risk Management	2015/07/02	Harvard Business School	Most companies use multidimensional visualizations, such as risk maps, to quantify risks along likelihood, impact, and controllability dimensions (Jordan et al. 2013). Electroworks and Aerotech conducted regular assessments and reviews of their high-level subjective rankings of their "top 10 risks." Companies, such as Wealthfund, with extensive historical data on asset pricing, covariance, and risk events go beyond simple risk map summaries by introducing data- and analysis-intensive statistical assessments, such as value-atrisk calculations and stress tests. We conclude from this variety that the choice of risk tools, ranging from qualitative descriptions and scenarios to the measurement of expected and unexpected loss, will be conditioned by (1) the availability of data and knowledge about a particular risk (loss) and (2) how relevant and reliable the available risk tools are in the eyes of risk experts and everyone else using the tools.

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00002580	Complex Procurement Strategies Require Additional Vendor Oversight	2015/07/03	OPEXShare	Procurement Specification for Commercial Grade Dedication of Electrical Panels, did not require MOX (mixed oxide) Facility approval and resolution on nonconformance's identified by AREVA. This contributed to a lack of wire separation in approximately 42 electrical panels that were commercially dedicated by AREVA and received at MOX. Over the past several years, AREVA has generated several nonconformance's related to incorrect wiring and components. It was not until Revision 2 of CCT-80002 (effective 8-Jan-15) that the documentation submittal schedule for the contract required AREVA to submit nonconformance reports (i.e., AREVA CRs) for MOX approval prior to implementation. Prior to revision of CCT-80002, AREVA CRs were only required to be submitted as part of the Final Record Package. As a result, there was lack of communication and problem resolution between AREVA and MOX regarding the wire separation issues that presented at AREVA in 2013.
00002579	An improper exit from operating equipment results in worker injuries	2015/07/02	OPEXShare	· The proper method for ascending or descending equipment ladders is to face the ladder and maintain 3-point contact · Improperly getting in/out or on/off of equipment steps/ladders increases the potential for misstepping or slipping while ascending or descending.
00002578	Value of Experience and Questioning Attitude	2015/07/02	OPEXShare	A questioning attitude and willingness to take the extra step by employees can have a positive impact across the organization and beyond.
00002577	Change Management Trends in Governance	2015/06/25	BenchMark Consulting International	A Change Management Governance Model incorporates all of the critical elements for successful change throughout the change lifecycle, from the initiation of an idea through the final implementation and subsequent critique for continuous improvement. Please review the Attachment.
00002576	Research Helps TVA Increase Operational Flexibility and Turndown Potential of Base-Load Plants	2015/06/29	COG #13, July 8, 2015	· For TVA, the added flexibility of turndown demonstrated in this research is of significant value to TVA in the utility's ability to better dispatch its units in the new generation marketplace, minimize start-up fuel costs, and consume significantly less component life related to unit cycling.
00002575	Decision not to Seal Weld Rocky Mountain Fitting	2015/06/29	COG #10, July 8, 2015	The stations Rocky Mountain fittings continue to a potential source of leakage with the potential to extend future outages.
00002574	(Preliminary) Low Pressure Turbine Inlet Steam Temperature Exceeds Operational Limits	2015/06/29	COG #7, July 8, 2015	· To be determined upon evaluation.
00002573	Wolsong - DEVELOPMENT OF CONSOLIDATED SPENT FUEL DRY STORAGE SYSTEM	2015/06/29	Korea Hydro & Nuclear Power Co. Ltd	In 2001, KHNP/NETEC selected AECL as a partner for the joint development of the MACSTOR/KN-400 storage module. The MACSTOR/KN-400 is an enlarged version of the MACSTOR-200 that retains its proven features while doubling its capacity. The MACSTOR/KN-400 is thus configured to store 400 fuel baskets in a four-by-ten array instead of a two-by-ten array. A storage density of approximately eighty-eight bundles per square metre is expected from the new module, about three times the density of concrete canisters and 1.3 times the density of the MACSTOR-200 module.
00002572	Design Plan - Not Authorized until Detail Design Completion	2015/06/26	AMEC	This OPEX highlights the importance of following-up on the Design Plan as well as the importance of accurately documenting percentage complete in the schedule.
00002571	Subcontractor Accidentally Cut into an Energized 15kv Cable	2015/06/25	U.S. Department of Energy	Review and update the AHA's identification procedure. Clarify the language to specify: test the cables at terminals and verify Lock Out/Tag Out. Ensure that the AHA captures actual activities being performed. Provide manhole as-built drawings to the subcontractor. Identify cables with tags that are corrosion resistant and suitable for the environment (manhole) in which they are installed. The quality of the tag must be good enough to read with portable lighting. [National Electrical Safety Code-NESC]
00002570	Management of Nuclear Construction Projects That Exceed $1 Billion: Impact on Nuclear Safety Culture	2015/06/25	U.S. Department of Energy	The Department has implemented a number of key improvements to its project management processes - project and contract management policies, guidance and practices, particularly since the initiation of the WTP project - that have helped establish a foundation for implementing a stronger nuclear safety culture at its nuclear construction projects. While the Department does not believe that its current contract management and project management processes have inherent flaws that would lead to safety culture problems or impede the resolution of nuclear safety-related issues in order to demonstrate acceptable project performance, it recognizes that simply placing requirements in directives and contracts is not sufficient to ensure adequate up-front project planning, integration and execution, attention to nuclear safety, or the development of high quality products. At this juncture, there is significant reliance on line management and Department oversight personnel to ensure safe,effective and efficient project execution.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002569	Lessons Learned From New Construction Projects that involved lapses in oversight	2015/06/25	INPO	Develop a clear division of responsibility and detailed procedures to ensure effective oversight of design compliance with the licensing basis. Ensure multiple independent oversight groups, in addition to line management, routinely review and assess project performance against predetermined goals and milestones. Deviations are promptly reported to senior corporate executives. Develop and implement an oversight program for source and receipt inspections and to define the division of responsibility for owner oversight for inspecting materials used from fabrication to installation.
00002568	RH Saunders (Corporate Health & Safety) Level 1 Work Projection Event	2015/06/22	OPG Safety Flash	eview orientation materials and local policies/practices to ensure all visitors to your site(s) are aware of their accountabilities. An immediate stand-down of the external audit team occurred. Following meetings with the external audit team it was determined that the infracting IMS auditor would be removed from the audit team and the audit could continue after the remaining IMS auditors received Level 1 WPC training. An addendum to the existing Orientation Package for External Auditors has been developed to help ensure audits team members understand their accountabilities while on OPG sites.
00002567	Delays Returning Emergency Power Generator #2 to Service	2015/06/22	COG	Unavailability of the EPG was initiated by equipment deficiencies, caused by less than adequate work instructions and spare parts quality, while the duration of unavailability was adversely affected by insufficient organizational alignment.
00002566	IAEA NUCLEAR SAFETY REVIEW 2014 - Nuclear Safety and Security Programme	2015/06/22	COG # 1 June 24, 2015	The Nuclear Safety Review 2014 contains an analytical overview of the dominant trends, issues and challenges worldwide in 2013 and the IAEA's efforts to strengthen the global nuclear safety framework in relation to those trends. The report also has an appendix describing developments in the area of the IAEA's safety standards during 2013. A draft version of the Nuclear Safety Review 2014 was submitted to the March 2014 session of the Board of Governors in document GOV/2014/6. The final version of the Nuclear Safety Review 2014 was prepared in light of the discussions held during the Board of Governors and also of the comments received.
00002565	IER L2-15-20 Glad Seal System Steam Leak Results in Cable Fire and Manual Scram	2015/06/22	INPO	Significant aspects of the event include decision by managers and operators to stand up without a complete understanding of the operational risk of power ascension with a known degaded condition, two latent equipment issues that increased the sevirity of the event, and and outage extension of approcimately 15 days to replace damaged cables.
00002564	Project and Portfolio Management Is a Business Process	2015/06/19	Gartner	Project and portfolio management processes examine effective allocation of capital. As such, they don't fall under the domain of the CIO; instead, they are part of the business organization. Chief financial officers and chief operating officers take note: PPM is a business process.
00002563	A Primer on Application Ownership	2015/06/18	Gartner	· An application has multiple stakeholders with different interests and value perceptions. o Split the whole application portfolio into six to eight application domains. · Application leaders struggle to assign a single owner and create a governance structure that serves the interests of all stakeholders. o For each domain, develop a governance structure that engages the three key stakeholder communities. · In many organizations, one or more stakeholder communities — often at the demand side — feel left out and find their interests unaccounted for. o Assign the specific responsibility for chairing each of the governance teams to individuals who will be able to forge an effective working relationship among the three stakeholder communities. · Application governance processes require clear application ownership and a balanced stakeholder representation. o Prepare responses to handle objections.
00002562	Best Practices to Drive Cost and Value	2015/06/18	Gartner	Enterprises often don't achieve the desired results from IT cost optimization initiatives due to poor execution, lack of "success" metrics and lack of clear accountabilities for results. Gartner benchmarking data shows that there is a 38% cost difference between average and best-in-class performing IT organizations. The largest opportunities for cost optimization come from asset optimization (through consolidation, rationalization and procurement), and from replacing costly IT services and technologies with more-cost-efficient alternatives. Staffing — the single biggest line item in almost all IT budgets — is still an untapped area of opportunity for optimization. Many organizations are still operating with the same organizational structures they had in the prerecession era. Gartner benchmarking data shows that there is a 38% cost difference between average and best-in-class performing IT organizations. ¦ The largest opportunities for cost optimization come from asset optimization (through consolidation, rationalization and procurement), and from replacing costly IT services and technologies with more-cost-efficient alternatives. ¦ Staffing — the single biggest line item in almost all IT
00002561	IER L2-15-16 Loss of Unit 3 Instrument Air Complicated Post - Scram Recovery from a Loss of Off-Site Power	2015/06/22	INPO	The sgnificant aspects of this event include weaknesses in opertor respone during the loss of Unit 3 IA and in operator proceures. Design errors in the development of the remote line relay protection set points by transmission personnel contributed to a latent vulnerability of off-site power pathway reliablity during an off-normal alignment.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002560	Unmanned Aerial Vehicle Utilized during Vacuum Building Outage Inspection	2015/06/17	COG	The UAV trialed during the VBO inspection provided a permanent record of both video and still image inspections. Inspections recorded during the VBO provided more details from a different perspective in less time. 15 inspections were performed in 15 minutes. This technology has the capability to eliminate the requirement for inspections to be performed from elevated platforms. Bruce Power workers identified an opportunity to save time and money during the VBO inspections by utilizing technology of UAV to perform visual inspections that were previously performed manually by individuals. Completion of all the required inspection locations was not possible due to low Global Positioning System (GPS) signal inside the VB concrete structure.
00002559	Lessons on Nuclear power plant organization and staffing for improved performance	2015/06/12	IAEA	Review the attached document for: LESSONS LEARNED WITH RESPECT TO NPP ORGANIZATIONAL DESIGN AND STAFFING
00002558	Lessons from the Last Nuclear Construction Cycle	2015/06/12	Financing New Nuclear Construction Workshop	In summary…the key foundation requirements are · Strong Leadership !!!!! · Effective Planning !!!!! · Great Processes !!!!! · Strong Leadership !!!!!
00002557	Digest of Lifting and Rigging Events (WANO)	2015/06/16	COG	· WER PAR 14-0457 – Enhanced checks are to be carried out to include the load path parts, which are not covered by the normal pre-use start checks. · WER PAR 14-0489 – The contractor shall submit a special transportation scheme for check and approval before transporting the expensive or fragile equipment. · WER PAR 14-0529 – Issue awareness brief with emphasis on the importance of crane pre-use checks. · WER PAR 14-0567 – Debrief with facilities personnel and reinforcement of lifting rules. Establishment of contingencies to make lifting operations safer, following a technical review.
00002556	#PRELIMINARY# A Worker's Fatality Accident from Choking Argon Gas	2015/06/16	COG	Units 3 and 4 are in the stage of construction. At Unit 3 the welding activities using argon were performed at elevation of -10m in the main reactor building. Two workers entered into the tank structure that contained argon gas. The first person entered the tank and collapsed, the second person attempted to rescue him and also collapsed. The first person died, the second person was in critical condition and transported to Nitra Hospital. The third person was the father of dead worker who was has got a shock when he was informed about the tragedy. The direct cause – extensive argon leak which led to casualty. The root causes are under investigation. Corrective Actions will be identified during event investigation. Applicable and Significant Issues: · Keywords: confined space, construction,c ontractor, fatality, gas, industrial safety · This event is classified as SIGNIFICANT by WANO because it resulted in a fatality.
00002555	Age-Related Degradation of Electronic Equipment	2015/06/16	COG # 1 June 17, 2015	· This report discusses age-related degradation of three electronic component types: circuit cards, capacitors, relays · This report presents key lessons learned that can be used by the WANO members to benchmark or assess experiences and practices in their own stations. The report can also be used by WANO when conducting technical support missions related to ageing electronic equipment.
00002554	Inspection of Corrective Action Program - U.S. Nuclear Regulator Commission	2015/06/12	NRC	Based on the inspection sample, the inspection team concluded that the implementation of the corrective action program and overall performance related to identifying, evaluating, and resolving problems at Virgil C. Summer Nuclear Station Units 2 and 3 was effective. Licensee and contractor identified problems were entered into the corrective action program at anappropriate threshold. Problems were effectively prioritized and evaluated commensurate with the safety significance of the problems. Corrective actions were effectively implemented in a timely manner commensurate with their importance to safety and addressed the identified causes of problems. Lessons learned from industry construction experience were effectively reviewed and applied when appropriate. Audits and self-assessments were generally used to identify problems and appropriate actions. The inspectors did not identify any trends that were not already being addressed in the corrective action program. Based on the independent assessment of safety culture results, interviews conducted during the inspection, and a review of the employee concerns program, employee freedom to raise nuclear safety concerns without fear of reprisal
00002553	List of Construction Inspection Reports - U.S. Nuclear Regulator Commission	2015/06/12	U.S. NRC	The inpection reports are posed for indiviual review, various lesson learned from Virgil C. Summer Nuclear Station, South Carolina Electric and Gas V.C. Summer Nuclear Station, Vogtle Electric Generating Plant, form 2011-2015, see additional OPEX libary items with specific lessons learned.
00002552	Container/Item Weight Review Prior to Lifting	2015/06/08	Oak Ridge LLC, Oak Ridge National Laboratory	A box, located in an area with other boxes that had been weighed, was mistakenly believed to have been weighed, so it was assumed to weigh the same as the other boxes in the area. Task Lead/Supervisor should walk down and fully evaluate/review all available information on each container/item prior to lifting.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002551	Moving Past Risk Analysis	2015/06/11	Project Management.com	Increasing Scope As tasks are added to the project and work is created in order to deal with risks, then the scope must beincreased. While you could try to force the project team to just work more hours, that is rarely good forthe long-term health of the project. Dealing with risks is part of managing the project, and the scope ofthe project should include the time and resources to deal with the risks. If the scope is not increased for the risk mitigation activities, then the stakeholders and managementteam must understand that the project is going to end up accepting the risks and dealing with theramifications instead of mitigation, which will most likely end up increasing the scope or time of theproject. Scheduling Everything The best way to document the increased scope and ensure that risk mitigation plans are executed is toschedule all of the tasks related to the risks. This lets everyone see what needs to be done and when itneeds to be done in the context of the entire project schedule. Putting solid dates on the actions related tothe risks and keeping them in the same place that other project tasks are kept will help keep the projectteam focused on acting upon the risks instead of ignoring them. You can have
00002550	The Next Generation PMO Leader	2015/06/11	Project Management.com	Portfolio management is a journey, not a destination. An organization cannot simply decide toimplement end-to-end portfolio management in the next reporting cycle and expect to be successful.Each year the organization needs to identify the areas of least strength in portfolio management and putplans in place to address those that are realistic for the capability and capacity that they have. Over the course of several years, an effective and efficient portfolio management process will develop,which should continue to evolve and mature over time. It's simplistic to suggest that "all" anorganization has to do to prepare PMO leaders for success is to ensure that upskilling businessmanagement skills are included in the areas under consideration, but that would be a step in the rightdirection. Unfortunately, it is a step that many organizations fail to make. I hope I have made it clear in this article that I don't see this as a problem with individual PMO leaders,but they aren't immune from blame here. Ifleaders are not stepping up to express concerns over theirreadiness to lead a portfolio management-focused PMO, then they are exposing themselves to almostcertain failure. Ultimately, they only have themselves
00002549	Getting Startegic with Resource Management	2015/06/11	Project Management.com	Resource management has never been easy, but it is becoming harder than ever for today's projectmanagers. As organizations become more strategic in their approach to resources, PMs need to take abroader view, understanding how their initiative--and the people working on it--fit into the enterprise asa whole and the set of projects that together deliver the goals and objectives. This is a fundamental change in the people management aspect of a PM's job, and they need to besupported in making that shift by an organization that creates an environment that encourages a strategicmanagement approach. Lastly, but by no means least, organizations must also apply this strategic resource managementapproach to their PMs, allowing them to grow and expand into new opportunity areas.
00002548	Using Correct Type of Seal (O-Ring versus Neoprene Gasket)	2015/06/09	Fluor B&W Portsmouth	An action was created to generate a lessons learned bulletin to heighten awareness to the wrong gasket being used if using VGII lids. Current inventory of 85 gallon drums should be examined to determine if the correct gasket is used on VGII lids. The extent of condition was completed on the current inventory of 85 gallon drums. The vent gaskets for the lids of those drums were replaced with the correct O-ring during the extent of conditions inspections.
00002547	OPG's Oversight of Contractor Safety Culture in Fall Hazard Exposure Event at Refurbishment DEC Mock-Up	2015/06/09	OPG SCR	New corrective action plan required to respond to the incident and any internal organizational factors whihc may have contriubted to this Contractor Fall Hazard expsosure event.
00002546	Lessons to be learned from Decommissioning of Gentilly 2	2015/06/09	COG # 19 June 10, 2015	Hydro-Québec made a presentation to all COG international and Canadian members in March 2014 to bring the Candu community up to date on G2 achievements and challenges.
00002545	Events Related to Deficiencies of the Reactor Cooling Chain	2015/06/09	COG # 2 June 10, 2015	· The aim of this study is to perform an in depth analysis of events that challenged the cooling chain of the NPPs such as component cooling system, residual heat removal system and essential service water system due to malfunctions of its components or supporting systems.
00002544	Incident Averted because of Good Work Planning and Hazard Analysis	2015/05/28	Thomas Jefferson National Accelerator Facility	When removing a pressure gauge used for routine testing, it was discovered that the threads were worn. (See Photo Attached) It was taken out of service and replaced immediately.
00002543	Cooperation between multiple organizations and companies key to achieving project success	2015/06/01	Fire Protection Services	During their annual 5 year internal tank inspection, the WTP Fire Service Water (FSW) tanks were identified as having a blistered coating. A new coating and cathodic protection system configuration was recommended as the solution. Cooperation between multiple organizations was determined to be key to the successful completion of the Fire Service Water Tank Recoating Project. Organizations realized that the good practices of the other organizations positively affected the activities that they were responsible for.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002542	CFSI Counterfeit (Suspect) Molded Case Circuit Breakers Industry Notification Eaton Cuttler Hammer EHD3015, EHD 3070	2015/06/07	V.C Summers Utility	C3-NFE. Review if similar product exists at OPG and disposition as appropriate (review stock, history etc). Issued this SCR. Obtained EO Manager Concurrence.
00002541	Niagara Tunnel and Lower Mattagami River Projects - Records Management	2015/06/01	HTO	(37) Provide detailed descriptions and examples of SCI number mandated to be used on a project managed by an outside consultant. Details in the attached.
00002540	Niagara Tunnel and Lower Mattagami River Projects - Stakeholder Management	2015/06/05	HTO	1. (35) The approach requires the contractor to resolve disputes at the labour board and may have prevented expertise from other skilled trades. This is a project-specfic LR approach. 2. (36) Upfront consultations and meetings with Regulatory Agencies. Development of working relationships.
00002539	Niagara Tunnel and Lower Mattagami River Projects - Environment	2015/06/01	HTO	1. (32) Throughout the EA process on future OPG projects, retain as much flexiblity as possible to accommodte subsequent (contractor) experience & innovations during detailed design & construction. 2. (33) Insufficient resources - probably one manager and 2 assistants would have been the appropriate level of environmetnal staffing, especially in the initial stages. The use of third party consultants, rather than site specialists, proved to be the manner of addressing many of the technical issues (e.g. water treatment, storm water managment plan). 3 (24) The addtion of the more robust sedimentation pond upstream of the initial pond with the cells operating on a rotating basis greatly alleviated the problem. Use of the sediment, combined with organic matter, proved to be a useful material for site restoration/revegetation.
00002538	Niagara Tunnel and Lower Mattagami River Projects - Health and Safety	2015/06/01	HTO	(31) Requirement to establish clear, consistent boundaries between the contractor and OPG.
00002537	Niagara Tunnel and Lower Mattagami River Projects - Project Controls	2015/06/05	HTO	1. (27) Ensure that future contracts stipulate OPG expectations on rebust inventory management to facilitate substantiation of procurement activities and control of OPG-owned project assets. OPG also needs to have proper project controls infastructure in place to support target price contracts. 2. (28) Decide on standard tools (project-specific) early in the process and allocate resources to ensure consistency and compliance with standards. Utilize simple forms (i.e. inspection, audit, or summary forms) to accurately capture and report on daily progress. Common scheduling approach required contractor tracked progress outside of P3 and to report using P3. 3. (29) More of a relationship issue - Emphasize requirements for a sub contractor management plan and OPG expectations. There are limited opportunities to update our contract T&Cs. 4. (30) limited use of DRB's in DB agreements (possibly to technical issues only) Before any 'new' process is used or considered for use as a dispute process, ensure it has been practically evaluated in (a) OPG: or (b) industry. Where speed of resolution outweighs risk of a finding against OPG, consider more informal resolution processes (such as an advisory
00002536	Niagara Tunnel and Lower Mattagami River Projects - Business Processes	2015/06/05	HTO	Reconsider OPG OAR policy given success with revised DBA precedent that permits flexible contract administration low cost (under $100K) and no schedule changes with approved cost and schedule envelopes do not require signing by EVP levels; set-up specific Project authories tailored to the project. Include detailed descriptions on PCD's.
00002535	Mochovce Nuclear Power Plant - Fatality	2015/06/01	Mochovce Nuclear Power Plant	see attached.
00002534	Niagara Tunnel and Lower Mattagami River Projects - Technical/Design	2015/06/04	HTO	1. (23) When using the Design-Build project delivery model, the Contractor should be required to have a design representative on site full-time during construction. 2. (24) Design-Build contracts should contain Owner's requirement for site positions, numbers, disciple and qualifications. 3. (25) In part this was made possible by scoring and choosing the correct Contractor during proposal evaluations.
00002533	Niagara Tunnel and Lower Mattagami River Projects - Integration Management	2015/06/04	HTO	(22) Project management teams employing external Owner's Rep's should reference NTP - reflects an excellent use of personnel and resources and effective time as well as risk mtitigation practices. Best practices employed with very successful results.
00002532	Niagara Tunnel and Lower Mattagami River Projects - Procurement Management	2015/06/01	HTO	1.(20) Use target cost approach with incentives/disincentives to optimize risk transfer to contractors. Consider utilization of the CII PDCS tool. 2. (20) Better model for underground works than fixed price.
00002531	How to Hire Effective Project Managers	2015/06/02	ProjectManager.com	Look in the Right Places The hunt for qualified candidates to join your organization can be a challenging task. Posting a job description to a free site may even cause more work than you bargained for. You'll spend the majority of your time sifting through unqualified candidates than wooing high performers. Place a strong focus on looking for people with shared contacts within your organization. Advertise internally as well as externally, as those internal referrals can produce your most dedicated and top performers. Look for project-management or industry-similar meetup groups in your town. Scan the web for conferences and seminars around digital design, development or quality assurance that you can attend to chat with potential candidates in person.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002530	Steam Generator - Waterlancing	2015/06/03	CANDU - IMS Steam Generator Refurbishment Inspections	see attached.
00002529	Faulty streetcar track installation latest problem associated with Leslie Barns - Oversight	2015/06/01	Toronto Transit Commission	In the public's eye that understand that their neighbourhood is disrupted for addition 5 weeks and don't care that its the fault of the contractor. To the public its the TTC who has always had a challenging reputation in the eyes of the public. Where and who does oversight? Read the attachment for more details.
00002528	Digest of Work Protection Control Events (WANO)	2015/06/01	COG # 4, June 3, 2015	WER PAR 14-0484 – Safety Rules Advice Bulletin issue to highlight error trap from non return valve preventing draining. Operations to review proposals for targeted independent verification of isolation scope with clarity on how this is achieved & recorded. WER PAR 14-0492 – There are insufficient barriers and processes in place to manage and control changes to Work orders, safety documents and scheduling during the execution phase of the outage. WER PAR 14-0507 – Develop a process to ensure that valves re-built with parts missing are controlled such that they cannot be used as isolation valves. WER PAR 14-0552 – Carry out a Safety Rules briefing for all nominated Competent Persons (nCP) to clarify the expectations on point of work briefs. Re-iterate the safety rules stance that the nCP should be part of the working party.
00002527	Condenser Circulating Water (CCW) Discharge Channel Partial Obstruction Due to Growth of Aquatic Plants	2015/06/01	COG # 18 June 3, 1015	· A process to periodically check CCW discharge channel water level and remove aquatic plants was implemented.
00002526	Capacitor Failure During Inverter Start-up	2015/06/01	COG # 15 June 3, 2015	· During the design phase of installing new station equipment research should be done to understand the service life and replacement requirements of all equipment components. At this time consideration should be made to developing maintenance plans.
00002525	Erroneous Indication of Annulus Gas System Transient	2015/06/01	COG # 11 June 3, 2015	· Knowledge based decisions during maintenance can lead to errors. Maintenance should be driven through procedure and when unsure the employee should stop and seek direction from supervision.
00002524	Niagara Tunnel and Lower Mattagami River Projects - Risk Management	2015/06/01	HTO	(16) Lessons learned commercial terms and conditions with installation contractors, design contractors, and owners engineer should stipulate involvement of all parties in co-operative risk management activities. Emphasize 'shared' risk register approach. (17) Lessons to be learned here where it was warranted by project scale and risks, you should adopt a combined risk management process ensuring the owner/contractor collaboration on risk management during execution of future OPG projects. (18) Populate risk registers in a database format to allow for easier sorting and review of register/track changes. (19) Risk Assessment must start before the contract stage. Each project must be thorough and document the risk in and addressed in the Contract.
00002523	Niagara Tunnel and Lower Mattagami River Projects - Communication Management	2015/05/01	HTO	(12) Establish a template and share with Project Management Office to share with other projects. (13) Adopt similar agreements & procedures with host communities where warranted by project scale & potential community impacts. (14) Ensuring the most recent/accurate information is available to those that require it. Much too often the information is not shared and by the time it reaches the level where it is required it is either too late or inaccurate. Sharing information with contractors is key to success. Incorporate contractor overall project communication matrix. Contractor discipline/management system are constant issues. (15) If partnering concept is established early in the project, it can be extremely effective. Partnering requires "give-and-take" on both sides. Having dividing sectors which may have individual needs that are put above completion as a whole are harmful and not in the spirit of partnering. recognizing/considering the thoughts/ideas of other companies is part of this approach.
00002522	Niagara Tunnel and Lower Mattagami River Projects - Human Resources	2015/06/01	HTO	(9) There is no real recommendation here since the project was a over 8 years but a pro active approach must be taken on staff planning. (10) Where its an organization team building event of simply a summer BBQ, these events should be held in a regular basis throughout the life of the project. Remember OPG's code of conduct and expense policies may restrict team building opportunities with external contractors and forego the benefits. (11) Start out with keep core (key) members and bring on others as needed.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002521	Niagara Tunnel and Lower Mattagami River Projects - Quality Management	2015/05/29	HTO	1. (6) Design-Build contracts should contain Owner's requirements for Contractor site positions, numbers, disciplines, and qualifications. If quality control is to be properly enforced by the contractor, a clear division/separation of the role must be made. Having production employees responsible for quality typically does not work. Independent management (i.e. 3rd party) of quality is better and recommended approach. · Further assessment of OPG contracting model/terms – emphasize inclusion of project specifics and/or OPG standards in the areas of safety, environment & quality. (SEQ). 2. (7) In tunneling the premise to battle through existing situations/conditions is the norm. Fixing a problem when its encountered should be given greater situation (i.e. over break, excessive construction water.) a. A more robust contingency planning process by the contractor to incorporate root cause techniques to support problem resolution of construction/technical issues must be in place. 3. (8) Lessons to be learned were when used properly, "Method Statements" are effective tool if taken seriously and preferred with the intent of being utilized and not just to satisfy a
00002520	Niagara Tunnel and Lower Mattagami River Projects - Contract/Procurement Management	2015/05/29	HTO	(4) Lessons to be learned here is to have clear language that identifies OPG's expectations to optimize expectations to optimize the net value recovered. Use of an unreserved auction was effective for a project of this size. (5) Wants and needs lesson was getting the right stakeholders involved early in the project. The Plan Group needed to provide sufficient time and resources to document what they want and its rationale. A dedicated resource should be considered.
00002519	Niagara Tunnel and Lower Mattagami River Projects - Cost Management	2015/05/29	HTO	(2) Lessons Learned – Projects should have a detailed cost broken out monthly in advance of project release. (3) Lessons Learned - Projects should have a forecasting model developed on order to forecast final costs based on current month actual.
00002518	Niagara Tunnel and Lower Mattagami River Projects - Schedule Lessons	2015/05/29	HTO	(1) Although OPG carries out a limited number of linear projects, it should consider employing this format on other types of projects. Project team should document the time-away scheduling process and any lessons learned to share with other project teams.
00002517	Niagara Tunnel and Lower Mattagami River Projects - Lessons	2015/05/27	HTO	Their are mutiple lessons learned in this 157 page document. On pages 1 - 12 there are 38 key lessons that will be sent individually NR OPEX SME's and PM's to ensure that these lessons have been reviewed and dispositioned appropriately.
00002516	Lower Mattagami Change Management Process	2012/05/27	HTO	See attached document for details.
00002515	Operating Outside an Approved Risk Management Framework	2015/05/06	OPEXShare	Functional area representation during a planning meeting should not be construed as concurrence or approval of the proposed course of action, especially when considering consolidation efforts across two disparate sites. Subsequent changes to planned implementation or deployment need to be fully vetted, not only by the functional area experts but the site specific SMEs as well. Change and notification procedures in place for one site or another, may not fully alert or disseminate new courses of action to all required personnel at both sites.
00002514	Maintaining Alignment Between Project Controls Tools	2015/05/27	OPEXShare	There are multiple project control tools that maintain schedule dates at different levels of detail. It is important that schedule dates align between these tools and ultimately provide consistent quality reporting among different users.
00002513	Niagara Tunnel Project Execution Plan	2015/05/28	Internet	The attached document has good lessons to be learned for: Organization, Roles and Responsibilities.
00002512	Fatality during construction of Unit Novovoroneezh-2 1	2015/05/28	COG	· A construction worker died, falling from a height of 20m due to the collapse of the supporting structure.
00002511	Nuclear Knowledge Management	2015/05/14	UK	Overall, knowledge can be considered as a function of data and information, but with the experience of use to understand the applications and context through meaningful interpretation. Therefore, capturing knowledge is much different than capturing data or information; a simple database or spreadsheet will not have the necessary functionality. Knowledge = f (info, experience of use, application, context).
00002510	Nuclear Cyber Security	2015/05/03	UK	Suppliers are often seen as the weak link in security. If two or more companies are bidding for work and they offer similar price, quality and service levels, then the company that can demonstrate good security practice tends to have the advantage." The first Certification Body to be approved by QG Management Standards is Cumbriabased Indelible Data. Indelible Data has been instrumental in driving cyber security within supply chains for a number of years. Some insurance companies are starting to offer incentives to organisations who conform to the scheme.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002509	Electrical Shock of a Non-Electrical Worker	2015/05/22	Lawrence Berkeley National Laboratory	Prior to the electric shock, at around 11 am, the Control Room operators prepared to start up the bending magnet's 480 VAC power supply. The operators noticed that the interlock chain in the Control Room indicated a cooling water flow problem, which was preventing the magnet from starting. The on-duty electronics technician was dispatched to troubleshoot the flow switches. He locked out and tagged out (LOTO) the electrical circuit, unplugged one of the flow switch connectors, inserted a jumper, and energized the circuit. The jumper was custom built with proper pins and was insulated for most of its length, but two locations presented exposed metal. While troubleshooting, the electronics technician had difficulty identifying the cooling water flow path, since the pipes were not labeled. He requested assistance from the Cyclotron operations staff, and the Operations Supervisor arrived to help with the identification of the water flow path. At approximately 12:30pm, the Operations Supervisor climbed up onto a fiberglass stepladder, and while pointing to the water pipes, contacted a grounded pipe with his right hand while brushing against the exposed metal on the energized jumper with his left
00002508	Do You Give Excuses	2015/05/20	Linkedin	I recall when I was beginning in my management career and was speaking to my grandfather one day on the telephone. We were having a great conversation and I had that feeling of anxiety as I had frequently when many people in my family I had not visited as frequently as i would have liked. Half way through the conversation I said I am sorry I have not visited more often, I just have not had the time with my new job. He responded, I think highly of you, respect what you have done and you will have a bright and prosperous future. However, please do not give me excuses why you have not been able to visit, if it were important to you, you would have found a way. I have taken that story with me in both my personal and professional life and never give excuses any longer. He was absolutely right, if it were important to me I would have found a way, otherwise what we do is provide an excuse. As a leader pursuing bigger and better things, it is imperative that you utilize your energy into asking what else can I do to yield the results I desire vs coming up with all the reasons why it cannot be accomplished. Once you begin giving excuses, you begin accepting excuses. Starting a downward vicious cycle that will derail you from success. Look for reasons why and how you can vs the opposite. If you are focused on the outcome, a solution will present itself. Remember, no one likes an excuse. Focus your energy as to how you can and will accomplish the challenge at hand and a solution will always present itself. Excuses are only
00002507	To Inspire, You Must Inquire	2015/05/01	Linkedin	If you seek solutions to a problem, tailored around a specific set of questions, you help your team in the ability to discover the correct answers on their own, rather then simply being told the solution. This helps build confidence and creates ownership and true feelings of pride that will lead to success. You are the gatekeeper to development and your team needs you to guide and coach them in order to elevate their experience and skillsets. Always remember that most people do not see the way you do, think the way you do nor pursue solutions in the way you do. In order to grow and develop healthy teams, you must take the route of patience to help untap the potential within your those you lead, otherwise you may find yourself having to work harder and longer. Do not allow yourself to consistently put out fires and be the person everyone goes to for solutions. Inquire, listen, engage and redirect when necessary. To inspire those you lead, you must first inquire with those of whom you lead. "We can teach from experience, but we cannot teach experience" ~ Sasha Azevedo
00002506	How to Stay on the Critical Path	2015/05/23	ProjectManager.com	Identify Slack in the Schedule Go through your task list and note down for each task: • The earliest possible start date • The latest possible start date • The earliest possible finish date • The latest possible finish date that wouldn't impact the end date for the project. The difference between the earliest and latest dates is the slack you have in the schedule. For example, if a task could start at the earliest on Monday but has to start by Thursday, you have three days of slack (Monday, Tuesday, Wednesday). Plot Your Critical Path Now you have those details for each task, it's time to work out which of your tasks are on the critical path. They won't necessarily be the tasks that are most important, but they are easy to spot. The critical path tasks are the tasks that have no flexibility in the start date or end date. They are the tasks you identified that have no slack. They might be the least important activities, but their completion dates determine the project's delivery date because you can't flex the dates forward and backwards. Highlight these tasks on your project schedule - these are the ones you really have to focus on managing to get the project delivered on time. Resource the Critical Tasks The easiest thing to

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00002505	TSSA Reconciliation Statement Missing	2015/05/27	Amec Foster Wheeler – Nuclear Canada	
00002504	Filler metal questioned for RFR Project	2015/05/27	N-2015-10853	Reported information to Darlington RFR project coordinator that this fill metal specification will be made obsolete or cancelled.Additional Information:- All Dissimilar metals welds involving I690 base material shall use 52M filler.- CS/SS metal weld (thermowell assembly) will not use 82 filler. 82 TS will be made obsolete or cancelled. This material could possibly lead to solidification cracking. - Original CS/SS weld material will be used for the thermowell assembly. There have been no issues with the original material. - It is understood that CS/SS 52M welds have little or no opex.- 52M assessment work conducted by EPRI does not consider CS/SS welds only feeder to feeder weldability.
00002503	Lessons from Past Nuclear Construction Projects	2015/05/23	Internet	History Repeats itself! Poor communications between design and contruction organizations Overconfidence in personnel Ineffective problem ID, reporting and corrective actions Unrealestic and aggressive schedules Inadequate assignments of responsibilities and authority Vendor issues Subcontractor issues
00002502	Implementing Document Management - Recommended Practices and Lessons Learned	2015/05/21	Intellect	Implementing document management solutions requires change and project management muchlike any other business projects. There are, however, many unique aspects to them as well.It is these aspects that will go a long way to determining the success of a document management solution. Effective document management will deliver real benefits to any organisation. These aresolutions that will enhance your organisation,and it is important to remember this and alwayswork towards the benefits that you are trying to deliver. You should make the most of guideslike this, and others that exist, as well as other sources of experience and information, toensure that your project delivers maximum value to your organization.
00002501	Insights from Engineering Vendors	2015/05/21	INPO 14-20	Ensure discipline in adhering to sound project management fundamentals and responsibilities and accountabilities with vendors are crystal clear and kept up to date as projects progress. /Hold the suppliers and station project support team accountable for meeting station objectives for implementation oflarge projects. Attributes to be emphasized include, butshould not be limited to, the following: A. The station must transmit achievable and understandable objectives, including project milestones, while the supplier remains accountable for meeting them. B. Respective technical and project management proficiencies must be assessed, understood by both sides, and maintained commensurate with the complexity of the project.Whenever knowledge, skill, or experience are in question or challenged, mitigating measures must be emplaced and assessed risk reconsidered. C. An oversight regime is established that ensures prompt reporting of events during project execution, and enables the needed transparency for third-party reviews of critical projectinputs, assumptions, and technical decisions that can impact project risk.
00002500	Establishing Healthy Technical Conscience	2015/05/21	INPO 14-20	Conduct a self-assessment to determine to what degree your organization has a healthy technical conscience using INPO 10-005, Principles for Maintaining an Effective Technical Conscience, or equivalent document as the basis for this self-assessment. Consider a survey format as input to this self-assessment. The self-assessment should include station processes and programs that promote and instill a healthy conscience as well as the appropriate leader and engineer behaviors. Ensure the principles are included in periodic training, and incorporate similar assessments in the organization's ongoing assessment programs. Attributes to be emphasized include, but should not be limited to, the following: A. Leaders • Leaders demonstrate personal responsibility to ensure the technical bases for proposed changes, evaluations, and decisions are thoroughly reviewed.• Leaders obtain the perspectives of cognizant technical organizations and experts for use in the decision-making process to ensure technical positions are fully understood and acted upon. • Leaders set high standards and reinforce expectations for thorough and complete reviews of conditions that could reduce operating, design or safety margins. If

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00002499	Integrated Risk Strategies	2015/05/21	INPO 14-20	While risk cannot be completely eliminated, the challenge is: how do wemeasure it, how do we minimize it as much as possible, and finally how do wemanage the risk that remains. In these events, leaders believed that sufficient measures were in place to manage projects, aswell as the operational enterprise risks, but in every case they underestimated the potentialconsequences of failure. Their misguided comfort levels were often influenced by a belief thattheir specific engineering projects had been performed successfully elsewhere in industry, andthat the vendors involved were subject-matter experts, capable of guiding them to a successfuloutcome as well. In other cases, the management of the project fell short because theorganization's structure and capacity were not aligned to the magnitude of work associated withthe size and/or complexity of the projects. Had they instead applied a consequence-basedenterprise risk model that first assessed the consequence ofproject failure, and then elevatedtheir level of examination and oversight commensurately, it is likely that greater project scrutinywould have followed and different outcomes would have occurred. Indicative of weak organizational technical
00002498	Real- World Risk Management	2015/05/20	PMI	From evaluating the mondane everyday risks involving budget and ascheudle to high-impact events such as oil spills and terrorist attacts, risk management should be at the core of the decision-making process for every project in the portfolio. Risk management is quite simply the best way for organizations to protect their assets and make the most of their project portfolio. "Whether it's adopting a new technology, pursuing a new market or doing more outsourcing," Mr. McClean says, "when you have a mature risk-management process, you can better appraise the value of your risk."
00002497	The Project Management Office: Aligning Strategy & Implementation	2015/05/20	PMI	With the right processes and the right talent in place, a PMO may be fairly confident it's getting the job done. But the only way to really tell is through the metrics, the lifeblood of a PMO."The reason the PMO exists is to improve capital performance," Mr. Wood says. At the very least, metricsshould track capital performance across the organization at both the project and portfolio level, with highlights reported to senior management, he says.Armed with that data, executives can pit current trends against the organization's long-term performance. But the most worthwhile comparisons aren't limited to within the company walls. PMOs should also consider benchmarking themselves against other organizations, Mr. Wood says. "Metrics on their own are OK, but to be effective you need to know where you sit against your peers."And PMOs should be looking beyond budget, scope and schedule to business-driven metrics, such as time to delivery and customer satisfaction. Almost one half of high-performing PMOs measure themselves by criteria other than simple project metrics, according to the Pulse in-depth PMO report. The high performers' assessment process regularly includes feedback from customers (76
00002496	Mobile Work Management a Game Changer at Exelon Nuclear Facilities	2015/05/20	COG	· A digitized work management system for the execution of maintenance activities can increase productivity while lowering costs at nuclear plants.
00002495	Digest of Engineering / Preventive Maintenance – Electrical Events	2015/05/20	COG # 9 MAY 27, 2015	· OE308455 – Due to the Design of the fuse holder it is possible to improperly install the fuse holder which would allow for the fuse holder stabs to back-out over time. (Service Water Pump Motor Circuit Breaker, General Electric Company, Model AM-4.16-350-1H) · OE308778 – STA switch contacts fail to operate (open/close). Failure causes interlocked equipment to subsequently fail to start or stop. (Switch, General Electric, Model 52STA) · OE308883 – The station did not fully evaluate the potential plant impact for the worst case scenario that could occur during the evolution. (AC Motor-Generator Set, General Electric Company, Model, 6PA4326A97) · OE309057 – Procedural Guidance could have contributed to static electrification based on past · vendor recommendations that were not implemented to ensure the transformer cooling control system was operating optimally. (Station Service Transformer, ASEA Inc./Subsidiary of ABB Brown Boveri, Model GBM 2279)
00002494	High Vibrations of Liquid Zone Control Helium Compressors 1-3481-CP02	2015/05/20	COG# 11 MAY 27, 2015	The need for several interventions on the equipment without fully remedy the problem was caused by: - Lack of spare parts for the execution of capital repair of compressor; - Insufficient time to test the equipment for collecting data after each intervention (tests can only be performed when no refueling is in progress); - Ongoing identification of new possible factors: the dimensional changes of the cap / body of bearing 6 because of wear could not be identified initially in the absence of information from the manufacturer; - Fixed bearing assembly tense, worn surfaces caused by rectifications; Part of these problems was related to improper assembly of the compressor during commissioning of Unit
00002493	Areva and Siemens Supplier Consortium	2015/05/15	Nuclear Energy Insider	

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00002492	Contruction Manager Weigh in on Engineering Design	2015/05/15	Engineering	All projects have lessons in them, if we're open to recognizing them and willing to learn. If I or my colleagues learned something from a project, then we need to pass this information on to keep the same mistakes from happening again. Lessons learned during engineering design are usually not well documented because of the demanding pace and accuracy needed to produce quality drawings. Let's face it, a project will likely take longer to complete if lessons learned are documented along the way, but it will make a similar design process easier and more efficient in the future. That will benefit the next designer and others that follow. As a construction manager, I can tell you that this is valuable information going into future projects. Lessons learned are discussed in weekly meetings on large projects. When construction completes their scope of work and the project moves towards completion, the design engineer's lessons learned are just as vital as the red line and as-built drawings. Because it is almost impossible to remember the day to day issues that arise in design activities, a daily journal is a helpful way to keep track. Look for lessons learned every day, talk to senior design engineers, talk to customer reps on
00002491	Smart and Skilled Contract Terms and Conditions 2015	2015/05/22	NSW	
00002490	The Alberta Report COAA Major Projects Benchmarking Summary	2009/02/01	COAA	The path forward is bright. While a focus on improved engineering and construction productivity is always warranted, quicker improvement is possible through increased focus on application of better project management practices. For owners, adherence to effective planning through asset development processes (ADP's) tailored to Alberta projects may be helpful. For contractors, revised emphasis on effective project execution plans (PEP's) may be needed. Intensive implementation of industry best practices and stern adherence to basic project management practices is recommended. Fortunately, the lessons of the past few years have created an improved awareness and added experience to the abilities of Alberta-based companies and personnel to manage the unique projects found in Alberta. Regardless, the only way to truly and objectively know whether or not project execution is improving is through continued measurement. Continued use of benchmarking products in current and additional aspects will generate improved intelligence concerning Alberta-based projects. There is ample reason to suspect that tomorrow's projects will be much better than those executed today.
00002489	Exelon Nuclear Risk Assessment Process	2015/05/14	INPO, Engineering	Improve:Site leadership engagementRisk management strategy developmentEnsure leaders are clear on what risk map reviews should look like Continue to find opportunities to leverage risk processUnit startup reviewOutage scope challenges Re-scale fleet level risk map for better discrimination Corporate issues created that are really site issues
00002488	Pharma Change Control	2015/05/14	FDA NEWS	A post-approval change management protocol describes specific changes that a company would like to implement during the lifecycle of the product and how these would be prepared and verified. It is a step-wise approach in the assessment of changes, which allows an early evaluation of the strategy for the change and a later separate evaluation of the data produced based on the agreed strategy (Figure 1). Such a stepwise approach is expected to lead to faster and more predictable implementation of changes post-approval, since the MAH will have obtained agreement from the Regulatory Authorities about the proposed strategy and tests to verify the effect of the change on product quality. Typically the variation category designated for reporting changes under an approved post approval change management protocol is at least one category lower than would normally be the case.
00002487	Small Diesel Fuel Spill from Pump at New Fire Pond - Maintaining Positive Control over Equipment and Calling Time-Outs	2015/05/14	DOE	Key Lessons Learned: Maintain positive control of trailer mounted equipment.Correctly position and use wheel chocksCall Time-Out when doubts/questions arise.
00002486	Fall Protection Recent Event and Focus Program	2015/05/14	DOE	Summary •Comply with requirements, controlling procedures and work documents associated with Fall Protection –DOE-0346, Hanford Site Fall Protection Program (HSFPP) –DOE-0344, Hanford Site Excavating, Trenching and Shoring –PAS-2-1.1, Integrated Work Control –Exhibit G, WCH Safety and Health Requirements –A-6004-286, Fall Protection Work Permit –A-7400-373 (REV 7), Hanford Site Excavation Permit –WCH-FS-290 (09/06/2011), Routine Work Determination Form •Pay attention to detail – IWCP
00002485	Construction Worker Falls 14 Feet from a Beam onto Concrete and Suffers Serious Brain Injury	2015/05/14	FACE	Recommendations: Consider using aerial work platforms or scaffolds to reduce the risk of falls when installing trusses, rather than having workers stand on the beam edge. Reduce exposure to falls by placing and securing plywood over the already installed trusses to create a walking/working surface to which an anchor can be secured for a personal fall restraint system.

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00002484	Koeberg South Africa Turbine Control/Protections Replacement Project	2014/12/18	Alstom	Schedule · A number of activities that could have been completed prior to the outage were done in outage, such as cable pulling, scaffolding. · Maintenance group was established to maintain digital systems and those members were highly involved in the development, installation, testing and commissioning stages of the project, which contributed greatly to the project's success. · Maintenance and engineering staff were involved in the installation and commissioning to learn (i.e. in a support role to assist and learn the new system). Eskom established a dedicated "digital maintenance" group and involved these personnel throughout the project lifecycle. · It was difficulties to retrieve from Eskom the existing up to date site documentation since it was first commissioned. Cost · Eskom found advantage in using the OEM (Alstom), with Alstom R&D capability and expertise in control system design/development. · The training provided was not adequate for the plant personnel and additional field training was required. Up to 1 year after installation and system commissioning a person/resource was contracted to stay on site to assist with field training at site. ·
00002483	VenDM alone is not a communication tool	2015/05/08	Planning and Controls	There are a couple actions that are required going forward: 1. Receiving company of documents through the VenDM must have a questioning attitude if they don't understand who the recipient is, and ask the sending company what is required. 2. Sending a document through the VenDM system requires the sender to inform the targeted vendor company/department/person to be notified by other means such as phone call or email that "Incoming" documentation has been sent to them through the VenDM system. 3. The "Sending" company that requires a specific turn around time must follow up with the "Receiving" company to ensure that all expectation required are understood by through the VenDM and/or email/phone. 4. Using the VenDM system does not alleviate any personal interaction with doing business.
00002482	Counterfeit, Fraudulent and Suspect Items	2015/05/11	CNSC	Some of the measures successfully put in place by the NPP operators to defend against suspect items include: the use of audited, qualified and reputable suppliers verification of items throughout the entire supply chain the establishment of awareness programs membership in international nuclear procurement groups These proactive measures form the first line of a defence to detect and prevent the intrusion of counterfeit, fraudulent, and suspect items. In the unlikely event that the first line of defence is breached, and such items are installed at NPP sites, the inspection and testing prescribed by the licensee's Fitness for Service Program is the next line of defence to identify and remove these items from service. In addition to these preventive and detection programs, there are other layers of defence, which include: conservative design and construction with large safety margins design redundancy and diversity multiple barriers in the design
00002481	UPDATE: Deviation on HK Medium Voltage Circuit Breaker Close Latch Springs	2015/05/11	COG#17 May 13. 2015	There is a potential for an aged HK circuit breaker with hardening grease and this reduced spring force not to close.
00002480	Contactor Failure Results in Failure to Automatically Extract Adjuster Rods	2015/05/11	COG# 12 May 13, 2015	· Failure of the plastic components due to material embrittlement due to aging (the contacts were in use for more than 18 years of operation) and operating conditions (variable temperature).
00002479	Conduct of Engineering Programs at Nuclear Power Stations	2015/05/11	COG #11 May 13, 2015	· The manual is not intended to create new requirements for conduct of engineering programs, but rather provide information for review and discretionary use to help achieve high levels of performance.
00002478	Unavailability of Fuelling Machine Resulted in Unit Derating Greater Than Ten Percent	2015/05/11	COG #8 May 13, 2015	· Replace the FM Magazine Position Error Indicating Alarm meter with new components.
00002477	Cyber Security	2015/05/07	Nuclear Energy Insider	Uncover a strategy to help maintain, manage and capture knowledge effectively so you can ensure a seamless transition through staffing challenges. Discover how the NDA's Information Governance Programme will be implemented to enhance efficiency across the NDA estate Gain insight into limiting cyber-attacks whilst still maintaining the benefits of interconnectivity through networked IT systems Understand the principles of the cyber essentials scheme and access guidance, tools and techniques to ensure your sensitive and commercial information is secure Limit the potential impacts of cyber-attacks by creating a security culture across all levels of your business Ensure your supply chain is protected in the event of a devastating cyber-attack with leading security experts QG Management Standards Understand how Cyber Essentials tools can protect businesses in the event of a cyber-attack by ensuring the security of their supply chain
00002476	Security Clearance Process Changes - Information for Hiring Managers and Contract SPOCs	2015/05/06	Worley Parsons	In light of OPGs Business Transformation Initiative (which has seen many transfers and movement of employees), coupled with the anticipation of numerous large scale projects on OPG's horizon, Security & Emergency Services has received approval to amend the clearance process. These changes will create efficiencies, garner cost savings, and address areas for improvement for our Security Clearance Program.

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00002475	Digest of Engineering / Preventive Maintenance – Valve Events	2015/05/06	COG#15 May 6, 2015	OE308713 – The valve dimensional clearances were based on analysis performed at thermal equilibrium; however, the assumption of thermal equilibrium is not valid for all thermal events when temperature rise is not uniform throughout the valve. (Moisture Separator Drain Valve, Fisher Controls International, Model 4195KB) OE308922 – A new Specification / Technical Requirements Document will be prepared such that in future Air Assist Control Panels meet the station_design and licensing bases requirements, including Spring Only Stroke Time Testing. (Main Steam Isolation Valve, Atwood & Morrill Co. Inc./Xomox, Model M-S-I VLVS2SM-001) OE309032 – Graphitic Corrosion can occur in over prolonged exposure to superheated steam environments below 600 degrees Fahrenheit. (Main Steam Isolation Valve, Rockwell Int/ Flow Control Div, FIG 612) OE309092 – The proper torque settings for all the sluice gates were verified. (Traveling Screen Sluice Gate Operator CW-14C, Limitorque Corp, Model SMB-2)
00002474	Platforms on Fuelling Machine Bridge Contacted South Feeder Cabinet Resulting in the Unit Outage Critical Path Delays	2015/05/06	COG#13 May 6, 2015	Not ensuring correct installation of the FM bridge platform (adequate clearance checks) can lead to personnel injury and equipment damage.
00002473	WANO Hot Topic Industrial Safety "Rigging, Lifting and Material Handling" Events	2015/05/06	COG#8 May 6, 2015	· WER ATL 13-0197 – Additional general contractor superintendents have been assigned to monitor the various work areas outside the protected area and the work activities in these areas will be lined out in more detail. Particular attention will be paid to work areas which change characteristics as demobilization continues, as required to the end of extended power uprate project field activity. · WER ATL 13-0766 – Ensure that safe work zones for lifting evolutions using an engineered temporary lift assembly encompass failure of the temporary lift assembly structure, when practical. Update procedures, training programs and qualifications to ensure nonessential personnel (those who are not required to be in the area to perform the lift) remain clear of a suspended load fall zone that includes temporary lift assembly structures should the assembly fail. · WER PAR 13-0331 – Rapid feedback report (RER) sent to other sites and to the Nuclear Corporate Engineering Unit. · WER TYO 14-0134 – Complete inspection and rectification measures were taken at site including high-risk work, edge protection, scaffold installation, construction power, firefighting, equipment operation etc. and all
00002472	PRELIMINARY: Fatality during Construction of the Unit	2015/05/06	Novovoronezh (PWR)	· A construction worker died, falling from a height of 20m due to the collapse of the supporting structure.
00002471	New Risk-Informed Inspection Standards Increase Plant Safety at CANDU Reactors	2015/05/06	COG#5 May 6, 2015	· To focus critical resources on those systems and components that can initiate or mitigate plant events, EPRI's risk-informed in-service inspection (RI-ISI) methodology has been revised and adapted to address CANDU technology.
00002470	Unit Power Reduction Caused By Momentary Loss of Low Voltage Instrument Power Supply	2015/05/06	COG#4 May 6, 2015	· The two year preventative maintenance strategy for the affected 45VDC power supply unit involved visual inspection and ripple testing of the voltage output. The existing strategy did not leverage thermography as a predictive monitoring method to detect heat that is normally evident when current is flowing through loose electrical connections. · As similar 45VDC power supplies in Units 3,4 and 0 (common services unit) are nearing their end-of-life, a strategic plan is in place to replace other aging power supply modules before they reach their end-of-life dates.
00002469	How to Estimate a Project	2015/05/05	ProjectManager.com	Once we take the estimate and we run that through our change control board, our stakeholders who approve it, that now becomes our budget that we use to track the project along the way and any kind of variances. An accurate estimate helps everyone. It helps the stakeholders have a confidence in their project. It helps the vendor partners be able to manage their own teams. It helps your team to know what they are to do and when they are to do it. And, it helps you as the project manager, for everyone to be on the same page. Watch this helpful vide:https://www.projectmanager.com/how-to-estimate-a-project.php?utm_source=Constant%2BContact&utm_medium=Email&utm_campaign=Project%2BManager%3A%2BMay%2B2015%2B-%2B%231
00002468	Poor work control process existed for over a decade	2015/05/04	OPEXShare Website	The material was inaccurately marked as classified information, the incident resulted from failure to evaluate work control processes and operational conditions for work activities in a classified subject area. A separate Office of Enforcement review of a security incident that involved differences in the inventory of classified accountable nuclear material revealed that inventory practices and documentation were inconsistent and inaccurate" for several years. Poor accounting and housekeeping practices caused significant difficulty in reconciling inventory discrepancies and determining the final disposition of a number of accountable items.
00002467	Teamwork Results in Effective Resolution of UPS/Generator Interface Issues	2015/05/04	OPEXShare Website	Through team work and dedication, seemingly insurmountable issues can be overcome in a safe and efficient manner while following all of the processes and procedures. When an interdisciplinary team focuses on a common goal, remarkable outcomes can be achieved.
00002466	TGR - ESES Detailed Design Phase	2015/04/30	Turbine Generator Project	
00002465	Occurrence Report - Contractor Failure to Follow LOTO Procedure	2015/04/29	Sandia National Laboratories	

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00002464	10 Principles of Leading Change	2015/04/27	Strategy and Business	Yet skilled change managers, conscious of organizational change management best practices, always make the most of their company's existing culture. Instead of trying to change the culture itself, they draw emotional energy from it. They tap into the way people already think, behave, work, and feel to provide a boost to the change initiative. To use this emotional energy, leaders must look for the elements of the culture that are aligned to the change, bring them to the foreground, and attract the attention of the people who will be affected by the change. 1. Lead with the culture2. Start at the top3. Involve every layer4. Make the rational and emotional case together5. Act your way into new thinking6. Engage, engage, engage7. Lead outside the lines8. Leverage formal solutions9. Leverage informal solutions10. Assess and adapt
00002463	Review WANO/INPO/SOER/SER/IER L1 & 2 and MRM selected SCRs	2015/04/29	CARB Meeting	Originally, industry lessons learned and mitigating actions taken were in response to a single open phase condition as described in the original IER L2-12-14. Subsequent international events, including open phase conditions in multiple phases, required a change in the scope of the operational and technical evaluations needed to ensure that all reactor types addressed the vulnerability to detect and mitigate an open phase condition. Undetected conditions during open phase events have resulted in the inoperability of important components1, losses of shutdown or maintenance cooling, and the potential to affect all trains of safety systems from a common-mode failure. An open phase event can occur during any operating mode. Personnel from operating plants as well as those shut down should review this IER if fuel is in the spent fuel pool. See attached report for further details. OPEX Evaluation required for potential impact to Site. CARB Review required. Potential for EOER.
00002462	Oversight Review of Vendor Reports and Quality Metrics	2015/04/29	CARB Meeting	The product has been customised to suit the multiple locations and multiple levels of rigour within the E.S. Fox workload, and also includes significance and resolution categories, and a coding set based on a similar system to that employed by OPGN. It includes event based, human performance, and causal factor codes. It has been running since October 2014 in pilot mode, and will be introduced to all company staff in the coming months. It has been deliberately made to have the same look and feel as OPGN's application, for ease of use by staff who have used OPGNs application.
00002461	Waste Minimization – It's all about that waste!	2015/04/28	OPG - Waste Management	Simple steps such as using reusable and washable items and helping prevent material from becoming contaminated can make a great impact in reducing waste. If every employee performs these simple actions regularly, we will collectively improve our nuclear waste efforts at OPG.
00002460	First New Nuclear Unit in U.S. in Nearly 20 Years Is on Track to Begin Operating in 2015	2015/04/27	Power Magazine	Arthur Despres, Derek Mcauley and Vijay Santhanam just returned from a benchmarking trip to Watts Bar. It is clear that in order to support clear understanding and realistic schedules the schedules must be: o resource loaded, o resource balance (availability matches requirements) o and we must have clear identification of quantities (units of measure, valves, piping etc). 2. Gary Harland (the Watts Bar host), was that "Watts Bar is a significantly, schedule driven project" and his thoughts is that it is a huge contributor to the success they have achieved as well as the recognition the industry is giving them. 3. Watts Bar is on track to be commercially operating by December 2015. They have approximately 140,000 man-hours of work remaining. This will be the first new units added in the US since the 1980. 4. Bulk construction on the plant is complete and they are in the final phase of completing construction on the remaining systems that are needed to be turned over so that we can perform the final testing on those systems,
00002459	Change Control Process	2015/04/27	Berkeley Program Office	
00002458	Turbine Generator Neutral Overvoltage Causes a Reactor Scram	2015/04/24	COG#17 April 29, 2015	Managers and supervisors should ensure that workers are proficient in using new tools as well as knowledgeable about tool limitations, failure modes, and critical functions such as fail-safe controls. Managers and supervisors should maintain sufficient oversight of vendor personnel, including industry professionals, to ensure site human performance and procedure use standards are being met. Must Know OE: Design and operating margins have been reduced or challenged by human errors during the development of plant modifications and plant operating and maintenance activities. Contributing causes include incomplete technical evaluations and insufficient understanding of design and operating margins (to properly assess the risks associated with activities).
00002457	Relay Settings Cause Standby Power 4.16 kV Transformer to Trip Unexpectedly During Safety System Test	2015/04/24	COG#14 April 29, 2015	This event highlights the importance of updating procedures when updates to protective relay specifications are identified.
00002456	UPDATE: Dropped Control Rod Blade in the Reactor Vessel	2015/04/24	COG#11 April 29, 2015	UPDATE: Managers and supervisors should ensure that workers are proficient in using new tools as well as knowledgeable about tool limitations, failure modes, and critical functions such as fail-safe controls.UPDATE: Managers and supervisors should maintain sufficient oversight of vendor personnel, including industry professionals, to ensure site human performance and procedure use standards are being met.

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00002455	Digest of Engineering / Safety and Licensing Events	2015/04/24	COG#3 April 29, 2015	OE311398 – The Operability Evaluation was overly focused on the equipment's ability to perform its specified Safety Function and the risk of shutting down rather than on the definition of Operability and compliance with the Technical Specification. The governance document for the Operability Determination program has been revised. OE312020 – Implemented a Standing Order to raise awareness of the issue of a Cooling Lake Dike Failure in an expedient manner until the design basis assumptions were specifically included in plant procedures. OE312166 – The Procedure for the 150 psig surveillance was revised to start the RCIC Turbine with the flow controller in Auto and set at 600 gpm and to verify that the RCIC System achieves rated flow in less than 30 seconds during the test. OE312501 – In support of the development of the engineering analysis, compensatory measures have been implemented, which provide adequate assurance that the UHS will perform its design safety function. Corrective actions to restore full compliance with design basis requirements are in development.
00002454	UPDATE R1: Nuclear Power Plant Software Quality Assurance (Good Practice)	2015/04/24	COG#1 April 29, 2015	This good practice document provides a graded approach to a software quality assurance (SQA) program for digital safety systems and cybersecurity elements and includes prudent approaches for other systems. The SQA program documents administrative configuration control of computer software development, use, validation, and revision, which reduces errors, helps minimize rework, and contributes to minimizing station events.A typical station program would contain the elements described herein.Systems addressed: Plant digital systems include safety-related digital systems, important-to-safety systems (including reactivity impact systems), and balance-of-plant control systems (such as turbine controls and feedwater control systems). Station-identified critical digital assets are also included; Information Technology systems include quality-related software applications in support of plant business operations, plant engineering support software, and plant business efficiency software.
00002453	Healthy Technical Conscience	2015/04/24	INPO	Technical conscience – the personal obligation leaders and individuals internalize and exercise to ensure plant operation, maintenance, and engineering activities are conducted in a manner that upholds plant design requirements and preserves operating, design, and safety margins – was found to be lacking at all levels.
00002452	Public consultations boost decommissioning project support across US	2015/04/24	Nuclear Energy Insider	The Nuclear Regulatory Commission (NRC) is clear that there should be a strong approach to having a discourse with the public, promoting community involvement through meetings. http://www.nrc.gov/info-finder/decommissioning/power-reactor/ Every time that licensee completes a decommissioning activities report after a reactor has been shut down, the NRC holds a mandatory public meeting. If local interest is high enough, public meetings will also be held every time that a decommissioning plan is submitted. As for the plant operators, they have been more than willing to do their bit to create a harmonious relationship with the local community, alongside local stakeholders.
00002451	Decommissioning sector calls for robust costing models	2015/04/24	Nuclear Energy Insider	While each decommissioning site's costs and requirements are bespoke, the costing models should be more flexible and universal so that tenders can be more competitive and stakeholders can budget appropriately.
00002450	Georgia Power Video Touts First Quarter Milestones At Vogtle 3 And 4	2015/04/22	Nuclear Street	Despite unpredictable winter weather, says the film's host Joe Washington, crews were able to make headway on the five-story high, 1,100 ton wall CA20 sub-module for Unit 4. In addition, the steam generator for Unit 3 arrived on site after a 7,191-mile journey from South Korea by ship and by rail. Georgia Power also touts its accomplishment in transmission upgrades the Unit 3 and 4 will require once they go online in 2019 and 2020. The company also noted a tour of the construction site granted to a distinguished visitor: Nuclear Regulatory Commission Chair Stephen Burns, which took place in February. It was another quarter of milestones and muscle in Waynesboro, Ga. View the clip for further details. http://nuclearstreet.com/nuclear_power_industry_news/b/nuclear_power_news/archive/2015/04/22/georgia-power-touts-first-quarter-milestones-at-vogtle-3-and-4-042202.aspx#.VTegDiHBzRY
00002449	How to baseline project scope?	2015/04/16	Planning and Controls	There are two simple steps. Number one, we have to define the scope first. In order to define it, we document it. We document it in a scope statement. The scope statement, again, is a description of the scope; what we are producing as a result of this project. Again, it's the project scope and also includes the major deliverables we're going to be producing during and as a result of the project. It also includes assumptions and constraints of the project that may or may not impact the scope. We take the scope statement along with the work breakdown structure, because the work breakdown structure takes the work at a high level and then it continues to break it down into further detail. Those details of the work packages are what we use to build the schedule and estimate the cost. It's very important. We use the work breakdown structure dictionary which is a more detailed description of each of these work packages. Define the scope, then we approve it. How do we approve it, and who approves it? Who approves it are the stakeholders. Generally, it's one stakeholder or multiple stakeholders. It depends on the size of the project. That's usually called our Change Control Board. The Change Control Board

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00002448	What is a Project Risk?	2015/04/20	ProjectManager.com	So a risk begins with an uncertain event or condition that could occur. So we recognize what are these events and we determine if these occur or not. If this uncertain event occurs then it could have an effect on the project objectives. It could have a negative effect or a positive effect. So if a risk event does occur, for instance a negative event could be for instance a company could put out a new product and if the market is very receptive to that product, but the company can not handle the demand, and that could actually be it sounds good because it's increased sales, the market adapts the product. But the increased sales if the company's not prepared for the demand then it could be a negative effect. Maybe they can't fulfill the orders, they can't fulfill the demand so they actually in essence lose those customers who probably may not come back. So a positive event could be that a market does adapt to that. The company can fulfill the orders and that could be a positive thing. https://www.projectmanager.com/what-is-project-risk.php But to look at some of the uncertain events, where do these uncertain events or conditions come from or where do we look when we're trying to identify these for a
00002447	What is project risk control?	2015/04/16	ProjectManager.com	First of all, on many of the whiteboard sessions on these type topics we start off by talking about something very critical to the project relating to the triple constraint. The triple constraint, if you consider the project plan documenting the items of the triple constraint, includes the scope, which we're talking about, the deliverables, the cost, which we're talking about and the budget of the project, time and schedule, as well as quality components. https://www.projectmanager.com/what-is-project-risk-control.php The reason we start out talking about this is because these changes and variables interject risk to the project, other things occurring impact these, as well. We want to look at how do we document these, how do we manage, control them. This is just a high-level process to let you know some of the important things we need to do when we're monitoring and controlling the risk. First of all, we want to identify the risk, so, we look at different components in the beginning of the project. We look at different documents, we look at the scope we have to identify the requirements, the deliverables we're producing, we analyze and look at the cost, we look at the budgets to see if we can identify any risk there. We also look at the schedule, any kind of dependencies or constraints to see if we can find any risk there, and also the quality. What quality are we expecting, and items can impact the quality. We also try to
00002446	Increased Trend of Reactivity Management-related Equipment Failures	2015/04/20	COG#15 April 22, 2015	The main failed barrier is Life Cycle Management (LCM) of electronic devices.
00002445	Engineering/Preventive Maintenance – Instrumentation & Control Events	2015/04/20	COG#9 April 22, 2015	OE308745 – Incorporation of OE was strengthened in system processes for turbine protection by tying existing work orders to replace drifted switches to this causal analysis with tracking actions to ensure they were completed within 6 months. Another action was created to provide future sustain-ability of preventing failures by refining the system monitoring plan and preventative maintenance strategies of the switches to ensure drift is captured, trended, and dealt with in a timely manner.OE309024 – Engineering failed to address controller aging power supply vulnerability and allowed work to be re-scheduled several times due to a believed parts availability issue.OE309157 – Establish a practice to preclude repetition of SSPS failures resulting from past failures with inconclusive results, in the course of and post troubleshooting. The intent of this action is to provide prompt and rapid issue identification and resolution of failures subsequent to an event occurring with an unidentified cause, without interfering with system operability classification.OE309217 – A preventive maintenance task is being processed to periodically replace the 'A' and 'B' RRP speed control Bailey 7000 circuit cards.
00002444	Digest of Fire Protection Events (WANO)	2015/04/20	COG#6 April 22, 2015	WER PAR 2014-0339 – Produce and implement job specific risk assessments for work on plant involving flammables, enhancing the defence in depth of the risk assessment process.WER PAR 2014-0443 – Carry out fire safety observations during the next Statutory Outage to identify whether standards have improved following training.WER PAR 2014-0503 – The addition of Thermal Imaging into the routine inspections will enhance the effectiveness of these routines in identifying underlying electrical faults before they become fire events.WER PAR 2014-0535 – Update Corporate procedures to include a process for oil leaks. This will include a flow diagram, clear responsibility and standards and clean up and assessment of spray patterns.
00002443	Inadequate Isolation for Standby Generator	2015/04/20	COG#4 April 22, 2015	Usage of event free tools such as effective communications, questioning attitide and Stop when unsure need to be enforced to prevent human performance events form occuring.

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00002442	Why You Need a Risk Register?	2015/04/17	ProjectManager.com	Watch this video to learn how a PMP defines a risk register; the documented results of the qualitative and quantitative risk analysis and risk response planning; plus when you should be using a risk register on your projects. https://www.projectmanager.com/what-is-a-risk-register-and-when-to-use-it.php Again, many of the whiteboard sessions we've started off by talking about the triple constraint of the project. If you consider our baseline project plan that we used, the triple constraint items in the plan happens to do with the scope because we're talking about the deliverables or the items that we're producing as a result of the project. We're talking about our cost and our budget. We're talking about our time and our schedule and the quality components. Many times throughout the project we have risk events that we start identifying and we want to manage and track, and we want to plan for it in case they happen. Sometimes, when these components of the triple constraints begin moving or changing, they can cause risk to different other areas of the project, and outside risk events that occur can also impact these. We want to track these from the beginning of the onset of the project. The risk register, specifically, as identified by PMI, the Project Management Institute's Project Management Body of Knowledge, it's the documented results of the qualitative and quantitative risk analysis and risk response planning.The qualitative portion is when we begin prioritizing the risk based on the probability and impact of the risk. Once we prioritize it
00002441	Knowing Projects Change is Key to Controlling Project Change	2015/04/17	ProjectManager.com	Watch this video to learn about what project change control requires when planning any project. https://www.projectmanager.com/what-is-project-change-control.php Some things we haven't thought about, maybe risks occur, issues happen, maybe there's a federal regulation we have to comply with or a natural disaster. There are numerous things that can invoke a change in a project. So if we look at this, what is change control? Change control is identifying changes. Changes are there, so being able to identify what the changes are. Again, being stemmed from issues, risks, federal mandates or things occurring on the project. It's identifying those changes, documenting the changes, so important to be capturing all of the changes that are occurring. Putting them in and tracking them in a change request log, so documenting the changes. The change control board for the project, it goes through their process of periodically evaluating them and approving or rejecting the changes. So throughout the project, continuing to manage, track, and control those changes, and continuing to, as the changes are approved, re-baseline the project plan. So this is project change control.
00002440	Quality Levels versus QA Program	2015/04/22	Amec Foster Wheeler	All CATIDs in BOMs must be selected with the correct QA Program for their specific application. Do not confuse Quality Level with QA program in AssetSuite.
00002439	Audit Reports Issued March 201S - NO-201S-022: Project Management Oversight	2015/04/17	CARB Meeting	Finding 1: Deficiencies in the Execution of Project Management Oversight SCR N-2015-06123 was initiated to identify the finding. Director, Pickering & NWMD Projects is the EO Manager for this Significance Level 2 SCR. Finding 2: Deficiencies in Projects & Modifications Staff Qualifications and Requirements SCR N-2015-06125 was initiated to identify the finding. Project Director, Contract Management and Project Control Office is the EO Manager for this Significance Level 2 SCR. Finding 3: Deficiencies in Project Management Program Governance and Supporting Documents SCR N-2015-06127 was initiated to identify the finding. Project Director, Contract Management and Project Control Office is the EO Manager for this Significance Level 3 SCR.
00002438	Balancing Risk, Reliability, and Safety at Plants Slated for Retirement	2015/04/01	Power Magazine	Maintaining safe and reliable generation requires strong leadership, clear communications, and heightened attention to operations and maintenance, staff morale, and post-shutdown plans. For utilities and other generators facing the challenge of winding down operations at an aging power plant without compromising safety or reliability, Kenny Mullinax, senior manager of coal transition for the Tennessee Valley Authority (TVA), has some succinct advice: "It's not saying the right things, but doing the right things." The reason for this advice is that successfully navigating the last few years of a plant's service life begins and ends with its staff.

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00002437	Create Task Dependencies	2015/04/14	ProjectManager.com	Define the Project TasksFirst, make sure that you have a complete list of project tasks. Include everything that you need to do in order to complete the project. Get your team together to collaborate on the To Do list because many dependencies fall during the handoff of a task to another team. Define Internal Dependencies Define External Dependencies Choose Dependency Types Update your Schedule Monitor the Dependencies See attachment for the details.
00002436	Excavator Damages Underground PVC Conduit Containing 120 Volt Energized Cable	2015/04/09	DOE Lessons	Excavation in areas congested with buried utilities or in areas where previous activities likely required buried utilities presents a risk to discover undocumented or undetected utilities. The importance of documented field determinations of potential utility locations on excavation permits and communication of these field markings to workers are critical steps in a hazard energy control process - a rigorous process to ensure the identification of the hazards that may expose workers to potential injuries.
00002435	Savannah River Site Salt Waste Processing Facility	2015/04/09	DOE Lessons	Rigorous oversight of subcontractor activities is needed to ensure quality records document the work was performed in accordance with requirements. The frequency and depth of review should be increased when processes change. Procedures/instructions need to include appropriate steps for activities that affect or are important in demonstrating quality. Sufficient checks and balances need to be in place to identify and minimize the consequence of errors. When auditing records ensure review is of sufficient depth and includes work details. Do not solely rely on the individuals that created the records possessing current qualifications/certifications.
00002434	Faulty Fuse Holder Results in Thermal Incident	2015/04/09	DOE Lessons	Several mechanisms can act independently and/or synergistically to degrade and cause fuse and/or fuse holder components to fail. Periodic inspections and monitoring of fuses and fuse holders should be conducted since NUREG-1760 indicates that a significant number of fuse failures are due to loosened holder clips or electrical connections.
00002433	Tips for Scheduling People on Multiple Projects	2015/04/09	Projectmanager.com	1. Minimize the Overlaps2. Schedule for the Busy Times3. Collaborate on Scheduling4. Where to Focus Your Resources5. The Right Level of Scheduling6. Talk to Other Project Managers7. Use Workload Scheduling8. Use Dashboards9. How to Manage Absences9. How to Manage Absences Read Full Article for details
00002432	Outage Lessons Learned – Installation of Foreign Material Exclusion Cover in Backup Heat Sink	2015/04/07	COG#2 Apr 15, 2015	Inadequate adherence to the requirements of the Outage Heat Sink Manual was the direct cause of this event. This procedure requires the Boilers to be configured and tagged in a prescribed manner when a Boiler is being used as part of the credited outage heat sink line-up. However, the accountability for timely tagging of the heat sink boilers was not clear in the associated procedures used to open the Boilers. As a result, the FME cover was installed on the hot leg opening of BO2. Also contributing to this event was crew awareness of the required heat sink line-up leading up to the event. The task to install the FME cover on BO2 should have been delayed to a more suitable period of the outage. Awareness of the current heat sink line-up would have resulted in a pre-job brief that evaluated the risks associated with FME cover installation on the back-up heat sink.
00002431	Boiler Spuriously Switched to Manual Control	2015/04/07	COG#18 Apr 15, 2015	Refurbished spares are the same vintage as the parts they are replacing and are thus prone to the same age-related failures.

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00002430	Inspections and Non-Destructive Examination Help To Identify and Repair Main Condenser Structural I-Beams Cracks	2015/04/07	COG#12 Apr 15, 2015	• Degraded Condenser I-Beams have the potential to damage Condenser Tubes and cause Condenser failures. By repairing the condition before returning the unit to service, risks to the reactor safety cool function and unit reliability were eliminated.• During refurbishment, previously used I-Beams were repaired and re-purposed to provide structural support to the Unit 1 and 2 Condenser Tubes. Numerous weld repairs had been completed by supplemental personnel to fix cracks found in the I-Beam material. This weakened the integrity of the I-Beams particularly at their joints.• Increased temperature cycling and exposure to higher steam velocities (through increased Condenser Steam Discharge Valve operation) accelerated the growth of cracks on the refurbished I-Beams.
00002429	Principles for Design Basis Management	2015/04/07	COG#1 Apr 15, 2015	The purpose of this document is to establish fundamental principles to be implemented into plant programmes and processes for the management of the design basis and beyond-design-basis considerations; that can reduce the probability of nuclear safety related events and the severity of their consequences.
00002428	The Importance of Radiological Characterization at Depth	2015/04/09	DOE Project Management Lessons Learned	Before attempting to decontaminate a surface, characterization at depth should be performed, even if this characterization will be difficult and costly. Implementation of D&D technologies (e.g., remote scabbling operation) that may have been assumed to be the best choice can instead result in increased exposure rates to personnel during subsequent D&D operations. At the WVDP MPPB Off Gas Cell, this resulted in a loss of four months on schedule, two of which were on the Critical Path.
00002427	A Construction Manager Weighs in on Engineering Design	2015/04/07	Online Article	
00002426	Expert Critics in Engineering Design: Lessons Learned and Research Needs	2015/04/07	Article - AI Magazine	The design task consists of a generate-testrefine- remember process. The designer uses a variety of cognitive operators to generate a design, test it under various conditions, refine it until a stopping rule is reached, and then store the design as a prototype or analog to help start a new process for the next design task. The design process is sufficiently complex that a correct and complete design simply cannot be deduced from starting conditions or simulation model results. An iterative refinement occurs in which the design is heuristically arrived at over a number of lifecycle repetitions of the generate-test-refineremember steps. For example, these steps are attempted to create a conceptual design; a technical design; and, finally, a fully operational design. In each life-cycle stage, a design is postulated, tested, and refined. This process is sometimes referred to as the waterfall model of the life cycle because the iterations of the process are like several cascades that ultimately combine into a rob st design.
00002425	Lessons for Successful Project Delivery	2015/04/07	MDM Engineering	Process Engineering Design - Process design informs all other engineering disciplines- Need to freeze the process design early in the study or project cycle- Changes to the process design always leads to engineering design changes- Changes to the process design always leads to project delays External Consultants - External process or engineering consultants, should the client elect to employ them, should be appointed early in the study or project cycle- Late appointment leads to late changes to the design- Late design changes result in:- Study or project schedule delays- Study or project cost overruns Client Teams - The client team should be established and maintained at the outset of the study or project- Changes to the team or late introduction of the client team to the project can be disruptive and causes delays or redesign- Separate client project and client operations teams can be problematic Logistics - Accurate estimation of the cost and time required to complete infrastructure refurbishment, particularly public roads, is essential- Correct and accurate shipping documentation is essential to avoid lengthy delays at borders and ports- Congestion at borders and ports must be taken into account when
00002424	Doing More with Less: New Solutions Help Address Power Plant O&M Staffing Difficulties	2015/04/01		Review attachment and pages 25-30.
00002423	Poor Work COntrol Process Existed Over a Decade at Y-12	2015/04/01	DOE Lessons	The material is believed to have been inaccurately marked as classified information, and Simonson said the incident "resulted from failure to evaluate work control processes and operational conditions for work activities in a classified subject area." A separate Office of Enforcement review of a security incident that involved differences in the inventory of classified accountable nuclear material revealed that inventory practices and documentation were "inconsistent and inaccurate" for several years. "Poor accounting and housekeeping practices caused significant difficulty in reconciling inventory discrepancies and determining the final disposition of a number of accountable items," Simonson said, noting that the issues had been addressed.

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00002422	Identify the Tasks to Estimate	2015/04/01	ProjectManger.com	Identify the Team ExpertsThe resources allocated to complete the task may not be the right people to do the estimate. You may also want to involve their managers or other subject matter experts. You could also bring in someone who did the task on a similar project – they aren't allocated to your project but they'll have a great insight into how long it takes to do the work. Do this for every task so you know who to work with for your estimates. Group tasks together so you can hold estimating meetings with the right people and focus on their sections of the project. Review Estimating TechniquesThere are a number of ways to estimate how long a task will take: · Subject matter expertise: someone who knows a lot about the task tells you how long it will take based on their professional opinion. · Historical data: use the results of a previous project to estimate how long the same task will take this time. · Math: multiply how long it takes to do one unit of work by how many units of work are required. (Also known as "parametric estimating".) · A range: work out the most likely, best case and worst case timescales for the task and estimate from that. · As a group: use the
00002421	How to Schedule a Project	2015/03/31	ProjectManger.com	http://www.projectmanager.com/how-to-schedule-a-project.php So when we're talking about the schedule, we're talking about the planning phase. That's when we create, we build our schedule. So the schedule tells us, it gives us the linked activities, all the activities that have to be done throughout this project. It shows how they're linked. It gives us the dependencies. It gives us the planned dates for those activities, the durations for them, and any major milestones we need to look for. It also gives us our people resources. So when your team members start asking you, "Well, what needs to be done on this project?" or "When will it be done" and "Who is going to do it?" Then you, as the project manager, say, "Well, now I need to build a schedule." In order to do that, we have four main steps that we do. And in order to do that, we define the activities. So again, the activities are all the different tasks and activities we have to do. So we take the work breakdown structure for the project, some people call it deliverables diagram, and we literally take it and we start defining it in further detail what has to be done to get all of the work done. Then we complete the estimates, the estimates of time and effort to do those
00002420	Valve Non-Conformance Issue	2015/03/30	COG#10 Apr 1, 2015	NH is a supplier to CANDU plants elsewhere in Canada and worldwide. We think Bruce and Lepreau have received similar letters. Potentially other CANDU plants may be affected.
00002419	Digest of Planning / Scheduling Events	2015/03/30	COG#8 Apr 1, 2015	· OE310199 – Single point vulnerabilities need to managed in Human Resources. More than one individual needs to be proficient in process tools. · OE311506 – The surveyors re-established the X-Y-Z axes for the remaining Piles and the contractor created a 3D model of the high risk Piles. Additional management was added to monitor the installation of the remaining Piles. · OE311574 – Planners were directed to not background model work orders from online surveillances used for outage PMTs. · OE311669 – A Tier 1 benchmark of the following topics was conducted: Operations during outages, Work Execution Center structure/preparation, tag-out strategies, schedule durations and assumptions, Work Order impacts, and protected equipment strategies.
00002418	3 Reasons Why You Should Plan for Testing	2015/03/24	Projectmanager.com	http://www.projectmanager.com/reasons-plan-for-testing.php In crunch time, when people start looking at trying to reduce the time in the schedule, it can be tempting to cut testing. Let's look at what that means. When we talk about cutting testing, it impacts the product, the deliverable we're producing as part of the project. There's an entire product development life cycle, which includes the analysis, coming up with the requirements of the product, the design and development of that product, the quality assurance and testing that make sure it complies, the implementation and deployment of that product, and then turning it over for maintenance and support. When we talk about cutting testing, it's talking about removing an entire process of this product development life cycle. We don't want to do that. Instead, that's why today, I want to talk about why it's so important to plan. Let's look at a couple of reasons why. Number one, it sets the stage. It lets you know what needs to be tested, when it needs to be tested, and who needs to test it. It also prepares for change because within the plan, it identifies when you start looking at alternatives what could possibly be cut, and what could
00002417	Approaches to Ageing, Management for Nuclear Power Plants - International Generic Ageing Lessons Learned (IGALL) Final Report	2015/03/23	COG#18 March 25, 2015	The main deliverable of the International Generic Ageing Lessons Learned for Nuclear Power Plants (IGALL) Extrabudgetary Programme (EBP), the IGALL Safety Report, provides an internationally recognized basis for an acceptable ageing management programme, as well as a knowledge base on ageing management to aid in the design of new power plants, design reviews, modifications and upgrades, and to serve as a source of information on ageing management. This publication is a summary of the national approaches taken by Member States participating in the IGALL programme. This information was collected during the first phase of the IGALL programme between 2010 and 2013, and explains different national practices in the area of ageing management and the preparation for long term operation.

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00002416	Nondestructive Evaluation: Quantification of Real Corrosion in Buried Piping	2015/03/23	COG#14 March 25, 2015	In executing its role of researching piping examination technology under the Initiative, the Electric Power Research Institute (EPRI) has conducted research into a variety of technologies to determine their suitability for the examination of buried piping.
00002415	Nuclear Knowledge Management	2015/03/19	N/A	However, factors such as security of supply and climate change issues (greenhouse gas mitigation measures) have contributed to a nuclear power renaissance. In order to avoid loss of related EU expertise and knowledge, action should be taken now to preserve and disseminate the acquired knowledge to the new generation of engineers, scientists and other interested parties. The nuclear human resources situation also needs to be monitored.
00002414	Phasing of LBNL - Old Town Demolition Project	2015/03/18	Lawrence Berkeley National Lab	Consider phasing Critical Decision-1 approved projects when available funding does not support continuation of the project through Critical Decision-2 approval. The LBNL Old Town Demolition Project was not funded at the approved Critical Decision-1 cost range high end. Phasing provided the ability to identify a scope subset which could be completed within existing funding constraints, to allow continuation of that Project Phase through Critical Decision-2 approval.
00002413	Stockpile Program Hardware Shipment Delay	2015/03/18	Consolidated Nuclear Solutions - Y-12 Production Site	Occurrence prevention of the previously stated can be accomplished with greater rigor of planning and preparation. Scope and schedule, laid out and integrated alongside stakeholders and their relative workloads, would produce a more holistic approach to delivering said product.
00002412	Industry Cumulative Impact Short Term Actions	2015/03/18	N/A	The short-term actions in this document are organized into four areas: ? Management and Leadership ? Human Performance ? Corrective Action Program ? Work Management These short-term actions provide suggestions and guidance to stations on how to address cumulative impact issues. None of the actions are required to be implemented at this time. Each station should consider its current performance level, schedule of activities, and priorities to determine the best course of action.
00002411	The What Else Process	2015/03/18	Integrated Waste Treatment Unit in Idaho	The "What Else" process is a best management practice that encourages project personnel to bring forward any plant issues that may need evaluation or correction. This process is a best management practice that aids in identifying potential plant problems early by creating an open atmosphere to bring everything to the table. Project team members were able to use lessons learned from previous testing data and the event to brainstorm other facility changes and improvements. This process represents a proactive versus reactive approach. This minimizes the problems finding you, instead of you finding the problems, and anticipating potential problems. This also increases a
00002410	Project Definition Rating Index (PDRI) Facilitation Training	2015/03/18	N/A	Read attached presentation for explainations and examples of the PDRI method
00002409	Probabilistic Modeling and Estimation of Common Cause Failures	2015/03/18	N/A	CCF events can significantly impact the availability of safety systems of nuclear power plants. The attachement contains the details of CCF in math models such as; Poisson Distribution, Failure Rate, and Exponential Distribution.
00002408	Savannah River Safety Flash for Work Injury	2015/03/18	Savannah River	You must know the weight of the object to be lifted. If you don't know, make a conservative estimate. - Realize that awkwardness of the situation does lower the safe weight limit. The grip, position of the load, configuration of the load, etc. can all make the lift or carry more difficult. Adjust ac-cordingly. - Consider also how to best move an object. Remember the Hierar-chy of Controls. Always consider mechanical means first prior to attempting to move a heavy object. - Report all injuries as soon as possible, especially muscular/skeletal ones-even just to say something does not feel just right - Supervision has the responsibility to ensure safe lifting requirements are met. Use the pre-job briefing to make sure weights are known, and ways to safely perform the lifts and movement of the objects are addressed. - If you start the work, and questions arise about performing the work-call a timeout. Uti-lize your Safety personnel for advice and assistance.
00002407	Issuing Procedures in Parallel	2015/03/18	N/A	When developing procedures in parallel, a delay in issuing one procedure may cause a cascading series of configuration control problems.
00002406	Laboratory Hood Fire Activates Sprinkler System	2015/03/18	Argonne National Laboratory	When using flammable liquids and electrical equipment, it is important to clearly state task requirements in the work planning and control documents, as well as during on-the-job training. In addition, it is important to read equipment manuals and incorporate warning statements into design and set-up of experiments.
00002405	Safe Walking Surfaces Change to Unsafe Walking Conditions	2015/03/18	N/A	Human Performance Improvement TWIN Analysis to Identify Error Precursors - The predominate error precursors were identified during event investigation and analysis. These error precursors influenced employee behavior leading up to the event. See attachement for full details
00002404	Consistency between Programmatic Documents and Lower-Tier Departmental Documents	2015/03/18	N/A	When developing internal documents such as level four documents the appropriate source documents should be identified and reviewed. The internal document should then be subject to a review by the appropriate SME knowledgeable of the applicable source document.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002403	How to have affective RIsk Meeting.	2015/03/18	DEC, OPG	
00002402	How to get late projects back on track	2015/03/18	ProjectManager.com	Calculate the Variance First, calculate how late your project actually is. Do this by comparing how much you had expected to have achieved by now (your planned progress) with how much you've been able to achieve (your actual progress). This will give you a figure in days that you can also represent as a percentage. The bigger the percent, the more behind your plan you are. Assess the Cause Now you want to find out what is driving that slippage. Drill down into your project plan and look for the tasks that have taken longer than expected. Here's a shortcut: Look for the shortest route through the project from start to finish using your dependencies. These are the tasks that cannot be delayed without changing the end date of the project (also known as the critical path). If any of these have taken longer than planned then your project will have slipped. Create an Action Plan Consider all the options available that will help you bring the tasks back on track. This could include: •Adding more resources to certain tasks •Changing the priorities of the work •Completing some tasks in parallel instead of sequentially •Accepting the delay and changing the end date of the project. Or any other strategy that helps you
00002401	Simplyfying your Project Reporting	2015/03/16	N/A	N/A
00002400	Consistency of Engineering Drawings & Piping Models	2015/03/16	AMEC NSS	It was observed that the coordinate systems used by Design Engineering and by Piping Stress Analysis were different for some systems. No problems resulted on this project; however, inconsistent coordinate axes can create error likely situations that could lead to re-work. It is recommended that work planning and/or technical PJBs establish the coordinate system to be used for a project at the start.
00002399	TVA fined for fire protection failure at nuclear plant	2015/03/16	NEI	"The potential consequences of missed fire watches concern us," McCree said in a statement today. "Although there are other fire protection features, fire watches are an important part of the plant's overall fire protection strategy, especially in areas where other equipment may be temporarily unavailable." TVA said it will not contest the penalty. John Carlin, the Sequoya site vice president, said TVA has upgraded equipment and procedures to limit the need for long-term fire watches and improved its oversight procedures to avoid a repeat of the problem during outages like the one in 2012 that caused the problem. NRC said in October and November of 2012, four contract laborers, including four foremen, "deliberately failed to conduct compensatory hourly fire watches as required." The hourly watches were required to compensate for fire equipment that was out of service at the time of a refueling outage at the Sequoya plant near Soddy-Daisy. "In addition, the NRC found that four foremen deliberately filed to exercise supervisory duties as required," McCrea
00002398	Digest of Work Protection Control Events	2015/03/16	COG#2 March 18, 2015	WER PAR 2014-0346 – Energized 6.6 KV Cable Severed by a Mechanical Digger – Contract workers were digging a trench to install four 200-mm sheaths. As the station did not have an electrical zoning plan, the trench was dug in 20-cm sections using a mechanical digger on rubber tracks. In the event of coming across a buried network or warning barrier, the instruction was to continue with manual tools. At a depth of 50 cm, a cable was inadvertently dug up and severed by a mechanical digger. There was no electrical arching, material damage or personal injury. Thinking that the cable was no longer in use, the workers left it as found. The conductor was an energized 6.6 kV cable that supplies buildings outside the fence of the unmonitored area. A warning barrier was found 10 cm 10 cm below the cable, rather than 10 cm above the cable, as required by regulations. WER PAR 2014-0348 – Electric Arc during Installation of a Recorder – During connection of a recorder, when the alligator clip was positioned on the third phase, there was a blast (noise, heat and flash) similar to a short circuit (the terminal upstream of the circuit breaker melted). The worker received burns on the left forearm, on his neck and at the
00002397	USA Technical Conscience Assessment Guidance	2014/11/12	Utilities Service Alliance	This assessment guidance will provide the necessary tools to allow Utilities Service Alliance (USA) members to execute a standardized evaluation of Technical Conscience at their station. This guidance provides direction for establishing teams, preparing for the assessment, use of evaluation tools and reporting assessment results.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002396	Workforce management lessons from women in power generation	2015/03/12	Power Magazine	How to hire and retain the best power plant workers This list summarizes the main lessons about recruiting, training, and managing all workforce populations that were stated and implied in interviews with senior-level women in the industry: - Commit to change. Without a senior-level champion of changes in policy and culture, even the best tactics will have limited success. - Reach out to potential industry ambassadors hidden in plain sight: employees, family, friends, and school and college counselors. - Upgrade your outreach. Hold open houses, develop Electricity 101 programs for all levels, provide early and frequent opportunities for exposure to the field (such as science fairs and summer programs), and consider extensions of internship and apprentice programs. Consider the advantages of hiring those from nontraditional educational and career backgrounds. - Develop mentoring programs at plant and larger levels.
00002395	Scope and Change Control	2015/03/10	ePMBook	All participants should understand that the later in the project that a change is addressed, the greater the likely impact in terms of costs, risks, and timescale. It is wise to surface potential changes as early as possible. The change control process should make it easy to do so.
00002394	Labor Crunch Complicates the Gas Turbine Arms Race	2015/03/10	Power Magazine	More recently, the drive for larger, more-efficient, and more-flexible gas-fueled power plants has led to more-rapid revolutionary changes and essentially new products, regardless of manufacturer naming conventions. Compressor changes, turbines with more power stages, and new packaging concepts are a few of the significant changes leading to larger units and higher power density. Most manufacturers have recently introduced or announced new gas turbine designs, each one larger, more efficient, or more flexible than their competitors'.
00002393	Implmenting Project Changes	2015/03/10	HN Computing	Document the reasons for the changes that occur during the project, including any corrective action taken and the justification for choosing that action. At the beginning of a new project it's a good idea to review the lessons learned from similar projects in order to plan appropriately and avoid the changes that occurred previously.
00002392	Project Reporting Examples	2015/03/10	Multiple Sources	The reports are to be examples of good report writing used in the industry.
00002391	Sellafield clean-up costs reach GBP53 billion	2015/03/09	World Nuclear News	N/A
00002390	Configuration Management in Nuclear Power Plants	2015/03/09	IAEA	The purpose of this report is to describe the various aspects that need to be considered in the development and implementation of a systematic plant configuration management system. The aspects that should be considered include design, procurement, operations and maintenance, methods/tools, human factors, cost/benefit, and implementation. A systematic and practical approach for improving configuration management systems, that may be weak or inadequate, is also described. In addition, examples are included from various countries that have implemented or improved such a system and the lessons learned during this implementation.
00002389	How to Set Up and Run a PMO	2015/03/09	ASPE SFLC Training	The full repot inclued details on how to set up and manage a PMO
00002388	Fuelling Machine Latch Ram Drive Control Solenoid Valve Failure Resulted in Potential for Stranding of Fuelling Machine	2015/03/06	COG#9 March 11, 2015	Due to the cost per unit of the SV, it is recommended that it no longer be refurbished and only new SVs be installed.
00002387	Lessons Learned From Radiological Incident During Annulus Gas System Purge	2015/03/06	COG#5 March 11, 2015	During the purge, outdoor wind speeds were estimated at 30 km/h from the Southwest direction. This disturbed the natural pathway for the contaminated air to travel and caused leaks of radioactive noble gases at several CES openings within the station. Contributing to the air disturbance was one of two out-of-service exhaust fans that serve to assist the travel of air outside the stack. Both conditions were identified as new precautions that must be resolved before conducting future purges.
00002386	Unit Shutdown Required to Fix Primary Heat Transport System Leak to Containment	2015/03/06	COG#17 March 11, 2014	Gaskets in a system with cyclical condition changes may fail, due to loss of rebounding flexibility.
00002385	Digest of Engineering / Safety and Licensing Events	2015/03/06	COG#11 March 11, 2015	• OE308032 – Individuals involved in the development and review of Surveillance Procedure did not fully understand the definition of unacceptable preconditioning. • OE308960 – Revise procedure the POD procedure to add appropriate process barriers to ensure the engineering evaluation adequately documents consideration of all field input information and assumptions for all safety functions. Include an independent review or supervisory review and require all assumptions be stated (including disposition of input data), i.e., UT, NDE inspection results and observations. • OE310071 – Failure to recognize that a negative RPV pressure is not allowed by the TS. As a consequence, the practice had been incorporated into the plant startup procedure and operator training. OE311652 – With the calibration of the flow indicators not in the surveillance program, Engineering did not identify that a commitment was associated with the components or the correct documents (ODCM) when performing the PM frequency changes.

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00002384	Project Master Integrated Schedule	2015/03/06	U.S. Department of Transportation	Without a schedule management plan, PMOCs have to rely on what each Grantee decides to provide to FTA and PMOC. As a result, FTA is exposed to schedule management risks and inconsistent schedule information and reports. These conditions, issues, and inconsistencies in reporting resulted in several disagreements, briefing papers to FTA, and ultimately a spot report development by PMOC that could have been minimized with stronger and more standard FTA SMP. A standard schedule management plan would have helped the Grantee management team to be more involved with the scheduling from the beginning of the project.
00002383	How Healthy Are Your Projects?	2015/03/06	ProjectManager.com	Add your own thoughts and ideas under the video, or take part in some of these great discussions within the Project Management Community: - Ratima asks "Do you do daily Agile standups?"https://lnkd.in/eCuW4rh - Eric wonders "What's your risk philosophy?"https://lnkd.in/dazHyiU - Helen asks "Can you plan without clear requirements?"https://lnkd.in/ehJtM_z
00002382	The Road to Best Practices - Using Lessons Learned in Cost Management	2015/03/06	Kildrummy Article	Read attached article for details
00002381	The Project management office	2015/03/06	Article	This document defined and described different types of PMO that exist across various organisations, the type of activity undertaken by these PMOs and the degree of influence they can have on key aspects of project, programme and portfolio management.
00002380	Project Integration Management and Role of the Project Manager	2015/03/06	Project Leadership Website	Overall this report looked at project integration management, outlining the processes that the PMBOK sees as important in integrating project management activities in pursuit of the project objectives. We have looked at the role of the project manager, providing some practical tips and defining it in relation to the project management office. Theory X and Y has been introduced to assist in the consideration of the approaches that can be taken to project team management.
00002379	Integrated Master Schedule	2015/03/06	Utron Article	Read attached document for the full article
00002378	HP and LP Differential Expansion Detectors are unable to be installed	2015/02/24	SCR	NA
00002377	5 Tips For Better Project Task Lists	2015/03/04	Planning and Controls	Every project begins with a comprehensive task list, so here are our: 5 Tips For Better Task Lists 1 - Work with your team List out the tasks you can think of, then ask your project team to sit down and brainstorm additional items for the project plan. Undoubtedly, they'll flag some tasks you hadn't considered. At this stage of the game, stay focused on recording everything - either on paper or in your project software - not allocating resources. Get the details down right, then get the team back together later to get the right tasks to the right people. 2 - Add structure to your list Once your list is complete, it's time to get organized. If you haven't already, add the tasks to your project software, then start putting them in logical groups. Add some subheadings to make everything easier to navigate, and to keep related tasks together. Building this structure in now will make it easier to find individual tasks later, and streamline task assignments and reporting. 3 - Set your task priorities Some tasks will always be a higher priority, so make sure the most important project tasks are easy to find. Use your task management tools to highlight the most important tasks, perhaps by using a different color, making the font bold or adding
00002376	Training expemption for experienced retired staff	2015/02/25	Report by Steve Mar	Inorder to save money and time and rather than the employee spending efforts to retake these CBTs , the resource can get an expedited credit for 2834 with Strat IV approval, per N-TQD-501-00001, sections 1.1.1b and 1.1.5. This is applicable to retires from OPG and Bruce Power.
00002375	Controlling Major Systems Integration Projects	2015/03/03	(Everyone) DC Velocity	Most problems that arise during the design and development of major systems integration projects can be resolved without significant impact to the project budget and schedule. However, an increasing number of these projects encounter problems that are difficult to control. Such new technologies as local area networks (LANs), client/servers, and Distributed Computer Environments increase the complexity and level of challenge to the systems integrator.
00002374	Eight Steps to Successful Systems Integration	2015/03/03	DC Velocity	The right steps are: 1. Make the case 2. Plan, then plan some more 3. Develop a realistic schedule 4. Organize the right team—and give it authority 5. Communicate constantly 6. Honor the schedule, but don't rush to the finish 7. Engage the workforce 8. Look ahead and look back
00002373	Integrated Project Management	2015/03/03	Book	It will be useful to all current and prospective PMI members in testing for the Project Management Professional (PMP) certification and keeping current. Traditional project management tools and techniques are framed in a series of integration models or metaphors. The integration model is a forwardlooking concept, beginning with the individual and building out to project outcomes, technology, team, organization, business systems, customer and market segment, the overall business regime, and, finally, the global economy. In this book, integration is defined at each level and builds toward a conceptual framework of interconnection and purpose that defines a successful project and program of projects.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002372	Use of Special Colour Vest during Maintenance at Open Equipment	2015/03/02	COG#5 March 4, 2015	The use of special colour vests during organisation of work with open equipment in the reactor compartment, to enhance control during maintenance at open equipment and to exclude the presence of unauthorised persons in the maintenance area.
00002371	Auxiliary Boiler Re-tube Cost Overrun	2015/03/02	COG#19 March 4, 2015	Adequate project oversight of contractors must be maintained by management seeking detailed project updates on a regular basis.
00002370	Alarm Occurrence from an Earthquake Detector	2015/03/02	COG#18 March 4, 2015	It is assumed that for Wolsong Unit 1, there was an amplification effect by background noise and excavation work for the construction of nearby structure. (For other plants, amplification phenomenon was not detected.)
00002369	Nondestructive Evaluation: Buried Pipe NDE Reference Guide—Revision 3	2015/03/02	COG#12 Match 4, 2015	• This report includes an overview of several commercially available NDE technologies that can be used to detect and characterize wall-loss damage in underground pipe. • Objective: To develop a reference document that nuclear-power industry professionals can use to gain a fundamental knowledge of commercially available NDE technology for the detection and characterization of wall loss degradation in buried and underground pipe.
00002368	Digest of Mechanical Maintenance Events	2015/03/02	COG#9 March 4, 2015	• OE306931 – A carbon steel street elbow was left in place following a drain hose removal during the refueling outage. Future actions are to permanently install an elbow at that location, revise operations training, and revise procedure to ensure as left configuration is verified. • OE308349 – HydraNut upper cell incorrect orientation not verified by technicians. Inadequate mock-up training prior to field work. Inadequate procedural guidance (visual aid). HydraNut load cell stroke regain must be verified to ensure proper stud elongation and to preclude hydraulic fluid leaking from the upper cell weep holes. • OE309460 – Incorporate EPRI best practices for small bore socket welding technique. Reworked lower flange welds on other vent piping. Performed inspections of welds performed by the same welder. • OE309804 – The Preventive Maintenance Work Order for the affected valves will be revised in order to replace the tubing between the actuator and positioner if the fitting is found to have no gap between ferrules or any indications of vibration. Tubing connections should be checked for over tightening and replaced if there is any indication of over tightening.
00002367	Digest of Radiation Protection Events	2015/03/02	COG#6 March 4, 2015	• WER PAR 2014-0331 – The remote alarm of the air supply terminal located as close as possible to the workers is required as soon as the workers cannot see or hear the air supply terminal alarms. It enables the bubble suit wearers to be warned of any malfunction. • WER PAR 2014-0338 – Insufficient database software capabilities caused nuclear power plant to risk the loss of control over radiation exposure of individuals travelling between plants. • WER PAR 2014-0351 – There is a lack of control and management of the vessel entry equipment. As a result, changes were made to vessel entry equipment without a fleet wide perspective. • WER PAR 2014-0359 – It was established as a result of this event that every hose decontamination task should be carried under a radiation work permit (PTR)
00002366	Units Conservatively Shutdown as Reactor Vessel Test Results for the Time Being Not in Accordance with Expectations	2015/03/02	COG#1 March 4, 2015	A test about mechanical resistance on an irradiated material sample of reactor vessel with hydrogen flakes didn't deliver the expected values. The root cause of the unexpected test values is under investigation.
00002365	Estimates at Completion	2015/02/27	EM Lessons Learned Program	The best measures to prevent inaccurate EACs is for the DOE project management team to conduct detailed reviews of the contractor's CPRs on a monthly basis. This allows project management teams to remain aware of cost and schedule performance trends. Additionally, the following actions help ensure accurate EACs presented by the contractor: 1. Provide more detailed EAC development training for CAMs and project control engineers. 2. Review EACs in the context of cost and schedule trends to ensure they account for recent performance. One method is to use the independent EACs provided by the Project Assessment and Reporting System (PARS II). The five separate iEACs calculate the EAC based on CPI, SPI, CPIxSPI, CPIxSPI (3 month average), and 0.8CPIx0.2SPI in order to provide a variety of EACs. These can be compared to the contractor's best, worst, and most likely cases to ensure they are realistic and reflect current performance. 3. Ensure bottoms-up EACs are prepared annually, using all comprehensive factors included in the monthly evaluation at the control account level are considered as well as direct and indirect performance to date, assesses commitment values for material to
00002364	Analyze and Respond to Hazards at the Task Level for All Tasks Being Performed	2015/02/27	Management Assurance System	Two different tasks, sawing and inspecting, were being performed and the operational and safety practices applicable to one were not entirely compatible with those applicable to the other. A thorough hazards analysis for each might have identified the appropriate controls. - The hazards associated with handling and inspecting a 32-inch long piece of glass in this compact space were not thoroughly considered or addressed. - The hazards associated with handling and inspecting damaged glass with sharp ends were not thoroughly considered or addressed. - To improve the quality of the cut, a glass worker will "feel" the tension of the glass part as the cutting
00002363	Due Diligence Necessary to Validate Procurement Transactions	2015/02/27	Department of Energy USA	The performance of "Due diligence" should be fundamental in procurement transaction to identify and prevent procurement fraud.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002362	Lab Worker Splashed with Nitric Acid	2015/02/27	Idaho National Labs	There are 4 lessons to be learned, one of them is: Long term chemical compatibility of sample and secondary chemical containers needs to be considered for each task. While some materials are suitable for many short-term applications, they may not be suitable for long term storage. This applies to all chemical containers; even those for chemicals still in the original containers as these can degrade over time as well. Please see full document for details and additional lessons learned.
00002361	Procurement of Non-standard Shipping Containers Requires Use of Design Control	2015/02/27	Hanford Operating Experience - Information Bulletin	The D-10 shipping container required a unique design to place the D-10 vessel and provide the necessary shielding to meet the radiological dose requirements identified by the F-SPA. TheD-10 shipping container represented a high cost procurement, with potential impacts to safety, cost, and/or company credibility for an inadequate product. The level of rigor applied to the procurement was not commensurate with the risks associated with its intended use.
00002360	How to Document Your Project	2015/02/25	Project manager Website	What's Worth Documenting: Client-Related Everything Legal Dictates The Right Amount of Process Changes to the Project Take the Time Have the Right Level of Detail Use Smart Storage Share with Others Version Control and Up-to-Date
00002359	8 Things Your Team Expects From You	2015/02/25	Project manager Website	The 8 common items that all project managers should look at: 1. Guide the project plan 2. Utter confidence in the plan… and the team 3. Data, data, data 4. Pipeline to project sponsor 5. Model time management 6. Support for work-life balance 7. Ongoing training opportunities 8. The right tools
00002358	5 Risks That Could Impact Any Project	2015/02/25	Project manager Website	Common Risks include: 1. Resources leaving 2. Change of strategy 3. Budget cuts 4. Scope changes 5. Missed quality targets
00002357	Mechanical Piping Design for Complex Projects	2015/02/23	AMEC NSS	The lesson learned for future complex mechanical design projects is that the design team should consist of separated process and piping groups (rather than process only), where the process group is responsible for the development of the process side of the piping design and piping group is responsible for the development of 3D models and isometric drawings. This will minimize the risk of having cost and schedule setbacks by ensuring a quality product is produced in the first iteration.
00002356	A four-steam-generator outage at Diablo Canyon-2	2015/02/20	Article	N/A
00002355	ANO-1 Main Generator Stator, Temporary Lift Assembly Failure	2015/02/19	INPO, COG, WANO, Entergy, Bruce Power	Extra caution must be applied to Refurb's two crane stator lift and LP rotor lifts. The stator lift includes two cranes with a beam which should all be tested, focusing on main cables and brakes which may not be replaced during Refurb. The beam is seldom used and should be load tested. LP rotor lifts will be close to single crane capacity and should also be thoroughly tested.Perform an independent review of all vendor-supplied designs and calculations for engineered temporary lift assemblies to ensure that the design is adequate to lift and transport the required component and that all code requirements are met. (The independent review can be conducted by any qualified engineering organization not associated with the vendor supplying the temporary lift assembly design.) Include: Owner's review for lift assembly design, third party independent review of vendor calculations, verification of load testing, finite element analysis of the design if load tested to less than 125 percent of the anticipated load, additional safety factors where load testing is not possible, and establishment of exclusion zones considering the potential failure of the lift assembly. This recommendation should be considered also for
00002354	Delays and Cost Overruns for Vogtle Expansion	2015/02/19	Power Magazine	Originally expected to come online in 2016 when the Nuclear Regulatory Commission gave the go-ahead for construction and operation in 2012, the project has experienced repeated delaysthat have now pushed back the startup date to mid-2019 for Unit 3 and mid-2020 for Unit 4. The company was informed of the delays by Westinghouse and CB&I, which are supplying and building the two new AP1000 reactors. Southern said it has not accepted the revised schedule and said it may press the firms to accelerate construction. In the filing with the Securities and Exchange Commission, Southern Co. warned that "ongoing challenges with the Contractor's performance including additional challenges in its fabrication, assembly, delivery, and installation of the shield building and structural modules" could lead to even more delays and added costs.The problems are an increasing black eye for a project that was intended to show that new licensing, design, and construction approaches would avoid the problems encountered with previous reactors, where costs often ballooned far beyond initial estimates. Southern Co., Westinghouse, and CB&I are already involved in litigation over previous delays and increased costs.
00002353	Email Management Guidelines	2015/02/17	Library and Archives - Canada Government Records	The attached doc contains additional information about regulations and recommendations.

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00002352	A risk-management approach to a successful infrastructure project	2015/02/17	McKinsey & Company	Management needed to formulate a clear business case for the value of risk-management activities and to devise a risk strategy that was tightly linked to the business. The appropriate transparency on risk cost and the key drivers and sources of risk then had to be established, along with a much clearer understanding of what risk-management levers and instruments were available. Having established this at the top of the organization, it was then vital that effective risk-management governance, organization, and processes were put in place and that a strong risk culture and awareness was driven throughout the organization
00002351	Faults in Equipment and Maloperation of Systems in Power Plant during Lightning Strike	2015/02/13	COG#15 Feb 25, 2015	Strengthen the lightning protection for equipment in areas sensitive to lightning protection.
00002350	Integrated Life Cycle Management (ILCM)	2015/02/13	COG#13 Feb 25, 2015	The objective of the ILCM project was to provide a standard methodology to support effective decision making for the long-term management of selected station assets.
00002349	Fueling Machine Latch Ram Failure Prevented Fuelling and Caused Unit Derate and Production Loss	2015/02/13	COG#10 Feb 25, 2015	Upon dismantling and inspection of the East FM Latch Ram, there was no clear identifiable failed component.
00002348	Thermal Fatigue Cracks in Feed Water Piping Tee	2015/02/13	COG#8 Feb 25, 2015	It is highly recommended that all mixing regions of flows at different temperatures are identified. This is especially important for process systems whose integrity is important to safety. Such mixing regions shall be carefully studied for structural design improvements and/or alternative operating modes shall be considered in order to mitigate the possible adverse effects of temperature differences, i.e., thermal stresses and fatigue.
00002347	Containment Isolation and Reactor SCRAM Caused by Water Leakage into the Reactor Building	2015/02/13	COG#3 Feb 25, 2015	Normally the drain system easily drain water flows like this. Drain lines between the upper drain system and the lower drain system were clogged by sludge therefore the water level outside the reactor building basement floor increased to 2.5 meters.
00002346	5 Steps to Document a Process	2015/02/13	N/A	1. Start with an Outline 2. Put a Frame Around the Final Document 3. Set Up Your Process Documentation Spreadsheet 4. Meet with the Subject Matter Expert 5. Convert the Spreadsheet into Your Document
00002345	Identify Document Disseminate	2015/02/13	N/A	If you are setting up a meeting with co-workers involving documents with OUO or UCNI, then: 1. The OUO/UCNI information may be included in a word processing file that is protected by a password ("Entrust Encrypt File with Password") and attached to the Outlook calendar appointment. Then the sender can call the recipients with the password so the file may be accessed. The subject line and first line in the body of the Outlook calendar appointment must be marked to indicate that it contains an OUO/UCNI attachment in a manner similar to an OUO/UCNI email. 2. The OUO/UCNI information may be sent in a separate, properly marked, Entrust encrypted email to all meeting attendees. DO NOT attach an OUO/UCNI document to a Microsoft Outlook calendar appointment without following option 1 above. If you do, the action may result in a Security Infraction.
00002344	5 Ways To Help Your Team Succeed	2015/02/13	N/A	Here are five ways that you can help your project team succeed: 1. Offer training 2. Give team members responsibility 3. Communicate well and often 4. Say "Thank you." 5. Facilitate Collaboration
00002343	How To Troubleshoot Your Project	2015/02/13	N/A	Guide lines for project managers 1. Regularly monitor risks 2. Rapidly address issues 3. Analyze project for quality control 4. Review your schedule 5. Reconsider resource allocation
00002342	Asset Performance Management: Bridging the Gap Between CapEx and OpEx	2015/02/13	N/A	The full dicument goes over many different aspects of preformance evalueation and asset management.
00002341	6 Tips for Better Reports	2015/02/13	N/A	Here are six tips for creating and delivering first-class project reports. 1: Customize your report for your audience 2: Make sure the data is up-to-date 3: Go beyond status updates 4: Go live, especially during meetings 5: Drill down into the data by filtering 6: Create a general health report
00002340	The Principles of Schedule Impact Analysis	2015/02/11	N/A	The full document contains details about different methods and approaches dealing with scheduling
00002339	Major Component Replacement OPEX: EPRI Chemistry Technical Strategy Group – Major Component Replacement Workshop	2015/02/09	Cook Nuclear Plant Training Center - 1 Cook Place Bridgman, Michigan	The events resulted from large components being restored to service with insufficient cleanliness following replacement work. In the DC Cook Nuclear presentation one of the major lesson learned is: " It is imperative that Chemistry personnel get involved early in major projects prior to establishment of contracts to ensure proper chemical cleanliness specifications and requirements are part of the vendor contract." Based on OPEX provided in the Workshop Meeting Material and OPEX available from other sources NR Chemistry Technical identifies areas of concern and improvement as: 1.Service/Equipment Purchase Specifications: Purchase practices should ensure replacement parts and equipment received with corrosion inhibitors have these coatings removed prior to installation, including flushes at vendor facility, selection of grit blasting material that could be used during primary side cleaning or other equipment manufacturing, shipment packaging and storage conditions. 2.Welding Procedures: Evaluation of the welding procedures should be completed to ensure that welding flux used during welding on systems in contact with process fluid will not affect post –maintenance chemistry. Review of post
00002338	Opportunity to Improve Radiation Protection - Hazard Postings	2015/02/09	Bruce	Individual workgroups are responsible to post and label radiological hazards after work activities are completed.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002337	Unit Synchronizing Breaker Fails to Open Resulting in Turbine Trip on Electrical Protection, Activation of Shutdown Systems and Forced Outage	2015/02/06	Bruce A	Opportunities to enhance the reliability of switchyard equipment have been learned from this event. The TSO is looking into incorporating periodic inspections on failed mechanical components into its existing maintenance strategies. The TSO also identified that the current 230 kV synchronization breakers are in need of replacement.
00002336	Adverse Trend: Delays and Quality of Projects	2015/02/06	Darlington	Successful identification of project risk leads to better mitigation strategies.
00002335	Guidance for Developing a Human Factors Engineering Program for an Operating Nuclear Power Plant	2015/02/06	EPRI	Guidance for utilities on developing a human factors engineering (HFE) program for modifications made to operating nuclear power plants.
00002334	Vogtle owner wants contractors to pay	2015/02/06	Tennessee	Those payments from Westinghouse Electric Co. and Chicago Bridge & Iron Co. would offset roughly a third of the costs Southern Co. could face if its two new reactors at Plant Vogtle were delayed an additional 18 months. Southern Co. subsidiary Georgia Power disclosed the potential delay last week and estimated it could cause another $720 million in financing and ownership costs. CB&I disputed it was responsible for the delays, while Westinghouse Electric declined to comment. "We think liquidated damages could offset a great deal of those charges," Fanning said. Southern Co. has not accepted the latest timeline from its contractors, which Fanning said might still be shortened. Nuclear industry supporters had hoped the new plant in Georgia and a sister project in South Carolina would prove reactors could be built without the delays and cost overruns common years ago. The first new reactor at Plant Vogtle was supposed to start producing power in April 2016, with the second reactor following a year later. The latest schedule would push back those deadlines roughly three years. Beyond paying damages for a late schedule, Southern Co. officials have assumed Westinghouse and CB&I will pay the bulk of
00002333	21 Project Management Success Tips	2015/02/05	N/A	The full article in the attachment discusses all the details and tips for more effective project management.
00002332	Robotic Inspections of Nuclear Power Plant Storage Tanks	2015/02/05	N/A	The Nuclear Energy Institute (NEI) has recommended that nuclear plant storage tanks, among other infrastructure, undergo periodic inspection. The guidelines for tank inspection were laid out in the publication NEI 09-14 (Rev 1), issued in December 2010. Historically, plant managers have utilized divers or drained the tanks and sent personnel inside to conduct manual surveys and non-destructive examination (NDE) inspections, but that process is often costly, time consuming, and can restrict operation.
00002331	Best Practices for Aligning Safety Metrics, Incentives, and Performance	2015/02/05	N/A	The full report discuss in deatils the following topics: Assessing the Safety Culture Behavior Observations Safe Work Traits Accurate Guidelines Near-Miss Reporting Eight Focus Areas
00002330	Chain Seperation from Chain Valve - 4-72100-V458	2015/02/05	Darlington Unit 4	Due to OPEX from Pickering. Operator checked condition of the chain operated valve before operation and during operation stood to the side of the valve.
00002329	Use of Scanning-Capable Copy Machines May Compromise Information Security	2015/02/05	N/A	1. Before scanning a document, consider the sensitivity level of the information and if transmission by unencrypted e-mail is contrary to LLNL information security policy and procedures. In situations where encryption is recommended but not mandatory, ask yourself if the security risk outweighs convenience or timeliness and whether the transmissions should be encrypted. If so, find an alternate way of obtaining an electronic copy, such as directly from the author or by using a conventional scanner. 2. Before making a conventional copy of a document, make sure the copier is in "copy" mode. 3. If scanning documents, manually return the copier to "copy" mode when finished. 4. It is recommended that, if the copier has scanning and e-mail capability, it should be labeled or a sign posted, so that users know of the capability of the copiers.
00002328	Without a reminder, classified working papers could exceed the 180-day marking limit.	2015/02/05	N/A	If the custodian set up an automatic reminder, which included the alternate custodian(s), then the chances of the classified working paper exceeding the 180-day limit would be greatly reduced, even if the primary custodian failed or forgot to perform the check. Additionally, conducting thorough employee exit briefings for departing employees would ensure that all classified matter is properly recognized, accounted for, and transferred, emphasizing all such time-related issues with the next custodian.
00002327	Staff member inadvertently creates and emails classified document	2015/02/05	PNNL	When a project involves potentially classified information, meet with a derivative classifier or the PNNL Classification Office to discuss potentially classified aspects of the work prior to the start of the project and to understand the classification level of each document and identify the need for classified information resources. Recognize the risks inherent in areas that are potentially classified. Co-mingling information is a key risk, especially when working on classified projects while using multiple files and data sources.
00002326	Potential Entrust Issue using BlackBerry's	2015/02/05	Nevada Test Site	This can occur if a receiver of an Entrusted e-mail has a Blackberry, reviews the e-mail on their desktop Outlook and unsecures the message using the Outlook Entrust Security "Actions" menu before the message is synchronized by the Blackberry e-mail server and before the desktop user moves the now unencrypted file from their Outlook Inbox.
00002325	Observations from Darlington Site Visit	2015/02/03	Darlington	Please see full attached documents for report.
00002324	Calculating Earned Value in Agile projects	2015/02/03	N/A	See full report for details

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002323	Computer Virus Found on Various Plant Laptops and Media	2015/02/03	Dungeness (AGR)	The root cause of the virus infection was failure to use the guidance for the handling of laptops and removable media. Inadequate administrative control was a contributor.
00002322	Delay Vogtle New Nuclear 18 months-No Integrated Schedule	2015/02/01	Vogtle New Nuclear	Delays threaten to add hundreds of millions of dollars to the budget of the more than $15 billion project. The 2017 and 2018 dates are themselves delays from the April 2016 and 2017 dates previously approved by the Georgia PSC. That schedule shift played a role in pushing up Georgia Power's estimated total project cost from $6.1 billion to the current $6.7 billion, according to the latest testimony from Philip Hayet, another consultant. A delay to 2019 and 2020, however, would bring the total to $7.8 billion.
00002321	Guidelines for Reducing the Time and Cost of Turbine-Generator Maintenance Overhauls and Inspections–2014: Supplemental Addition and Software	2015/01/30	EPRI	Objective: To provide general guidelines for planning and performing a steam turbine maintenance outage.
00002320	Simultaneous Stalling of Multiple Computers Resulted in Near Miss Dual Control Computer Loss	2015/01/30	Pickering	Recent carpet installation in the MCR may intensify the static electricity build up due to low humidity.
00002319	Defense Industrial Base Assessment: CounterFeit Electronics	2015/01/30	N/A	
00002318	Consistency between Programmatic Documents and Lower-Tier Departmental Documents	2015/01/30	N/A	Lower-tier documents or training programs must be reviewed to ensure they are consistent with programmatic documents.
00002317	Radiological Assistance Program Implementation	2015/01/30	N/A	An assessment of MSA's DOT compliance of the RAP Team revealed the noncompliance with DOT regulations. As a result of this assesssment, this reduced the potential of fines levied by DOT.
00002316	Inadvertent Premature Public Availability of Information	2015/01/30	N/A	Automated systems designed to make information available to the public may inadvertently result in premature release of information.
00002315	Limit Prefabrication of Complex Components without Well Defined Field Conditions	2015/01/30	Y-12 National Security Complex	Design planning for work that may require/warrant future prefabrication of parts should include walk downs that are conclusive and use appropriate lift and lighting equipment for accurate results. Construction planning in such areas should be scheduled such that fabrication of materials for use in high risk areas allows for additional design verification.
00002314	Assure all Planning Discussions are Documented	2015/01/30	N/A	Make sure that all discussions regarding work processes and safety issues that are held during planning meetings are documented on the final work plans.
00002313	Who is in charge Part 1&2	2015/01/30	N/A	Roles and responsibilities for identifying and mitigating hazards must be clearly defined, especially when work is being conducted by subcontract.
00002312	Training Implications Associated with Organizational Structure and Changes	2015/01/30	N/A	Organizational structures must consider the training requirements associated with various key positions within nuclear organizations, especially during changes to the organization.
00002311	Technical Pre-Job Briefing not conducted appropriately for some design work	2015/01/30	DEC	Technical PJBs should be conducted when a project is started but also can be conducted when a turnover occurs due to changing resources, the design project's scope changes, etc.
00002310	System Vulnerability Review Report for Hope Creek Reactor Recirculation System	2015/01/27	Hope Creek Reactor	Read full report for all deatils.
00002309	Scope Change Control	2015/01/27	N/A	Read fullfull article in attachment.
00002308	Project Cost Management - Cost Control	2015/01/27	N/A	Read Attached document for more detials
00002307	Unit 6 Forced Outage Due to Fuel Channel Feeder Pipe Grayloc Seal leaks on channel G18 East and West End Fittings	2015/01/27	Bruce	Read Complete report and additional documents attached
00002306	Reactor Area Bridge Contacts Fuel Channel End Fittings During Refurbishment Project	2015/01/27	Bruce Unit 1	The position of the handrail in Unit 2 is fixed. In Unit 1 the handrail moves with the reactor bridge. The workers were more familiar with working in Unit 2 and failed to note the difference when operating the bridge until contact had been made. - The work platform operator in the restart control room had limited camera views of the Reactor face and the clearances with the reactor bridge handrail. The camera views are positioned on a sharp downward angle and do not give a good perspective between the handrails and end fittings. Full details in attached report.
00002305	Improvements Learned For Containing Leaks From Reactor Channel End Fittings	2015/01/27	Bruce 4	Read attached report for full details.
00002304	Miscellaneous TVA LessonsLearned from CC Plant Construction Projects	2015/01/26	N/A	

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002303	Watts Bar Nuclear Plant Unit 2 Completion Project	2015/01/26	N/A	The WBN2 Project was experiencing cost overruns and schedule delays. A new management team was put on the project and began to implement an improvement plan. This plan consisted of: • Defining the problem • Performing a cause analysis • Developing a rigorous corrective action plan • Developing a new estimate for project completion • Developing project oversight and monitoring tools to track performance improvement The new project estimate was compared to the cost of new build gas. The analysis demonstrated that completing WBN2 at the new estimate is a good value for the ratepayers. The corrective action plan put in place has resulted in demonstrated improved project performance.
00002302	Adverse Trend – Missed Deliverables/Schedule Delays	2015/01/23	OPG Nuclear Projects	Acommon cause analysis identified five common causes that contributed to an adverse trend of schedule delays and missed milestones.
00002301	Legacy Engineering Change Control Process resulted in Unapproved Modification and Equipment Damage	2015/01/23	Pickering	The barrier failures could have been prevented by the appropriate use of Event Free Tools, COMS process, Walkdowns, Understanding of Design Requirements, and Industry Standards & Codes.
00002300	Degraded Ability to Mitigate Flooding Events	2015/01/23	NRC	The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice (IN) to inform addressees of recent operating experiences related to external flood protection where deficiencies with equipment, procedures, and analyses relied on to either prevent or mitigate the effects of external flooding at licensed facilities have resulted in degraded ability to mitigate flooding events. Information from the following events may apply to the design and maintenance of physical protection features such as flood barriers, the ability to effectively implement abnormal operating procedures to mitigate the effects of external flooding, and the accuracy of analyses that are used to determine design-basis flooding elevations, as well as flood water inundation times.
00002299	Auditor General Report New Brunswick (Pt Lepreau)	2015/01/23	Point Lepreau Generating Station Refurbishment – Phase II	We concluded that key project costs of the Point Lepreau Generating Station Refurbishment Project were generally reasonable. As a result of our testing and expert consultation, however, we believe NB Power can make improvements in areas such as: procurement; contract management; and active risk management of key contractors.
00002298	Fostering a Strong Nuclear Safety Culture	2015/01/21	Nuclear Energy Institute	Revision 1 of NEI 09-07 is based on industry experience with initial implementation of Revision 0 of NEI 09-07. Based on industry feedback, Revision 1 provides more flexibility and encourages tailoring the monitoring process to each site's specific circumstances.
00002297	Planned Reactor Shutdown to Attend Generator Exciter End Seal Liner Babbit Temperature High Problem	2015/01/21	Kakrapar (PHWR)	Periodic inspection of the seal liners has been introduced as a part of preventive maintenance. Inspection and cleaning of the damper tank at specified frequency has been introduced to ensure dirt free seal oil.
00002296	Inadequate Controls of Respiratory Protection Accessibility, Training, and Maintenance	2015/01/14	NRC	The importance of having adequate procedures to properly implement and maintain an effective respiratory protection program.
00002295	Project Scope Management	2015/01/12	N/A	Completion of the product scope is measured against the requirements while completion of the project scope is measured against the plan. Both types of scope management must be well integrated to ensure that the work of the project will result in delivery of the specified product.
00002294	Same Lessons Learned Over and Over-again	2015/01/12	N/A	Project scope drives project cost and schedule.
00002293	Subcontractor Cut through energized 120 V Circuit	2015/01/12	Oak Ridge National Laboratory	Multiple corrective actions resulted from the investigation of this event. However, the most significant of these is to ensure a UT-Battelle employee is in charge of all Chestnut Ridge work. This will be accomplished by training employees and by ensuring that the roles, responsibilities, accountabilities, and authorities (R2A2) for hazard identification and mitigation, including hazardous energy controls, and for proper work planning and execution for facility modifications at Chestnut Ridge are clearly defined in Chestnut Ridge processes.
00002292	Lessons in engineering development for Major Projects	2015/01/09	N/A	The perception is that any open scope and planning deliverables can be finalized after project sanction. However, without the appropriate scope definition, the sanction estimates will not carry the level of confidence needed at this stage. This exposes the project to the risk of major issues in detailed engineering, field construction and eventually start up and commissioning.
00002291	Limit Switch Failure Challenges Testing of Emergency Coolant Injection Isolation Valve	2015/01/09	Bruce A	The effects of Primary Heat Transport (PHT) Pump vibration and high electrical contact resistance were identified as likely causes for the limit switch problem. The station has initiated actions to reasonably control the hazards that both failure modes present to this equipment. Plans are also in place to inspect and replace any similar limit switches that show signs of defects in future unit outages.
00002290	Advanced Welding Methods for Irradiated Materials	2015/01/09	EPRI	Objective: To develop and demonstrate advanced welding methods that can be used for the repair of irradiated reactor internal components.
00002289	Unit 6 System Service Transformer minor Oil Leak	2015/01/09	Bruce Power	Good monitoring and reporting by Operations field staff identified and corrected this leak at an early stage.
00002288	INPO Event Report - Improper Setpoints Lead to Generator Trip and Reactor Scram	2015/01/09	R.E. Ginna Nuclear Power Plant	Lessons learned include the following: 1. Rigorous adherence to processes is important in preventing events. Informational procedures can have as much impact as continuous use procedures if not followed. 2. Supervisors need to insist on following rigorous engineering processes for setpoint changes.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002287	INPO Event Report - Integrated Risk	2015/01/09	Various Nuclear Stations	In these events, leaders believed that sufficient measures were in place to manage projects, as well as the operational enterprise risks, but in every case they underestimated the potential consequences of failure. Their misguided comfort levels were often influenced by a belief that their specific engineering projects had been performed successfully elsewhere in industry, and that the vendors involved were subject-matter experts, capable of guiding them to a successful outcome as well. In other cases, the management of the project fell short because the organization's structure and capacity were not aligned to the magnitude of work associated with the size and/or complexity of the projects. Had they instead applied a consequence-based enterprise risk model that first assessed the consequence of project failure, and then elevated their level of examination and oversight commensurately, it is likely that greater project scrutiny would have followed and different outcomes would have occurred.
00002286	Koeberg NPP (S. Africa) Turbine Control & Protections Project OPEX	2014/12/18	Telecon	Complete lessons learned are available in attached meeting minutes. Key lessons learned were: 1.Eskom documented a specific change management process to deal with managing, controlling and tracking of technical changes to the system and the plant simulator as there were numerous "tweekings" required and the station's conventional change management process was not adequate to ensure a smooth installation and commissioning period. Eskom provided a copy of this procedure. 2.Eskom recommended to include functionality to enable manual step changes for turbine run up for commissioning. Would have been useful to allow operators in control room to input step changes. 3. Recommended to have a very competent Alstom commissioning engineer who is capable to modify software, on site during commissioning. They contracted their commissioning engineer to stay on site for a year after AFS. 4. Maintenance and engineering staff were involved in the installation and commissioning to learn (i.e. in a support role to assist and learn the new system). Eskom established a dedicated "digital maintenance" group and involved these personnel throughout the project lifecycle. Dedicated
00002285	Idea Tracking Sheets	2015/01/06	N/A	I participated inCommunity OPEN House for the Toronto Transit Corporation (TC) whichused idea rating sheets as a hands-on tool that allowed community members to rank their own ideas for transit improvements. Everyone participated in a relatively short period of time. A tool to be used where appropriate
00002284	Modify Filter Sampling Lines - OPEX Report	2015/01/05	OPG	The underlying objectives of this OPEX Report are to keep the extent of modification to a minimum, provide OPEX data support for relocation of the sampling points and to identify lessons learned with regards to Design, Constructability, Operability, Maintainability and Safety and document them into the Issue Tracking File (ITF) so that they are incorporated into the design.
00002283	North American Electric Reliability Corporation Annual Report	2015/01/05	N/A	
00002282	Pickering East Boiler Drain Issues	2015/01/05	Pickering	
00002281	OPEX summary for Steam Generator	2014/12/31	N/A	
00002280	OPG DNGS TG Refurbishment - Thermal Services	2014/12/31	N/A	Document contains the OPEX events and details.
00002279	PT. Lepreau SG Refurbishment OPEX Conference Call	2014/12/31	OPG	Questions addressed in the report. 1. Contracting Strategy 2. Scheduling/Layup 3. Primary Side Clean 4. Access Ports 5. Inspection and Waterlancing Activities 6. General Questions
00002278	Earned Value Management Implementation Guide	2014/12/31	N/A	
00002277	Top 10 Tips for Your "Lessons Learned" Review	2014/12/22	N/A	1. Determine when to conduct a Lessons Learned review. 2. Initiate and set the right tone. 3. Consider a neutral facilitator and note taker. 4. Determine the appropriate level of effort and timing needed. 5. Identify who should participate and how. 6. Solicit design services for surveys or interviews. 7. Convene in a timely fashion. 8. Customize the review to your needs. 9. Hold people accountable to desired behaviors. 10. Summarize, publish, and utilize outcomes.
00002276	OPEX Review for RQE	2014/12/22	OPG	Release Quality Estimate (RQE) is required for the Darlington Refurbishment to obtain financial approval for the program of work. It is a significant milestone of the definition phase of the project. A review of Lessons Learned from other mega projects identifies the following should be included in a RQE: a. full definition of scope and what is out of scope b. complete and accurate assumptions list c. identify associated risks and adequate contingency d. estimate of costs
00002275	Performance Contracting for Construction	2014/12/22	N/A	Using a performance contracting approach on suitable construction projects will allow State and local DOTs to better define and communicate to contractors specifically what they want to achieve in their projects and to hold contractors accountable for agreed-upon outcomes. Contractors will enjoy the flexibility of determining how to achieve the outcomes rather than using a specified method. This flexibility should enable them to perform profitably and competitively without compromising quality. They will also share the rewards from a project well done.
00002274	Lessons from Past and Ongoing Constructions Projects	2014/12/22	Prague, Czech Republic	

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002273	Broken Cable of Fuelling Machine Catenaria	2014/12/22	Cernavoda	The field-routed witing and hoses should not interfere with othe installations
00002272	Corrosion Mitigation of Conventionally Reinforced Concrete Structures	2014/12/22	EPRI	This report provides power plant staff with a state-of-the-art summary of corrosion detection and mitigation methods for corrosion control of reinforcing steel in nuclear power plant concrete structures, including typical implementation requirements, lessons learned, and operating experiences, with emphasis on cathodic protection systems.
00002271	System Min-Flow Valve Controller Failure Leads to Reactivity Management Event	2014/12/19	Vermont Yankee (BWR)	Refurbished obsolete components should undergo more rigorous pre-installation testing than new off-the-shelf components. In this case a *thermal challenge of the valve controller prior to its installation would have likely prevented this failure <2 hours after it was put in service by more adequately challenging its reliability. Thermal Challenge: controller service condition is brought up to ~120F on the bench during its pre-installation (or post-refurbishment) functional check to simulate more challenging operating environment. For GEMAC controllers specifically, aged components that are more likely to fail early in life will fail under these conditions.
00002270	Construction Management Systems: Automated Contract Tracking	2014/12/22	N/A	Automated systems improve efficiency for everyone involved. Agency staff spend less time on paperwork and more time monitoring progress and quality at the project site. Contractors experience faster turnaround on payments and speedier resolution of contract change orders. Suppliers receive faster certification that their materials meet specifications. Recordkeeping is easier and more accurate, and agencies save in reduced hands-on time. Michigan, for example, reported annual State-wide savings of more than $16.8 million following implementation of its system.
00002269	Transportation Performance Management	2014/12/22	N/A	A guild on performance management
00002268	Current Design-Build Practices for Transportation Projects	2014/12/22	N/A	The most important lesson learned is that someone has to be in charge. This person, usually the Project Manager, must be responsible and accountable, with the ability to make decisions based on what is best for the project and owner.
00002267	Bodies of Knowledge Management	2014/12/22	N/A	The management functions also provide the structure and specific goals for the capability aspect of maturity. The procedures described in each function are used as the basis for defining different levels of capability and the attributes described in the maturity model provide benchmarks for the organizational implementation of the function. The goals and procedures described in the functions form the basis of the knowledge and performance criteria listed for each competency. In return these provide benchmarks for the individual performance of the function.
00002266	Interim Performance Agreement and Appraisal Process (IPAAP)	2014/12/22	N/A	Accountability for the achievement of specific business results and implementation of organizational values will then be cascaded down to employee performance agreements. Each employee performance agreement will reflect how each individual can contribute to the overall team results given the nature of his or her responsibilities in the organization. In formulating employee performance agreements, consideration of employee needs for training and development as well as their needs for balancing work and personal life are to be considered in setting performance expectations and evaluating results.
00002265	Discrepancies in Data Used Refurbishment Component and Equipment Design	2014/12/15	Darlington Refurbishment	While validating data from 00044-REP-03460-00002 (contractor file # P1047/RP/001 R00), dated March 13, 2008, for use in designs for Darlington Refurbishment, non-conservative discrepancies were identified with respect to calculated fuel channel garter spring radiological activities. The predicted activities were used to prepare specifications and initiate the procurement of waste containers for the DN retube refurbishment work. SCR N-2013-18012 was raised to document significant changes in predicted radiological activities for Darlington retube waste components. Further details of the activation discrepancy can be found in SCR N-2013-18012. A subsequent report was requested from AMEC and received October 9, 2013 (contractor file # P1688/RP/001 R00). The new report traced the source of the discrepancies from the original 2008 report, to a physics code from the Industry Standard Toolset (IST), used in the calculation of the garter spring activities. The new report also identified that calculations for fuel channel girdle wire, pressure tubes, calandria tubes, calandria tube inserts, end fittings, and shield plugs would also be affected. Due to these discrepancies, there is concern with the D-RWC
00002264	Lessons From Modifications Made to Increase Unit Generator Output	2014/12/15	Bruce A	Deficiencies with the design change and troubleshooting processes were identified as the causes for this event. Changes to both processes and the delivery of a case study using the lessons learned from this project highlight some of the initiatives the site is taking in response to this event.
00002263	Service Water Piping Failure Requires Manual Unit Shutdown To Repair	2014/12/15	Bruce A	The cavity formed as a result of pipe wall thinning. The thinning was caused by localized corrosion that accelerated the internal and external degradation of the pipe. The age of the affected section of pipe was greater than 30 years old. The affected section of pipe was replaced and inspections of similar piping were initiated across the station.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002262	Unexpected Turbine Trip and Outage Caused By Loose Fibre Optic Cable	2014/12/08	Bruce A	The preventative maintenance strategy and diagnostic testing capabilities for these computers are being improved using the lessons learned from this event.
00002261	Value Engineering (VE) on Transit Projects	2014/12/12	N/A	Value Engineering (VE) is defined as an organized effort to analyze the function of systems, equipment, facilities, procedures and supplies by a multi-disciplined group for the purpose of achieving the required function at the lowest total cost. Considerations are given to effective ownership consistent with requirements for performance, reliability, quality, maintainability and safety. FTA guidelines endorse the use of value engineering in analyzing the design and cost effectiveness of federally funded projects. In keeping with the FTA guidelines, The T, through their standard consultant selection process, solicited proposals for value engineering services to be performed on three of their major design components of the Commuter Rail Project. These components included the Intermodal Transportation Center in downtown Fort Worth, the Downtown Rail Corridor, and the RAILTRAN Corridor. Following selection of the VE consultant, The T collaborated with the consultant in the development of a customized work program which was tailored to the specific issues and needs of the Railtran/Commuter Rail project. The five - phase VE process (Information, Speculation, Analysis, Development and Presentation) was
00002260	Railcar Procurement Schedule Recovery	2014/12/12	N/A	The lesson to be learned from M-6 problems relative to timely completion and implementation of the Master Test Plan and relative to completion of the required Prototype Vehicle Program suggests a more strict enforcement of all contract milestones particularly those related to vehicle testing and to prototypical vehicle development. Compliance with a baseline schedule prepared at a sufficient level of detail to reflect all critical testing requirements is essential. Such insistence upon schedule integrity would have resulted in a much earlier revenue service date for the M-6 vehicles and an acceptance testing program which did in fact require an extensive and lengthy retrofit program. A firm position at an early date to assure that the vehicle manufacturer provided adequate management and engineering staff to the program should have been insisted upon as well as should have an independent and effective on-site monitoring of corrective measures agreed to and the M-6 railcar builder.
00002259	R&D Projects – Computer Based Systems Warranties	2014/12/12	N/A	This contract was originally viewed as a standard contract with no differentiation between software and hardware warranty warrantee requirements. This is not uncommon for automatic train control systems which are more hardware-based than software-based, or for a computer-based system that is based on a prior similar system installation elsewhere. Such systems contracts normally would not have varying hardware and software warranty start dates. In this new age of fast paced technological development, computer based systems are more vulnerable to systems component obsolescence, thereby increasing the risk of R&D occurring within the contract envelope schedule, through no fault of the contractor or contracting agency. The contracting agency must carefully weigh the risk associated with possible obsolescent equipment versus the risk of contract delays if it elects to approve state-of-theart equipment upgrades.
00002258	Project Management Plan (PMP) Development	2014/12/12	N/A	PMOC teams of veteran project management personnel can provide valuable early guidance, and help a grantee achieve an understanding of FTA's project management objectives without compromising its role in the Project Management Oversight process. The technique of grantee/PMOC informal working sessions to achieve a joint objective early in the PMO process encourages cooperation, a spirit of team work, and mutual respect that brings about an advantage in resolving oversight problems which may occur during the remainder of the project. Completion of an approvable PMP helps to avoid delays in filing a completed Grant Application. With the grantee's clear understanding that an acceptable PMP is expected to be maintained and adhered to, the Plan becomes a management tool for the grantee and a useful tool to the PMOC for monitoring the Project.
00002257	Creation and Benefits of Positive Public Relations	2014/12/12	N/A	Several important lessons regarding positive public relations have been learned during the course of this project. These lessons include: •Open, accessible approach builds trust •Position in the organizational structure underscores importance of community relations •Involving community in setting rules of construction has benefits •Plans need monitoring to be effective •Quick response is key to resolving daily crises •Neighbors can accept disruption more easily when prepared in advance •Creativity with "mitigation" can be helpful •Maintaining a good data base is time consuming but essential •Media relations require careful attention

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002256	Arrow III Overhaul – Introduction of New Technology	2014/12/12	N/A	NJ Transit recognized, at a very early stage, the need to retain "Engineering Experts" to provide assistance through the overhaul program. This expertise augmented NJ Transit's in-house staff to create to team of individuals with the capabilities to successfully implement this ground breaking program. The decision to create this hybrid team at the onset of the program was invaluable, as it streamlined the progress through the design phases. All members of the team were involved at every step, and this cooperation undoubtedly led to the overall success of the program.
00002255	Unplanned Delays Can Provide an Opportunity to Review Design	2014/12/09	San Jose, California	Often constructability reviews, integration and interface checks are accomplished under tight schedules with results that are marginally acceptable. Take advantage of any delay to undertake additional time in design development or more in-depth reviews to re-evaluate all aspects of the project design and schedule. In addition, when developing project schedules, plan realistic durations for the design reviews. Often review times are arbitrarily reduced to achieve an artificial revenue operations date. Time spent on detail reviews and interface checking "up-front" can save a project delays and cost during the construction phase.
00002254	Reliability of Capital Cost Estimates Resulting from Early Planning Studies	2014/12/09	N/A	Neither transit agencies nor the FTA should rely on capital cost estimates resulting from preliminary planning studies such as a MIS unless the alignment assumptions have: 1. Undergone sufficient engineering to validate their viability, 2. Been thoroughly tested in the public involvement process, 3. Have generally been documented as feasible by those entities, such as railroads, over which the transit agency has no control. 4. Been cost escalated with adequate project contingency to cover unforeseen events. Such capital cost estimates should be thoroughly reviewed by qualified professionals for methodology and applicability of unit costs before the estimate becomes a published number. When this estimated cost is ultimately determined to be severely understated, it may lead to public disenchantment with the project, and almost always has a deleterious effect on the preliminary financial planning performed by FTA to include the project in a federal funding program with established congressional limits. In the Phoenix case described, cost was not a factor in local decision making to proceed with the Locally Preferred Alternative, nor does it appear that the citizens of the participating cities were
00002253	Interface with NSRR and Flaggers	2014/12/09	Mecklenburg County, North Carolina	This issue might have been avoided and/or greatly minimized during development by close coordination of design and contract special provision during the project development phase if sufficient, accurate, and relevant details had been put into the agreements and master plan. Early coordination and interface plan between contractors, third parties, suppliers, real estate, and NSRR were critical in early detection and resolution of issues with minimum schedule and cost impact.
00002252	Earned Value/Progress Measurement, Integrated Cost and Schedule Control	2014/12/09	Los Angeles	An "Earned value" management control system provides an effective framework for developing management information in a manner that provides enhanced visibility so that managers can make better informed decisions. This, in turn, should lead to more efficient and effective project execution. Adjunct or ancillary lessons that are equally important include the concepts that effective management control must: Be planned for and implemented with rigor and discipline early in the project, so that the process is instilled in the corporate culture. Routinely involve management at all levels of Project activity. Require routine reporting by responsible functional and line managers to maintain effective 'checks and balances'. Be subjected to routine audits and effectiveness reviews.
00002251	Cost Benefits to Construction Manager/General Contractor	2014/12/09	N/A	Awarding CM/GC contracts prior to start of construction allows for valuable contractor input during final design in the form of constructability reviews and second party cost estimates. Tri-Met found the assistance invaluable for reconciling conflicting capital cost estimates and in value engineering practicable cost savings that would keep Interstate MAX within the $350 million budget. Establishing a Guaranteed Maximum Price (GMP) with the CM/GC contractor before construction actually begins provides greater certainty about the final project costs. Typically many quantities and work elements are negotiated as lump sum costs and only if there are significant changes in design or scope occur would these prices change. Change orders are still allowed under the CM/GC contract but are expected to be fewer and lower cost on average. Reducing the owner's claims risk was especially important for Interstate MAX where the construction budget was constrained and costly claims during the course of a contract would threaten Tri-Met's ability to complete the project as planned.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002250	Configuration Management	2014/12/09	New York City	It became rapidly apparent to the MTA, New York City Transit that the need for a written system to manage the configuration of a state-of-the-art data and voice transmission network should have been planned from the early stages of design. The major lesson is to make the determination as early in the planning stage as possible. Additionally, developing a Configuration Management system after a physical plant has been delivered is not cost effective and can cause an organization to place an indefinite "hold" on system changes or acceptance until system status is identified. The system or network can deteriorate into a constant state of "catching-up".
00002249	Computerized Control System - Change Management	2014/12/09	N/A	The agency's research established that software to address the specific requirements of transit construction was commercially unavailable. Consequently, in view of the magnitude of the rail construction program, it was decided that the most effective action would be to develop software which would be capable of tracking not only contractor change notices and change orders but also contractor requests for information and potential claim notices. Furthermore, it would be able to link with other systems that had been identified to form a comprehensive Management Information System (MIS). The agency engaged a consultant to develop the CCS, building in solutions to all of the known problems by involving user groups to assist in each stage of the system's development. The consultant was responsible for development of not only the CCS but also the other units of the MIS, making structure of the databases consistent for ease of further development if necessary.
00002248	Building and Updating Accurate Project Budgets	2014/12/09	Mecklenburg County, North Carolina	Project cost analysis requires all aspects of the project to be addressed and considered in detail. Project cost evaluation needs to have an accurate estimate of all the known issues or changes plus the risks and unknowns allowances. It is also essential to have a detail procedure and guidelines for development and maintenance of project cost. FTA/PMOC/Grantees have the ability and means to look at existing technical issues and estimate their cost reasonably. However, other elements exist that are much more difficult to estimate, such as: Schedule delays and impacts Project potential risks Project and contract contingency Evaluation of various options
00002247	Additional Filling of Alternative Resin on Primary Demineralisers for CVCS and SFP (KHNP)	2014/12/05	Kori (PWR)	Macroporous resin is an effective method for capturing the micro particles at RCS in nuclear power plants and has contributed to the reduction of radiation fields and the usage of primary filters during shutdown evolutions.
00002246	Field Validation of Technical/Operating Procedures is Essential in Developing a Useable Procedure	2014/12/02	N/A	A field validation of a technical/operating procedure, when properly performed, can improve the usability of a procedure, as well as minimize errors and subsequent rework (i.e., formally revising the procedure after it has been issued because it is found to be unworkable).
00002245	Seven Steps to Performance-Based Services Acquisition	2014/12/02	N/A	
00002244	Elevated Dose Rates Observed During Fuel Transfer Canal Draining	2014/12/02	Salem (PWR)	Refueling technicians did not apply sound accounting and verification techniques to ensure the irradiated bolt heads were transferred from the bucket to the debris basket, based on previous successful transfers. The RP Department did not fully consider the possibility of residual irradiated debris remaining in the transfer canal, which could pose elevated dose rates in the upper cavity during drain-down. As a result, detailed surveys of the upper cavity were not performed before allowing worker access. Additional actions are now required to ensure workers can hear their electronic dosimeter when wearing modified power-visor hoods.
00002243	Reassessment of Effective Dose Equivalent External results in Additional Dose Assigned	2014/12/01	Palisades (PWR)	This root cause resulted in this event because guidance in the Regulatory Guide was not known resulting in inaccurate dose assignments to the workers on the control rod drive housing replacement project during the refueling outage.
00002242	Mobile Gantry Crane Tipped Over and Struck a Worker Resulting in a High Maximum Reasonable Potential for Harm	2014/12/01	Pickering Unit 7	Secure equipment when unattended to protect workers and seismic area equipment.
00002241	Card Replacements Involving Field Programmable Gate Arrays: Case Studies	2014/11/28	EPRI	The objective of the project was to participate in two circuit card replacement projects involving use of Field programmable gate arrays (FPGAs), assist the project teams in applying the EPRI FPGA application guidelines, and document the experience and lessons learned.
00002240	Leaks and Cracks of the Reactor Coolant Pressure Boundary	2014/11/28	IAEA	Overall recommendations have been made on the basis of the lessons learned derived from the events analysed. The recommendations are structured in two categories: those aiming at the prevention of leaks and cracks, and those aiming at their detection.
00002239	TMOD for Steam Generator Lay-up Secondary Side Chemical Addition Skid	2014/11/28	Darlington	A review of operating experience has resulted in little OPEX findings for the use of a chemical addition skid. Findings were in-line with any modification activity; such as ineffective operating procedures, issues caused by lack of regular maintenance inspections, non-procedural compliance and inadequate planning of work. The noteworthy items identified in the findings of this report, Section 5.1, will be added to the ITF upon approval of this document.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002238	Use of Contractor with Limited Resources Leads to Project Delay	2014/11/28	Oak Ridge National Lab	Ensure that selected service providers have sufficient staff and resources to execute their planned scope of work. Vendor selected to perform foaming activities to fixate contaminated ductwork only had one individual capable of directing work. Upon the individuals illness, the vendor was unable to perform work, forcing the project to select and perform the work via another technical method.
00002237	Lessons From New Construction Projects That Involve Inadequate Commercial-Grade Dedication	2014/11/28	URENCO USA (UUSA)	This construction experience IER highlights events related to commercial-grade dedication (CGD). The lessons learned are relevant to new build nuclear projects under construction and to operating plants that are replacing safety-related components with commercial-grade components. The overall impacts on the new construction projects were schedule delays and increased costs.
00002236	Tracking Commitments to External Entities	2014/11/28	N/A	Commitments made to those outside of your organization must be identified as such and receive cross discipline and subject matter expert (SME) reviews and be tracked to completion. Commitments made as risk management strategies must also be vetted through cross discipline and SME reviews to assure that unintended risks are not created.
00002235	Attention to Detail in Equipment Maintenance History Documentation	2014/11/28	Bechtel National Inc / Waste Treatment Plant	Documentation of maintenance activities for equipment being installed in a Nuclear Processing Facility must have sufficient details to tell a history from the first Preventive "as found" and "as left" conditions to the last corrective maintenance activity.
00002234	Computer Hard Drive Impacts SharePoint	2014/11/06	DEC	Ensure you have sufficent space on your hard drive while working and sharing documents in the SharePoint Team sites. Being over quota in your hard drive will impact your ability to save, move and create. Keep your data diet in control or it will impact your work.
00002233	New Training Method Enables New WCH Employees to be Qualified in Less Time	2014/11/27	N/A	In order to provide timely and effective training for the surge of newly hired employees, hired due to the American Recovery and Reinvestment Act (ARRA),plans should be put in place to assure the challenges of training larger groups of employees atone time are resolved.
00002232	G20 Skills Strategy	2014/11/27	N/A	In a nutshell, the building blocks of any skills strategy must be solid foundation skills and stronger links between the worlds of education and work. This in turn requires good-quality education in childhood; good information on changes in demand for skills; education and training systems that are responsive to structural changes in economy and society; and recognition of skills and competencies, and their greater utilization in the workplace. To be effective, policy initiatives in theseareas will also need to be closely linked with economic and social policy agendas.
00002231	Planning is Key to Success with Large Scale Office Moves	2014/11/26	N/A	Develop a comprehensive move and safety plan, including "what if" scenarios prior to executing a move to assure a safe and on time completion. Provide consistent and informative communications to employees regarding the move schedule and ways to safely execute the move. Share lessons learned with employees regarding past moves. Maintain a questioning attitude regarding safeguards and security; with many employees changing building locations, it is more difficult to detect people who don't belong. Be especially mindful during move periods and verify personnel badges as you pass by and greet people. Complete ergonomic evaluations at the new office locations.
00002230	Lessons from Ramp Down and Project Closeout	2014/11/26	N/A	As a result of the closeout activities, the project teams developed some useful tools to capture outstanding issues, comments/open items, and project status at the time of closure, which should be applied to similar activities and in the event of a project restart. The spicefic lessons can be found in the attached report
00002229	Turbine Rotor Damage Discovered During Refurbishment	2014/11/26	Koeberg Unit 1/2	Consideration is currently being given to performing rotor inspections on Unit 1 and 2 at an earlier opportunity than originally planned.
00002228	Lay Up Strategy - Self Assessment Report	2014/11/26	N/A	
00002227	Consistency between Programmatic Documents and Lower-Tier Departmental Documents	2014/11/26	N/A	Lower-tier documents or training programs must be reviewed to ensure they are consistent with programmatic documents.
00002226	FH - Storage Bay Cooling Design not Analyzed for Refurb Requirement	2014/11/26	Darlington	Refurb organization failed to recognize refurb defueling strategy would require thermal loading of the Irradiated Fuel Bays outside the design requirement. Refurb. organization failed to follow N-STD-AS-0024 Change Management "A change that fundamentally changes a requirement and impacts training, resources, level of risk, business objectives, processes, etc., is considered to be significant."
00002225	Estimates at Completion	2014/11/26	N/A	The best measures to prevent inaccurate EACs is for the DOE project management team to conduct detailed reviews of the contractor's CPRs on a monthly basis. This allows project management teams to remain aware of cost and schedule performance trends.

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00002224	Installation of WEAR (Wire Energy Absorbing Rope) Pipe Restraints on Main Steam Piping for Vibration Suppression and Post Refurbishment Fatigue Life Extension	2014/11/26	Point Lepreau Generating Station	The turbine had been producing 610-620 MW(e) before the plant was shut down for the refurbishment outage. After refurbishment, the turbine is expected to return back to full power output, ie 680 MW(e) or higher. Higher vibration would be expected at higher power output based on plant operating experience. Upgrade of the existing MSL vibration pipe restraint system is required to control higher post-refurbishment MSL vibration.
00002223	Procurement trends and challenges: nuclear contracts to face greater scrutiny	2014/11/25	N/A	Procurement contracts are a work in progress with nuclear systems, turbine, civil and marine works, marine works, earthworks, and with mechanical, electrical erection and site enabling contracts.
00002222	Lessons from the London 2012 Construction Project	2014/11/25	London	The lessons include area such as engineering and design, planning, procurement and supply management, projects, sustainability, transport, and Archaeology.
00002221	Best Practices in the Management of an Operating Experience Programme at Nuclear Power Plants	2014/11/25	N/A	
00002220	Pickering Work Management Elevation Follow-up - NO-2014-108	2014/11/24	Pickering	Given these conditions, Elevation cannot be cleared at this time due to: •?13 week rolling average of 58% for 3k3 T-7 survival has not been met in the last quarter •?Corrective Action Plans evaluated were found to be ineffective and gaps identified have not been incorporated into the Work Management Business plan (as of August 12, 2014). Gaps identified in EOERs are captured in P-2014-20542 WM.1-1 AFI (P-2013-11143) and Nuclear Oversight Audit ~ NO-2013-012 (P-2013-03748) CAPs Ineffective a C2 ACE (AR#28170137).
00002219	Breach of Containment Events at Darlington Airlocks - NO-2014-219	2014/11/24	N/A	There were two insights initiated: 1. Consider; change the procedure (NK38-OM-21000A 4.2) usage classification from Information to Reference or in-hand for contract Staff. 2. Consider; adding a page to the CAL 68838 SAFE OPERATION OF AIRLOCK DOORS to explain the implications of a Breach as related to our Operating Licence, Reportability to the CNSC and Risk to Plant Personnel and Public.
00002218	Pressure Boundary (PB) Design Control including PB Procurement - NO-2014-020	2014/11/24	Darlington	There is one audit finding. Finding 1: Preparation, Review and Verification activities lack diligence. N-2014-22944 initiated C3 NFE S. Lawrence N-ESEMM.
00002217	Ops and Maintenance Fundamentals Low and Intermediate Level Waste - NO-2014-312	2014/11/24	N/A	There were four problem development sheets (PDS) initiated. 1.1 PDS No. 1 – Less than adequate safety culture (N-2014-22878, C3 L. Morton WNWLILWOD) 1.2 PDS No. 2 – Expired Electrical PPE in Service (N-2014-22873, C3 NFE M. Billington WNWMM) 1.3 PDS No. 3 - PDS #3: Non-Compliance with M&TE Governance (N-2014-22879, C3 M. Billington W-NWMM) 1.4 PDS No. 4 - PDS #4: Parts Unavailability (N-2014-22876, C3 NFE M. Billington WNWMM)
00002216	Environmental Management - NO-2014-314	2014/11/24	N/A	For WWMF groundwater inspection wells, there are no interim actions to address potential FME or groundwater ingress issues already identified for 64 wells. Additionally, there are no interimactions for 35 wells which have not been assessed due to accessibility issues – the condition of these wells remains unknown. There is however significant progress being made to address all WWMF well concerns through the Groundwater Monitoring Project (Project #80058).
00002215	Fleet Performance Assessing: Heavy Water follow up - NO-2014-309	2014/11/24	N/A	Performance in response to the 2012 HW audit has been effective, although gaps were noted in documentation at BHWP 1.1 PDS No. 1 – Gaps in documentation at BHWP
00002214	Nuclear Oversight Assessment Report: Management of Operations and Maintenance Fundamentals - NO-2014-311	2014/11/24	Darlington	This assessment has resulted in one Problem Development Sheet (no SCR generated) 1.1 PDS No. 1 - Darlington leadership team did not effectively identify cross cutting issues in Conduct of Maintenance and Operations
00002213	Ageing Related Events	2014/11/24	IAEA	The lessons learned presented in this Study may provide for further information to facilitate better understanding the current issues associated with equipment ageing; in particular specific ageing effects that were not detected on time by existing plant programmes (maintenance for active and ageing management for passive components) and that resulted in SSC failures.
00002212	Foreign Material Exclusion Practices in the Field: What Good Looks Like	2014/11/24	EPRI	The goal of this video is to demonstrate what preventive foreign material exclusion practices look like, using a real world example.
00002211	Foot Injury During Material Handling	2014/11/24	Robinson (PWR)	The supervisor knew the proper equipment to use when staging the steel beams but was complacent because this equipment had been used previously without incident. Since a prejob briefing was not conducted for staging the material, the workers did not have any operating experience to draw from to stop the unsafe worker practices used in the staging area. Additionally, the risks associated with moving the material were not discussed before staging the steel beams. The work crew deviated from the work plan and did not communicate this change to station management. Had the supervisor notified management that the crew was staging steel beams, additional oversight and perspective could have been provided to mitigate the potential for injury.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002210	Darlington Performance Assessing – DNR Engineering: NO-2014-200	2014/11/21	Darlington	This assessment has determined that, although still in-progress, the Change Management Plan has not been fully effective in implementing the modified ES-MSA Engineering Strategy as intended. Some activities critical to the success of the plan implementation are past their due dates.
00002209	2014 Q1-Q2 Aggregate Performance Assessment Review: NO-2014-318	2014/11/21	Refurbishment	The primary identified issue is incomplete/ineffective corrective actions and unsustainable performance. In some cases, the corrective actions were completed but the identified adverse conditions continue to exist in the field (M&TE) and in others (Work Protection) the fleet performance has not been sustained. A Nuclear Oversight assessment of Darlington Fuel Handling resulted in the release of the escalation.
00002208	Contract Administration Assessment NO-2014-310	2014/11/21	Refurbishment	The assessment has determined that N-PROG-AS-0007 Project Management and its associated governance is not effective in providing the guidance for carrying out contract administration and monitoring activities relating to contractors performing work for OPGN. In addition management expectations and/or directives have not been well established. As a result, OPGNs ability to prevent contractor events and demonstrate due-diligence with respect to contractors meeting or exceeding safety, quality and performance requirements has been reduced. This assessment has resulted in three Problem Development Sheets.
00002207	Fukushima Initiatives Audit - NO-2014-027	2014/11/20	Refurbishment	At Darlington, Pickering and NWMD-Nuclear Waste Low & Intermediate Level Waste Mgr (L&ILW) deficiencies continue in supervisor verification of work reports. There are requirements for the recording of M&TE under N-INS-09100-10012 Rev 005 and supervisors are to verify that the work reports contain pre/post use torque check values, final torque values and the recording of all M&TE devices used in Panel 305 or work reports as applicable.
00002206	CNSC staff's Integrated Safety Review -Plant Condition Assessment Type II Inspection Report	2014/11/20	Darlington	Four of the Action Notices required the quality problems with the CCAs to be evaluated to determine cause so that all of the affected CCAs could be identified and corrected. The scope of the investigation for SCR D-2013-20839 covered: 1- Finding #5 - CCA 's contain inadequate traceability/documentation of references. 2- Finding #6 - Use of unqualified staff for CCA preparation and review. 3- Finding #7 - Lack of review of CCA's screened out based on an equivalent Engineering Program. 4- Finding #8 - Technical adequacy of the CCA's
00002205	Nuclear Refurbishment Q3 2014 - SCR Trend Report	2014/11/20	Refurbishment	Analysis of the Q3 2014 SCRs trended by NR Alert Groups identified the same three adverse condition areas as Q2. They are; Quality of Engineering Products from Contracted Vendors 21% up from 16% in Q2, Delivery of OPG Engineering support 20% up from 15% in Q2 and Management of Contractors 10% down from 14% in Q2. For both engineering deliverables, this represents a relatively consistent number of events based on ratio of applied code vs SCR generation rate.
00002204	CNSC staff's Integrated Safety Review -Plant Condition Assessment Type II Inspection Report	2014/11/20	Darlington	The eight Action Notices AN01-AN08, were raised for the findings related to staff qualification, inadequate traceability/documentation of references, technical adequacy of CCAs and nonintent changes affecting CCAs conclusions.
00002203	Issues with outsourcing manufacturing/engineering	2014/11/20	N/A	There are 7 specific lessons discussed in the report. A significant problem noticed is the short sightedness of planning with results in the eventually failure of the business.
00002202	Hydrotreater project fosters enhanced risk evaluation process at PNNL	2014/11/20	N/A	Recognize when a proposal presents a high hazard potential and engage PNNL's Process Safety Board early (see Details section below). Communicate frequently with all stakeholders and involve qualified experts in hazards analysis/evaluation early in the process. To help assure sufficient rigor in conducting high-hazard operations, consider engaging a capability manager to coordinate and manage all phases of the work.
00002201	Assigning ownership of areas/projects/processes to multiple organizations	2014/11/20	N/A	This Program Sponsor is a critical member of the Program Governance Board, which may take the form of a steering committee, review board, board of directors or some other organizational construct. This is the board that is responsible for approving the business case for projects and programs and justifying the resources expended to deliver on them. The PM's in your organization is responsible for negotiating with the different stakeholders that own the resources required to perform the work to ensure the right resources are available at the right time.
00002200	Magnet Failure - Dry Storage Cell	2014/11/19	Cambridge Mfg	Procedures must be created for the use of magnets.
00002199	D-2014-31923:OPEX: Boiler Sulphate Excursion during RTS after refurbishment (COG OPEX Database No.51375)	2014/11/17	Pt. Lepreau	It is recommended that DND NR Chemistry, Performance Engineering, Operations and Projects review Pt. Lepreau OPEX and propose mitigation strategy to prevent such occurrence during DND restart after refurbishment. That may include introducing mandatory wipe down procedures for any secondary side refurbished component (replaced or refurbished) that may have been subjected to a coating containing sulphate.
00002198	SOER Evaluation Guideline	2014/11/18	INPO	Lessons and guidelines for the use of SOERs and other documents

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002197	Digest of Work Protection Code Events	2014/10/30	COG	First check - When performing action by yourself, call the dispatching facility and use equipment designators and/or be asked probing questions. Revised site procedure for Component Identification to not allow node numbers to be used as the sole source of component identification and to state that the alternate component identification process is not to be used for major/ large plant components. Addittional lessons can be fould in the document attached.
00002196	Recommendations for Managing an Effective Cathodic Protection System	2014/11/14	EPRI	Best nuclear practices guidance on specific tasks and frequency of tasks required to evaluate the effectiveness and efficacy of a CP system, with emphasis on steps to maintain system availability and operations.
00002195	Verify Worker Area Access	2014/11/13	N/A	Ensure software programs used to validate worker eligibility requirements are designed to perform that function, and include a validation of all requirements. Correct gaps in the understanding of eligibility validation processes so all personnel understand the actual capabilities of these software programs and especially what they do not perform. Ensure that worker training and qualifications are met by using the appropriate program (HSWET) for verification. This program is designed to be accessed by supervisors/managers and others that assign work, to ensure that all requirements are met prior to assigning job tasks to workers.
00002194	Staying Focused During Transition	2014/11/13	Hanford/All	During pre-job meetings focus your attention on clearly communicating expectations, including roles and responsibilities for the job, and then ensure your workers understand them before proceeding. Recognize when a complex activity is perceived as routine and bring the entire workforce back into focus for the task at hand.
00002193	Finger Injury from Fan – Ensuring Tools/Equipment Are In Safe State	2014/11/13	Z Area Fabrication Shop at the Savannah River Site	Inspect work areas for fans that have guard openings greater than one-half inch and remove from service any equipment that does not meet that specification. DOE LESSONS LEARNED Communicate to employees the importance of placing portable tools and equipment in a safe state before modifying or adjusting. Examples beyond shop fans included portable saws, grinders, drills, pneumatic nailers, etc. Reinforce personal protective equipment (PPE) usage. While PPE is our last line of defense, utilization of protective gloves for the handling and use of tools/material/equipment could have lessened the extent of injuries.
00002192	Slip, Trip, and Fall Hazards Increase as Weather Conditions Change	2014/11/13	N/A	With the tank farms presenting so many unique walking and working surfaces, several actions should be taken to help prevent accidents in the future. Communication needs to be full circle ensuring everyone involved knows of any changing conditions so they can be addressed properly. Mitigate hazards with non slip surfaces or through limiting access until the weather permits. Workers should not be permitted to work if hazards cannot be adequately addressed. Perform a review of walking surfaces (i.e. steel plates) and apply non skid paint to the walking surfaces identified as not having adequate non skid coating. Raise worker awareness for slip, trip, and fall hazards and methods to prevent injury through employee accident prevention councils, lessons learned, and the use of the slip simulator.
00002191	Selective Defuelling Delta P measurement not occuring before ZPH	2014/11/12	Bruce Power	PICKLESK 2007/11/25 Recommned 3C ACE to DPTBANFM to determine why activities were not completed as per the outage schedule and why other outage activities(e.g. power raise) were completd without this activity not being completed.
00002190	Defuelling 9hr Delay Critical Path Due to Stop with I/F in Air (D1041)	2014/11/12	Facility D: East shuttle pump room	MASURKED 2010/02/18 FHMM was notified and visual trouble shooting of the system was initiated. It was determined that the cause was a faulty accumulator in the shuttle hydraulic circuit. Repairs to made and the system was returned to service.
00002189	Defuelling Hardware Improvements – 2008 Refurbishment Outage	2014/11/12	New Brunswick	Based on AECL's recommendations the Defuelling Hardware design will be improved by completing the following: 1.Analyze the design (materials, tolerances, part interactions, etc…) 2.Computerized Modeling of the Defuelling Hardware operation 3.Fabricate Prototype Defuelling Hardware 4.Test Prototype Defuelling Hardware (visual and functional testing, dimensional verifications, cycle testing, etc…)
00002188	Negative Performance Trend with the Accuracy and Completeness of Documents and Records	2014/11/12	N/A	A potential negative trend was identified concerning the accuracy and completeness of documents and records. 366 Problem Evaluation Requests (PERs) initiated between October 2008 and March 2011 with noncompliance to 10 CFR 830.122 (d)(2), "Specify, Prepare, Review, Approve, and Maintain documents and records." The more significant issues involved: • Incomplete/Inaccurate information sent via Formal Correspondence to the DOE-ORP • Incomplete Software Life Cycle Documentation packages for Safety Significant systems • Numerous waste transfer documentation errors • Commercial Grade Survey Documentation Issues

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00002187	Metal/Non-Metal Mine Fatality	2014/11/12	United States	Establish traffic patterns to ensure safe alignment of vehicles with access equipment. Identify and control all hazards associated with the work to be performed and use methods to properly protect persons. Ensure that persons are trained, including task-training, to address the hazards associated with the work being performed. Always use fall protection when working where a fall hazard exists. Always be aware of your surroundings and any hazards that may be present.
00002186	Lessons from the London 2012 games construction project	2014/11/11	London, England	The Park project has shown that the changes in practice and behaviour that are required to deliver a low carbon, sustainable built environment are starting to occur. There is real and significant innovation happening in the construction supply chain, particularly innovation by manufacturers and suppliers. The Games has provided an opportunity for those manufacturers that are investing in research and development to improve the sustainability impact of their products, to gain a competitive advantage in the marketplace and to be rewarded by increased sales.
00002185	Importance of Looking Holistically at Corrective Actions	2014/11/11	N/A	Remove software from use pending resolution of documentation concerns and review previous calculations to ensure software has not adversely affected calculation results. Remove other software with the same or similar issues. Charter an Independent Review Board to perform software documentation reviews and approve any safety software placed operational in site inventory.
00002184	Code of Record Documentation	2014/11/11	N/A	Project Personnel and subcontractors need to ensure the SOW remains the main contract document to provide guidance throughout the life of the project, not only at project initiation. Documentation must include justification/rationale when a reference or revision to a reference used in the design process does not align with the SOW.
00002183	Workers Refine New Equipment and Process Prior to Field Implementation	2014/11/11	N/A	Ensure procedures and processes allow and recommend the use of realistic mock-up activities when implementing new equipment and/or processes Utilize worker expertise for developing training and implementing process improvements Encourage feedback between co-workers, management and vendors so that improvements can be implemented
00002182	Concrete-Health Effects	2014/11/11	N/A	Care must be taken when dealing with concrete and appropriate safety measure must be ensured.
00002181	Structural I-beam Failure	2014/11/10	Darlington	This is a legacy item - field work quality control and Field Engineering oversight at the time of construction failed to detect the deficiencies in construction.
00002180	Principles for Excellence in Nuclear Supplier Performance	2014/11/10	N/A	The document is intended to be a resource for nuclear suppliers and their customers and should be used in conjunction with other INPO documents, Advanced Process documents (for example, AP-930, Supplemental Personnel Process Description), and other standards applicable to specific projects and tasks. Suppliers should use the principles both to establish work processes and to assess existing work methods and programs.
00002179	Structural Integrity of the Fuelling Machine Shielding Doors under Seismic Loading	2014/11/10	N/A	To inform CANDU 6 stations of recently discovered issue of the low existing safety margin for the stability of the fuelling machine shielding door assemblies under seismic loading. This SIB is applicable to all CANDU 6 stations. It is not applicable to OPG or Bruce Power CANDU stations. Applicability is not limited to operating stations, but is dependent on what equipment important to safety has the potential to be damaged if the fuelling machine doors do not maintain their structural integrity. Note: Candu recommends further investigation for applicability and significance at each site.
00002178	Refurbishment of Wolsong 1, South Korea	2014/11/05	Wolsong, South Korea	Each team developed and tested processes so everything was ready and working when needed. The article provides a big picture of the entire refurbishment project from planning to the end of execution. It state the final numbers for cost, human resources, and time.
00002177	Project Status Reporting Workflow	2014/11/05	N/A	Communicate to the team and management: 1.How the project is doing against plan 2.What issues are currently being dealt with 3.What (potential) risks have identified and what is being done about them 4.What changes have made to the plan since the last status report 5.What impact recent events related to this project may have on other projects in the portfolio
00002176	Material Handling Dangers	2014/11/05	N/A	Work planning for material moves must include walk downs of the areas, review of collateral tasks that may affect work completion and result in working fatigue, and possible re-evaluations of work. Additional hazards analysis may be necessary to ensure that materials moves can be safety completed.
00002175	Operation and Maintenanace Experiences	2014/11/05	N/A	The report shows in depth information regarding Plant shut down, reactor disassembly, defueling, and plant start up. These can be source for lessons that can be learned but reviewing results of other plants.
00002174	Work Management Workshop	2014/11/05	DEC	The attachement contains the flip charts containg information on what was coverd during the workshop.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002173	Turbine Trip due to Spurious Activation of Sudden Pressure Relay on Main Output Transformer	2014/11/05	Darlington	Equipment degradation occurred (causing a forced outage) before planned replacement during the Darlington Station Refurbishmet outage.
00002172	Grid Distribution Line Trip Leads to Generation Rejection and Forced Unit Outage (SCRAM)	2014/11/05	Bruce A	The station is working with the Transmission System Operator (TSO) to improve the reliability of its electrical protection system equipment so that similar events can be prevented. The station is also taking action to improve its trip margin on indications of low boiler level after a turbine trip.
00002171	Conditions on Electrical Grid Cause Generation Rejection and Forced Unit Outage	2014/11/05	Bruce A	The station is working with the Transmission System Operator (TSO) to improve the reliability of its electrical protection system equipment so that similar events can be prevented. The station is also taking action to resolve several known equipment issues discovered from this event.
00002170	Year End Results and Board Assessment (2008/09) - Energie NB Power	2014/11/04	N/A	Tools used by NB Power can be checked for their usefulness and application to the Darlington Refurbishment plan.
00002169	Insight into Nuclear Decommissioning	2014/11/04	N/A	By studying the impacts of different events on other nuclear plants,we should be able to predict outcomes of similar events for OPG.
00002168	Reducing Events Resulting From Foreign Material Intrusion (SOER 95-01)	2014/11/04	WANO	Verify the work control process reinforces the implementation of FME controls. Prejob briefs should specifically address FME boundaries and special work controls. Work monitoring should be performed based on the importance of the task and the potential risk associated with foreign material intrusion.
00002167	Circuit Breaker Reliability (SOER 98-2)	2014/11/04	WANO	Preventive and corrective maintenance procedures, work package instructions, and drawing have, at times, lacked the technical guidance needed to conduct effective maintenance. Due to the complexity and diversity in circuit breaker designs, even knowledgeable and experienced maintenance personnel need accurate instructions and reference materials to successfully maintain circuit breakers.
00002166	Managing Core Design Changes (SOER 03-2)	2014/11/04	WANO	Perform risk evaluations when making significant changes to the core operating regime or fuel design. The evaluation should address the potential for anomalous core behavior and identify appropriate contingency plans and monitoring requirements. Review risk evaluation results and monitoring plans with a senior nuclear executive before proceeding with a significant change.
00002165	Emergency Power Reliability (SOER 03-1)	2014/11/04	WANO	Recommendations That Each WANO Member Is Expected To Address:Review existing emergency power system design for vulnerabilities to common cause and common mode failure. Verify the validity of existing analysis or conduct additional analysis as needed to assure that potential common cause and common mode failures are identified and addressed. Implement appropriate changes to system design as found necessary by this review. Other lessons to be learned can be found on page 20-33 of the attached document.
00002164	Reactor Trip Breaker Failures (SOER 83-8)	2014/11/03	WANO	Maintenance and Testing 1.The preventive maintenance program should include adequate periodic inspections and maintenance activities to ensure operability of the reactor trip breakers. The inspections should include, but not be limited to, examinations for: a)broken, missing, or deformed parts b)presence and tightness of fasteners c)freedom of movement d)proper alignment e)cleanliness and freedom from corrosion f)proper lubrication g)abnormal wear 2.Maintenance records for RTBs should provide a means for maintaining equipment traceability. If components are interchangeable, equipment serial numbers should be correlated with maintenance work and physical plant location. 3.Maintenance procedures for RTBs should include methods for performing periodic adjustments and any limitations associated with performing those adjustments. 4.Corrective maintenance for RTBs should include efforts to determine root causes of failures. As part of these investigations, through documentation of as-found conditions and any problems encountered during maintenance should be provided on the work control documents. When the root cause is determined, changes to prevent failures in similar equipment
00002163	Valve Inoperability Caused By Motor Operator Failures (SOER 83-9)	2014/11/03	WANO	Training 1.A training program on motor-operated valves should be established for maintenance and engineering personnel. This program should consider those items included in appendix a of the referenced inpo report (83-037). 2.Training on motor-operated valves should be provided for operations personnel and should include the following: a.construction and theory of operation of valves and valve operating mechanisms including functions of torque and limit switches b.limitations such as pressure, temperature, and maximum differential pressure for which valves are designed to operate c.valve operation including precautions associated with damage from use of excessive force when operating manually d.case studies of operational problems Procedures 3.Detailed maintenance procedures should be developed that address the following: a.operator assembly and disassembly by motor-operator model (for a sample procedure, see Appendix C of the referenced INPO report 83-037) b.operator to valve installation and removal by motor- operator model (for example, see appendix b of the referenced INPO report 83-037) c.replacement of valve packing. d.electrical setup, checkout, and adjustment of

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00002162	Bolt Degradation or Failure in Nuclear Power Plants (SOER 84-5)	2014/11/03	WANO	Administrative 1.Ensure that operating and maintenance practices require prompt repair of leaking pressure boundary joints in systems containing borated water. Procedures 2.Ensure that procedures governing the procurement of bolt materials provide the necessary controls on specification, certification, identification, receipt inspection, and handling. 3.Ensure that maintenance instructions define proper preload for bolted joints (for both pressure boundary and support joints) and establish methods for obtaining this preload during bolt installation. 4.Ensure that maintenance instructions or procedures for the assembly of flanged fittings in borated systems taken into account the considerations discussed above. Training 5.Training programs for maintenance, plant engineering, and quality control personnel should include the following: a.industry experience concerning bolt failures, including the effects of borated water leakage on closure bolts b.specification, verification, inspection and handling of bolt material c.proper assembly of pressure boundary flanged fittings d.establishment of proper preload in bolted joints (both pressure boundary and support)
00002161	Reactor Trips Caused By Turbine Control and Protection System Failures (SOER 84-6)	2014/11/03	WANO	Maintenance 1.The hydraulic portion of the turbine control system should be monitored and maintained as part of the plant's preventive maintenance program. Activities should include regular filter change out, fluid sampling, verification of backup pump operability, and other actions included in vendor maintenance recommendations. 2.The electrical portion of the turbine control and protection system should be maintained as part of the preventive maintenance program. Sensors, relays, and controllers should be calibrated and verified operable on a schedule consistent with vendor maintenance recommendations. 3.EHC System Tubing And Tubing Supports Should Be Inspected For Vibration During Normal And Anticipated Transient Conditions And Should Be Modified As Necessary To Minimize Failures Due To Cyclic Fatigue. 4.Work on turbine control and protection system components should not be allowed while the turbine is in service without specific approval by senior maintenance and operations group management. When such work is required, activities should be carefully planned and controlled to minimize errors. Training 5.Simulator training for control room operators should cover all aspects of
00002160	Valve Mispositioning Events Involving Human Error (SOER 85-2)	2014/11/03	WANO	Training 1.Train operators, maintenance and supervisory personnel in methods of determining the position of the various types of valves installed in the plant. This training should identify valve design features that may result in an erroneous determination. 2.Train operators, maintenance and supervisory personnel in procedures used to position and verify valve positions. This training should stress the need to comply with procedures and the need to identify incorrect procedures so that they can be corrected. 3.Review industry valve mispositioning events and discuss the events and lessons learned with operators, maintenance, and supervisory personnel. Encourage their input as to how plant individuals could prevent these events from occurring. This training should include factors that affect human performance, such as attitude toward the job, understanding importance of valve operation, and the need for paying attention to detail when manipulating valves. Additionally, training should alert personnel to unusual plant equipment, such as reverse operating switches or valves that could contribute to the likelihood of personnel error. Administrative 4.Normally, employ written valve manipulation orders for valves that can affect
00002159	Internal Flooding of Power Plant Buildings (SOER 85-5)	2014/11/03	WANO	Design and Analysis 1.Assess the vulnerability of safe shutdown systems to a complete loss of system function due to internal plant flooding. Vulnerability to both direct flooding and flooding of necessary support systems should be examined. Where the potential for a complete loss of system function due to flooding is found, implement corrective actions to protect essential equipment from flooding. Administrative 2.Perform assessments of flooding vulnerability as part of the plant design change review process. Assessments should determine if design changes would increase the potential for flooding, or locate essential equipment where it would be susceptible to flooding. Procedures 3.Ensure procedures or administrative controls that address the opening of water systems, such as circulating or service water, identify special precautions to be taken to minimize the risk of flooding. 4.Ensure that applicable plant emergency procedures and recovery plans adequately address the responses to plant flooding events and subsequent recovery. Training 5.Provide training to operations, maintenance, engineering, and supervisory personnel on identified flooding concerns and on appropriate

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00002158	Reliability of PWR Auxiliary Feedwater Systems (SOER 86-1)	2014/11/03	WANO	Administration 1.Monitor the operational performance of AFW systems, and take steps to improve identified weak performance areas. In particular, trend AFW equipment performance to identify AFW system problems and correct identified problems in a timely manner. Maintenance 2.Review preventive maintenance programs for motor-operated valves in the AFW system, including steam supply valves to turbine-driven pumps. This review should verify that torque and limit switch settings and setting calculations are applied correctly and that the performance of valve operators is monitored and trended. Testing 3.Test AFW pumps periodically under conditions and configurations expected during any operational event demand. This should include fast, cold starting of the pump; simultaneous and automatic starting of all pumps; and testing of the pump for various steam supply, condensate supply, and pump discharge flow configurations that may reasonably occur. 4.Review surveillance procedures to ensure that failures of instrument and control circuits associated with equipment in the AFW system, particularly automatic start logic circuitry and controllers for the flow control valves, are detected
00002157	Inaccurate Closed Position Indication on Motor Operated Valves (SOER 86-2)	2014/11/03	WANO	Identify motor-operated valves with remote position indication in which existing limit switch settings can result in a closed indication while the valve is actually partially open. Take action where necessary to prevent premature closed indication due to limit switch settings.
00002156	Public Performance Reporting	2014/11/03	N/A	This Guide will assist preparers and others responsible for performance reports by identifying report features and/or missing information that could influence a user's perception of the report's credibility and usefulness. For each feature, a reference to the related paragraph(s) in SORP-2 is provided. This guide is about the report itself, not the results produced by the entity for the public.
00002155	ALSTOM LP Erosion Protection Rings Presentation	2014/10/31	N/A	From examining the procedures used by vendors to review their products, OPG can ensure the vendors have the sufficient infrastructure to meet deliverables.
00002154	One year $600M delay for SCANA due to contractor being unable to deliver	2014/10/31	N/A	Delays caused by contractor unable to meet requirements must be prepared for within contingencies during the planning phase.
00002153	Vogtle Nuke Contractor dispute due to changes in regulation	2014/10/31	N/A	Ensure regulatory requirements are met in the planning phase. Research should be done into and proposed laws and requirements that may be implemented and can affect the NR project. Contingencies can be developed if there are risks of requirements being changed.
00002152	Inaccurate Closed Position Indication on Motor Operated Valves (SOER 86-2)	2014/10/31	WANO	1.Identify motor-operated valves with remote position indication in which existing limit switch settings can result in a closed indication while the valve is actually partially open. Take action where necessary to prevent premature closed indication due to limit switch settings.
00002151	Kemper County plant will cost at least another $496M to complete	2014/10/31	Kemper County	The project plan, schedule and cost estimates prepared during theplanning phase should include contingency where the scope and resource requirements are clearly defined. This will minimize delays and cost overruns during execution.
00002150	Automatic Reactor Trip Due to Loss of 400 kV Power Following an Arc Strike on the SF6-insulated	2014/10/31	Gravelines (PWR)	The cause of the transformer bushing arc strike was failure to comply with tolerances regarding the length of the expansion joint. Inspections of the phase 0 expansion joint showed that it was stretched too tightly (and thus insufficiently plugged in).
00002149	Inadvertent Reactor Trips Caused By Instrumental And Control (I&C) Problems (SOER 83-7)	2014/10/31	WANO	Initial and periodic reviews of maintenance and surveillance test procedures should identify sensitive steps where misapplications could easily lead to inadvertent reactor trips. Such steps should be appropriately flagged, cautioning personnel as to the potential impact of their actions while performing these steps.
00002148	DC Power System Failures (SOER 83-5)	2014/10/31	WANO	Review vital dc power system annunciator and monitoring systems available to the control room operator, and evaluate the need for the following: a.alarms 1)bus under voltage/over voltage 2)system ground fault 3)battery charger trouble 4)battery/battery charger input/output breaker positions b.battery capacity monitor (amp-hour meter) The report also includes on detailed and department oriented recommendations.
00002147	Check Valve Failures or Degradation (SOER 86-3)	2014/10/31	WANO	Maintenance 1.Establish preventive maintenance procedures (i.e., a test and inspection program) that identifies existing and incipient failures of check valves in appropriate systems. Based on industry experience, the following systems should be included in the program: •main steam •nuclear service water •auxiliary feedwater (PWR only) •diesel air start •suppression pool support (BWR only) •chemical and volume control (PWR only) •main feedwater •residual heat removal and low pressure injection Other systems should be added to the program based on in-house experience. The program should include a combination of the following elements to ensure check valve reliability: •Periodic testing to demonstrate that check valves will operate, i.e., open and close--If it is necessary that the check valves prevent backleakage, this should also be tested. •Surveillance monitoring (i.e., acoustic and vibration analyses) to identify seat leakage and other developing problems •Disassembly and inspection on a sampling basis to ensure check valve internals are intact and are not experiencing abnormal wear Design 2.For those check valves included in the program discussed in Recommendation 1, perform a design review of the

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00002146	Steam Generator Tube Ruptures Caused By Loose Parts On Secondary Side (SOER 82-12)	2014/10/31	WANO	1.A program should be implemented for the surveillance of the secondary side tube sheet of steam generators for loose parts using fiber optics, by video or other appropriate techniques. Such inspection for loose objects should be conducted during the next appropriate outage. Subsequent inspections should be performed following major secondary side steam generator maintenance and when loose objects are suspected.
00002145	Core Damaging Accident Following An Improperly Conducted Test (SOER 87-1)	2014/10/31	WANO	Administrative/Management Controls 1.Ensure positive management control of special tests and other non-routine plant evolutions through actions that include the following: a.Plant management review and approval of special tests is required prior to initiation. b.Clear lines of authority and responsibility are established for special tests. c.The required level of management and/or supervisory oversight is specified for the conduct of special tests and other non-routine evolutions. d.Necessary technical support at the appropriate level is available around the clock for special tests. Some or all of these controls may be specified in the test procedure document (see item 2 below). Test Procedures 2.All procedures for the conduct of special tests, as well as changes to these procedures (including procedures to test plant modifications, as appropriate), should be prepared and reviewed by persons with the necessary technical expertise. This applies to tests and temporary modifications on balance-of-plant systems that might affect plant safety. Ensure that such test procedures include the following: a.Clearly defined purpose, scope, and applicability b.Detailed prerequisites and initial conditions for the overall test and
00002144	Turbine Generator Exciter Explosion (SOER 82-9)	2014/10/31	WANO	Plant procedures should be developed to monitor and trend hydrogen gas usage. The procedures should also provide guidance on what actions should be initiated when gas usage exceeds a specified level. Plant personnel should be trained in the explosive fire hazards of hydrogen and made aware of those areas where hazardous gas mixtures could exist through use of warning signs or other means. A review of the generator exciter cowling should be made to ensure that capturing of hydrogen gas in closed spaces is prevented or minimized.
00002143	Reactor Coolant Pump Seal Failure (SOER 82-5)	2014/10/31	WANO	Plant personnel should be trained and qualified for RCP seal maintenance to ensure quality work and minimize radiation exposure per ALARA program requirements. (Consider using seal mockups, vendor training or job performance aids to improve expertise.) Utilities should consider establishing criteria to determine maintenance and inspection periods. Information exchanges on seal operating performance with vendors and other users could facilitate the definition of these criteria.
00002142	Auxiliary Feedwater Piping Overpressurization (SOER 82-3)	2014/10/31	WANO	The referenced events demonstrate the vulnerability of AFW suction piping to overpressurization when the suction piping is isolated, unless the piping is designed for full pump discharge pressure. AFW systems utilizing motive powered valves and/or check valves in the suction piping are vulnerable to this type of event.
00002141	Pipe Failures In High Eenrgy Systems Due To Erosion/Corrosion (SOER 87-3)	2014/10/31	WANO	1.Perform an engineering review to identify all piping sections in high-energy (greater than 200 degrees Fahrenheit) systems that are potentially susceptible to erosion/corrosion wall thinning. The review should accomplish the following: •Establish which high-energy systems have piping that is potentially susceptible to erosion/corrosion. •Within each system, identify those piping sections that are susceptible to erosion/corrosion. •For each identified section, determine where individual wall thickness measurements should be made. •Establish pipe section inspection methods. •Establish pipe section inspection frequencies based on the magnitude and rate of wall thinning. •Establish pipe section replacement criteria based on the amount of allowable wall thinning. Maintenance and Initial Inspection 2.Implement an ongoing inspection program for those piping sections identified as potentially susceptible to significant erosion/corrosion. The inspection program should be designed to detect the onset of pipe erosion as well as the rate of pipe wall thinning. Conduct extensive spot checks of pipe sections considered most susceptible to erosion/corrosion to identify if unacceptable wall thinning has already
00002140	Radiation Overexposure of Maintenance Personnel (SOER 82-1)	2014/10/31	WANO	Reliable water level information should be available in the control room and on the refueling floor while in-vessel activities are underway. One method of achieving this in a BWR is to modify one of the feedwater control system level transmitters to provide fuel zone indication. Utilizing this same transmitter, install a temporary level indicator and alarm unit on the refueling floor.

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00002139	INSTRUMENT AIR SYSTEM FAILURES (SOER 88-1)	2014/10/31	WANO	Operations 1.Provide procedures to assist operators in the identification, control, and recovery frompartial or total loss of instrument air events. Operating, abnormal, and emergencyprocedures should provide the following: ?indications of loss of instrument air; that is, alarms, automatic actions,functions lost, and so forth ?identification of critical components operated by instrument air and theposition in which they fail SOER 88-1, Rev. 1 Instrument Air System Failures Page 12 of 16 ?expected system and plant responses to a loss of instrument air and theconsequences of these responses ?actions to take if critical components do not fail in the intended position ?manual actions the operator should be expected to take to respond to a loss ofinstrument air event ?restoration actions to be taken after instrument air is regained Training 2.Provide classroom and simulator training on loss of instrument air events tooperators. This training should provide the bases for such things as failure modes ofcritical components and expected operator action, so that operators will understandthe major concerns involved in a loss of instrument air event. Simulator trainingshould illustrate such items as the following: ?transients
00002138	Desiccant Carry Over To The Instrument Air System (SOER 81-9)	2014/10/31	WANO	Plants should reviewed their procedures and designs and modified as necessary to ensure that: The desiccant within the drying towers is inspected by use of telltale indicators, observation ports, desiccant samples or other suitable means and replaced on a schedule specified by the manufacturer to avoid degradation into small-sized particles.
00002137	Testing of Steam Turbine/Pump Overspeed Trip Devices (SOER 89-1)	2014/10/31	WANO	Testing 1.Develop and implement periodic testing requirements that demonstrate the operability of all overspeed trip mechanisms supplied with the turbine. A.For Terry (Dresser-Rand) turbines these tests should include the following: 1)Conduct setpoint verification testing once per refueling cycle or more frequently if needed. 2)After maintenance which has the potential for affecting the overspeed trip setpoint is conducted, post- maintenance testing should include verification that both the mechanical and electronic (if supplied) overspeed trip mechanism setpoints are correct by actual functional testing. CAUTION: In order to minimize the possibility of damage during testing, measures such as the following should be taken: •Electronically verify the operability of the electronic overspeed trip device (if supplied) prior to overspeeding the turbine. •Use manual control of steam pressure to allow a slower approach to the speed at which the trip is expected. Additional control can be achieved by the use of reduced steam pressure or compressed air as the motive force. •Decouple the pump from the turbine to prevent a discharge piping overpressure or damage to the pump. 3)Conduct overspeed trip mechanism freedom
00002136	Spurious Actuation of Safety/Relied Valve (SOER 81-8)	2014/10/31	WANO	Reviews should be conducted to identify adverse component failure modes which may occur as the result of unusually high pneumatic control system pressures. Plants which utilize either Target Rock Model 7567F (2-Stage) or Target Rock Model 67F (3-Stage) safety/relief valves should ensure that applicable procedures address operator actions in the event of development of unusually high pneumatic control system pressures.
00002135	Ground Faults on AC Electrical Distribution Systems (SOER 90-1)	2014/10/31	WANO	Maintenance 1.Include provisions in the preventive and/or predictive maintenance programs to periodically inspect electrical busses and electrical distribution systems. This includes the switchgear (4160 volts or above), main generator, and the connections to the main and auxiliary (startup) transformers. Inspections should include the following: •verifying the cleanliness and environmental conditions of the electrical busses •checking the integrity of the bus connections by inspection for indication of problems such as loose connections, localized hotspots, and corrosion •ensuring the proper calibration of the selected protective relays and instrumentation •verifying that electrical characteristics such as insulation and connector resistance are within design parameters The components covered should include the bus insulators, bus ducts, disconnect switches, transformer bushings, grounding transformers, grounding resistors, and ground detection systems. Periodicity requirements should be based on available vendor recommendations and plant and industry electrical distribution system experience. 2.For groups performing maintenance on electrical distribution systems, establish clear functional responsibilities
00002134	Partial failure of Control Rods to Insert (SOER 80-6)	2014/10/31	WANO	Since designs and conditions vary from plant to plant, it is recognized that any one set of specific recommendations cannot apply to all BWR plants. Therefore, these recommendations are presented as objectives which should be attained, with examples of possible ways to achieve these objectives.

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00002133	Nuclear Instrument Miscalibration (SOER 90-3)	2014/10/31	WANO	Operations/Training 1.Provide control room personnel with the procedures and the supporting training necessary to detect and respond to miscalibrated nuclear instrumentation. Careful consideration and caution should be exercised before adjusting nuclear instrumentation down to match other indications. Such adjustments should only follow a full investigation and comparisons with other power level instrumentation and indications. a.Startup and power ascension procedures should be reviewed and changed as needed to include the following: •Following refueling, relocation of nuclear instruments, or other modifications affecting nuclear instrumentation response, provide for conservative adjustment of the nuclear instrumentation (so that there is confidence that the nuclear instrumentation indication is equal to or higher than actual power and the reactor will scram before actual power exceeds the design limit). Alternatively, provide for an adequate reduction of scram setpoints and limitation of reactor power until the accuracy of the nuclear instrumentation is verified. •Provide for periodic comparisons of alternate indications of power, including comparison to at least one indication independent of calorimetric
00002132	Stud failure In Anchor Valves (SOER 80-3)	2014/10/31	WANO	If you have Anchor Valves with type 416 stainless steel studs in safety-related system: 1. Determine if the studs comply with the specified ASTM codes by either documentation or test. 2. If necessary, replace the noncompliant studs.
00002131	Intrusion of Resin Lubrication Oil, And Organic Chemicals Into Reactor Coolant Water (SOER 82-13)	2014/10/31	WANO	Plant administrative procedures should establish controls to preclude the entry of organic chemicals into the reactor coolant system and for usage of organic chemicals on reactor coolant system piping and components. (Examples of controls include "approved consumable material lists" and various NSSS vendor manuals for approved materials and processes.) Plant chemistry programs should provide procedures and equipment necessary to detect and analyze reactor coolant system water for potential organic chemicals at low concentrations. Plant procedures should address actions to be taken in the event of excessive unexplained lubricating oil loss.
00002130	Plugging of Floor Drains In Energency Equipment Rooms (SOER 80-2)	2014/10/31	WANO	Recommendations 1.Normal plant operating procedures should preclude intentional plugging of floor drains especially in vital equipment areas. 2.It is understood that there will be specific instances when intentional plugging is required. These cases should be governed by administrative procedures.
00002129	Reducing the Occurrence of Plant Events Through Improved Human Performance (SOER 92-1)	2014/10/31	WANO	1.Administration a.Ensure active line management involvement in identifying and eliminating the causal factors of human performance problems. The following key tasks should be addressed by line management: •fostering an environment that encourages timely reporting of potential problems, nonconsequential events, and suggestions for improvement •monitoring human performance on an ongoing basis, including nonconsequential human performance problems, to facilitate the prevention of more significant problems •investigating consequential human performance problems or adverse trends in nonconsequential events to determine root cause(s), generic implications, and necessary corrective actions •implementing corrective actions that address the fundamental causes of human performance problems, rather than the symptoms of the problems •evaluating the effectiveness of corrective actions to verify that the root causes have been accurately identified and corrected b.Perform multidisciplinary investigations of events involving procedure-related human performance problems. The investigations should involve line management, supervision, affected work groups, and training and should
00002128	Loss of Redundant Emergency Diesel Generator Starting Air System (SOER 80-1)	2014/10/31	WANO	If you have independent Air Start Systems and do not test them independently: 1. Test each starting air system independently as soon as possible. 2. Revise surveillance procedures to require independent and simultaneous testing of each starting air system on an alternating basis at a frequency consistent with the technical specifications.
00002127	Nonconservative Decisions And Equipment Performance Prolems Result in a Reactor Scram (SOER 94-1 R1)	2014/10/30	WANO	•Conservative operational decisions, including removing the main turbine from service and especially initiating a manual reactor scram, should be made without hesitation when faced with uncertain or degrading conditions that affect the reactor. Management support for conservative decision-making during plant operation must be communicated in clear and unequivocal terms and frequently reinforced.

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00002126	Conduct of Infrequently Performed Tests or Evolutions (SOER-91-1)	2014/10/29	WANO	Management Controls for Infrequently Performed Tests or Evolutions 1.Establish controls to ensure that the expectations of management are met during infrequently performed tests or evolutions that have the potential to significantly degrade the plant's margin of safety. Station policies and procedures should include the following: a.definition of infrequently performed tests or evolutions that warrant additional management oversight and controls. A means to periodically review and update this definition to ensure that subsequently identified tests or evolutions receive this additional management attention prior to their performance. This definition should include the following: •evolutions not specifically covered by existing normal or abnormal operating procedures •evolutions that seldom are performed even though covered by existing normal or abnormal procedures (for example, plant startup after a prolonged outage or after any outage that involves significant changes to systems, equipment, or procedures related to the core, reactivity control, or reactor protection) •special, infrequently performed surveillance testing that involves complicated sequencing or placing the plant in unusual configurations
00002125	Reducing Events Resulting from Foreign Material Intrusion (SOER 95-1 R1)	2014/10/29	WANO	Review station guidance to verify that management expectations for foreign material exclusion (FME) controls and practices are clearly established and communicated. Verify the work control process reinforces the implementation of FME controls. Prejob briefs should specifically address FME boundaries and special work controls. Work monitoring should be performed based on the importance of the task and the potential risk associated with foreign material intrusion.
00002124	Eight Powerful Project Performance Reporting Processes	2014/10/29	N/A	The main objectives of a performance report are: •Progress on deliverables •Progress on milestones •Activities •Cost/Budget Analysis •Quality Management Results •Risk and Issues The report should be written considering the audience, including forecasts, addressing key questions.
00002123	Complexity Praxis Framework	2014/10/29	N/A	Complexity models can work well in a closed environmental, like an organization may develop a complexity model based on its own frame of work. This can help make decisions like matching a project with a project manager or much to invest. Ultimately the point of complexity is to understand the diversity of work.
00002122	COAA Major Projects Benchmarking Summary	2014/10/29	Alberta	Productivity is better on Alberta for some disciplines but worse in others. The results are also influenced by the difference in pay when compared to the US industry. The benchmarking initiative can be used by any company that submit their data to compare them to their Alberta and US counter parts.
00002121	Project Planning Guide	2014/10/27	N/A	The guidegoes over the follwing points:What's Important and When Pre-Planning PhaseFeasibility Study Phase Program Development Study Phase
00002120	Finding the Right Fit	2014/10/27	N/A	The information in this booklet has been put together to help with human resource needs related to recruitment, hiring and retention of employees.
00002119	Shutdown of Unit 1 and Unit 2 Caused by Jellyfish Flooding into Water Intake of Circulating Water Filtration System	2014/10/27	Hongyanhe (PWR)	The direct cause was jelly fish ingression. Push forward the design institute to improve design and installation of trash prevention facilities at the water intake for Phase I Project.
00002118	Fuelling Machine Bridge Moved Unexpectedly	2014/10/27	Pt Lepreau	Post event analysis determined that the failure mode was determined to be a faulty encoder. Fueling Machine Encoders may have surpassed their reliable service life and replacement should be considered.
00002117	Nuclear Plant Makeup Water Chemistry Guideline: A Gap Analysis	2014/10/27	EPRI	This report is applicable to nuclear power plant and station personnel in applicable guidance related to makeup water treatment. •The results reveal that significant guidance related to makeup water treatment design and operation is found in the fossil station guidelines. •The results also point to certain makeup water treatment effluent chemistry limits that can be found in other documents available to the industry.
00002116	5 Steps For Managing Project Risk	2014/10/27	N/A	The questions to askthat help manage risks are: Step 1: Where are the risks? Step 2: What is the impact? Step 3: What can you do? Step 4: Who is responsible? Step 5: What's next?
00002115	The Remedy for Repetitive Project Pain	2014/10/24	N/A	Always document communications. Especially for a large project that may evolve over 3-plus years and involve 25 different contacts. Create and confirm a clear line of communication. Once you're assigned a project as project manager, you must create a clear line of communication. You must notify the primary contact of your role.
00002114	Decision Making Models in Project Management	2014/10/24	N/A	Time, cost and scope are the triple constraints of any project. A project managershould understand the needfor effective tools which can be used all through the life cycle of project management.
00002113	Reusable PPE Performance Degrades Over Lifecycle	2014/10/20		Performance characteristics of reusable anti-contamination clothing can degrade during the clothing's lifecycle.
00002112	Using a Personal Electronic Dosimeter in a High Noise Environment	2014/10/20		When wearing a personal electronic dosimeter, it is essential to wear the dosimeter in a manner that allows the user to detect the built-in audible and/or visual alarm in a noisy environment.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002111	Offsite Response Planning with Interface Agencies	2014/10/20	N/A	Two facility EPHAs documented that the release of HAZMAT had a distance to PAC of 5 miles, more than doubling the current 2-mile offsite PAR and offsite planning. Additionally, the site lacks an EPZ that, when implemented, will necessitate additional offsite emergency planning with state and county agencies to reflect the EPHA consequence assessments and bounding event scenarios for the site.
00002110	Top Industry-Shaping Events	2014/10/20	N/A	Major nuclear incidents can cause public confidence and support to weaken. Human factor designs within control rooms can be made to assist operators. Improved abnormal and emergency procedure guidance was provided for switching power supplies and restoring power to affected buses when power is lost to instrumentation
00002109	Fuel Handling Events (SER 2004-2)	2014/10/20	WANO	Continued emphasis is needed to ensure fuel movement procedures and administrative controls governing equipment interlocks are rigidly enforced. Supervision and oversight must be commensurate with the risks involved. The potential for error increases with repetitive tasks, and supervision must remain vigilant.
00002108	Errors in the Preparation and Implementation of Modifications (SER-2005-3)	2014/10/20	WANO	The following events led to the errors during operation: Insufficient knowledge and skills with new technology Inadequate failure modes and effects analyses (FMEA) Inadequate scope and depth of postmodification testing Overreliance on the expertise of supplemental personnel
00002107	Gas Intrusion in Safety (SER 2005-1)	2014/10/20	WANO	Valve leakage was a common cause, including leakage through multiple isolation valves in series. Criteria for filling and venting systems were not clearly described in procedures and relied on operator knowledge.
00002106	Safety System Status Control (SOER 98-1)	2014/10/17	WANO	Numerous administrative processes -- methods of doing business -- influence the way nuclear power plant personnel maintain awareness of and control plant operational activities. In addition to providing an administrative framework, strong administrative control processes collectively can provide effective and diverse multi-layered barriers or defences to the occurrence of events. Most plants have specific administrative control processes for establishing and maintaining system status control. However, other plant administrative processesand programs, such as work control, outage scheduling, outage testing, and postmaintenance testing, can also affect system status. Weaknesses in these administrative processes or in the interfaces among these processes have contributed to the loss of system status control and have resulted in unplanned impairment of safety systems.
00002105	Unplanned Radiation Exposures (SOER 2001-1)	2014/10/17	WANO	One of the most important administrative controls in protecting workers from unplanned radiation exposure is the radiation work permit process. Radiation work permits ensure that appropriate radiological risk assessments are performed and that protective actions are specified, prior to the worker ever arriving at the job site.
00002104	Shutdown Safety (WANO SOER 2010-1)	2014/10/17	WANO	To ensure sufficient safety margins, the key safety functions defined in WANO 08-001, Guidelines for the Conduct of Outages at Nuclear Power Plants, must be maintained. The key safety functions are decay heat removal, reactor coolant inventory control, electrical power availability, reactivity control, and containment. Installed systems, and any necessary support systems, must be available to provide these key safety functions in order to ensure shutdown safety. Industry experience has demonstrated that insufficient defence-in-depth will result in events that challenge shutdown safety.
00002103	Rigging, Lifting and Material Handling (WANO SOER 2008-1)	2014/10/17	WANO	Stations need to gain assurance that their programmes and processes are sufficiently comprehensive to ensure high levels of performance by workers and equipment, and to avoid problems that could lead to more serious events.
00002102	Intake Cooling (SOER 2007-2)	2014/10/17	WANO	This SOER recommends that utilities perform an aggregate assessment of site-specific intake blockage scenarios and include a review of the environmental changes that have occurred since original station construction; improve monitoring and prediction methodologies to anticipate intake cooling water blockage; review the adequacy of intake structure, component and associated system design features based on station and industry operating experience; implement maintenance strategies to ensure reliability of intake cooling water systems; and upgrade operations procedures and training to prevent or mitigate intake cooling water blockage events.
00002101	Reactor Pressure Vessel Head Degradation (WANO SOER 2003-2, Rev 1)	2014/10/17	WANO	The CRDM nozzle leak and the wastage in the RPV head went undetected for several years, although symptoms of leakage and corrosion were present. These symptoms were not fully investigated because the station organisation, although aware of the potential for CRDM nozzle leakage, was confident that leakage was not occurring, despite the inability to examine the RPV head area near CRDM nozzle 3. Organisational weaknesses did not cause the CRDM nozzle leak, but they did affect the station's ability to identify, evaluate, and correct the leakage before the RPV head was seriously damaged.

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00002100	Reactivity Management SOER | 2007-1 Rev 1	2014/10/17	WANO	The main cause of reactivity-related events continues to be personnel performance at nuclear stations. In many of the analysed events, operators relied solely on the reactor protection system to protect the core without taking pre-emptive conservative actions. The potential consequences of improper core reactivity management can be nuclear fuel or reactor core damage as described in WANO Report, In-Reactor Fuel-Damaging Events – A Chronology 1945-2003.
00002099	Severe Weather (SOER's 2002-1 Rev 1)	2014/10/17	WANO	The lessons learned from these events and good practices are the basis for the recommendations in this SOER. The recommendations address severe weather in terms of the preparation and the decision making processes when severe weather occurs.
00002098	Release of Tritium Activity Through Storm Drain	2014/10/16	Narora (PHWR)	The event highlighted the importance of having a procedure for transfer of liquid radioactive waste from mobile tanker to downgraded heavy water storage tanks and the need for including the barriers in liquid waste handling systems in preventive mainetenance and surveillane programs.
00002097	Failure of Control Rods to Insert on Demand (SER 2009-1)	2014/10/15	WANO	Always ensure sufficient conservatism in the design. Stational personnel should be aware of specific design requirments applied.
00002096	Delays with constructing new TTC streetcar facility	2014/10/15	Toronto	Poor geological study resulted and planning of resources caused the delays. Contractors should be scheduled before execution for the duration of the project.
00002095	Temporary Air Compressors Trip During Reactor Building Leak Rate Test	2014/10/15	Pt Lepreau	Increased air density in a pressurized environment increases the load on electrical motors resulting increase in current draw.
00002094	Industrial Safety Events	2014/10/15	COG	Lack of focus on the task at hand resulted in a trip and fall with injury. The individual was coached and counseled on personal accountability for safety. Inadequate communication contributed to inadvertent closure of a security gate and injury of a security officer. More in document
00002093	Eventual Reactor Flux Measurement Unavailable if Shutdown	2014/10/15	Embalse (PHWR)	The Operating Manual MO 63700 does not specify when start-up instrumentation must be installed and connected to the SDS#1 trips. No specific risk assessment was performed
00002092	Segments of Installed Emergency Diesel Generators Power Packs with Different Material	2014/10/15	INPO	Contractor procedure includes the requirements for spare parts installation, including Quality Assurance (QA) approval, and documentation that must be preserved for inspections. Contractor and plant personnel failed to comply with these procedure requirements since the spare parts installation was not approved by QA personnel and the documentation was not preserved.
00002091	Bruce Nuclear Power restart lessons	2014/10/15	Bruce Power	By successfully completing numerous first-of-a-kind engineering accomplishments through innovation, transforming its workforce through new hiring and training, and positioning the site for long-term stability to achieve the province's environmental goals,
00002090	NEPG Overhead Door Emergency Drop Stop Installation	2014/10/15		Dealt directly with door sub-contractor as prime to avoid additional project management fees from a General Contractor. This approach resulted in more time spent to manage the contractor with respect to OPG policies and procedures (ie Change process, EPSCA, etc) resulting in higher PM costs in the end.
00002089	Limitations of Testing Practices Diminish Robustness	2014/10/15		Sites should review the testing procedure and/or checklist for their emergency communication systems to ensure that all systems are included. The testing procedure and/or checklist should include the frequency (e.g., weekly or monthly) and testing methodology for each system.
00002088	System Capabilities and Testing and Maintenance Program	2014/10/15		To ensure the reliability of the backup power systems that sites rely on to power important equipment sitewide, sites should designate an AHJ to review all fixed backup power systems and establish the appropriate NFPA-110 or NFPA-111 test and maintenance program or optional standby system requirements.
00002086	Abitibi Canyon G3 Turbine up-Rate Lessons	2014/10/15		Delays causedshould be included as a contingency. No project can be done entirely with internal resources. Consumables can beunderestimated. Lack of in depth experience on generators at times caused delays for research and consultations.
00002085	Nipissing Penstock Removal Installation Project	2014/10/14	Powassan	Lessons Learnt include the following departments: Engineering Permits Project execution and more.
00002084	Writing a Good Lessons Learned Statement	2014/10/14	N/A	Recommended Structure for a Lessons Learned Statement should be used to maximize readers.
00002083	How to achieve more timely, accurate and transparent reporting	2014/10/14	N/A	A smart, efficient closing cycle creates a foundation for evaluating performance and supporting business decisions. problem areas include: Lack of speed Insufficient accuracy and/or control Dependence on manual processes Ineffective decision support
00002082	Escalation Estimating: Lessons in Addressing Market Demand	2014/10/14		using best practices which we summarized as follows (with the last bullet added this year): • get economists (or at least their input) on board; • use probabilistic methods; • estimate and manage escalation and contingency distinctly; • use timely market intelligence that is specific to your industry (and address the fact that our market is capex-driven); and • work with business on developing shared market scenarios.

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00002081	Guidelines for Nuclear Power Heavy Water Reactors	2014/10/14		There are four major phases, as follows: • PLiM pilot project phase • PLiM assessment phase provides the methodologies and studies dealing with critical systems, structures and components, which could affect life attainment or extension • Plant life attainment programme which is essentially the implementation phase of the PLiM programme. • Plant extended operation (or plant life extension) programme.
00002080	Total Cost Management Framework	2014/10/14		The TCM Framework's structure will provide consistency and support development. TCM Framework addresses strategic asset cost management practices in business and capital planning, operations and maintenance, and product cost management.
00002079	Identifying Risks in Operations	2014/10/14	N/A	When formulating a risk statement, the operations staff should consider the root cause or originating source, of the risk condition. Understanding root causes can help to identify additional, related risks. There are four main sources of risk in IT operations: People Process Technology Environment
00002078	Standards & Procedures for Project Monitoring	2014/10/14		Provides project-specific instructions for such things as: • weekly status reporting, • time reporting, • project tracking, • revising project work plans, • earned value reporting.
00002077	Resource Managment	2014/10/14		
00002076	Project Management Monitoring and Controlling Tools	2014/10/14		Tools and techniques that are used by project managers to conduct the Monitoring and Controlling of a project fall into one of four general categories. The first is the collection of project performance information. Techniques supporting this category are Pulse Meetings, Variance Reports, and Program Reviews.
00002075	Predicting Project Performance: Evaluating the Forecasting Accuracy	2014/10/14		During each project simulation run, the periodic time and cost performance of the project is measured using Earned Value Management data which are then used to predict the final duration and total real cost of the projec
00002074	Guide to Lessons Learnt Review	2014/10/14		By involving all contract parties and key stakeholders we are able to identify what went well and not so well so as to improve future project delivery.
00002073	Project Portfolio Management Tools: Priority Systems	2014/10/14		
00002072	Case Study: Importance of Radiation Protection Controls	2014/10/14	Windscale, Cumbria	The case highlights the need for proper preparation and monitoring of transport packages. Adhering to approved container preparation procedures would have detected the omission of the shielding bar before the radioactive material was loaded to the package.
00002071	Case Study: Contamination of Workers	2014/10/10	Czech Republic	After any hazardous operation with open sources it is necessary to control daily the personal clothing and protective aids. Contamination of the body surface may considerably interfere with the in vivo measurements of alpha emitters.
00002070	How to accurately estimate and forecast in project management	2014/10/10	N/A	Projects can be better maganed by follwoing four essential steps. 1: Clarify the project priorities 2: Ensure planning allows for proper and complete estimate 3: Apply lessons Learned 4: Don't make the team's plan fit the managment's guesses
00002069	New Generator, Turbine Overhaul	2014/10/10	OPG Niagara	Various lessonslearnedare indentified dealing with organization structure, stakeholder involment, P&C participation, change control, cost estimation, supply chain, communication, turnover process, scheduling. Document also provides detailed descriptions of problem and recommended solutions.
00002068	Project Status Reporting	2014/10/10		Effective communication is a component of successful project management and is eighty percent of the job. Dealing effectively with communication issues the probability of the project success increases.
00002067	Best Practices in Contract Management	2014/10/10	N/A	Cantracts can be better managed by understanding theprocess thatcan be analyzed using a six-phase model. These six phases include Procurement Planning, Solicitation Planning, Solicitation, Source Selection, Contract Administration, and Contract Close-out
00002066	Risk Managment Guide	2014/10/10		This guide has been structured to provide a basic understanding of risk management concepts and processes. It offers clear descriptions and concise explanations of core steps to assist in managing risks in acquisition programs. Its focuses on risk mitigation planning and implementation rather on risk avoidance, transfer, or assumption.

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00002065	Refurbishments and Life Extentions	2014/10/10	Candu Refurbishment Projects	While the Pickering A Retube experience is now over a decade old it is still directly applicable to the challenges before us. We must learn from our history and each other in order for the Industry to succeed. As Industry leaders we set the 'end' that we want the people to focus on. We set the tone of co-operation and sharing or autonomy that our people align to. We cause the Industry to succeed as an integrated entity or struggle as discrete components.We have a task in front of us that is bigger than anything we have dealt with in the history of the Industry. It has taken us 3 decades to enhance our performance to the point where nuclear energy has emerged as an energy choice that the Public and our business stakeholders see as worth `reviving'. The environment of our children and our successors depend heavily on the decisions we make and how we work together to make the next three decades successful and not a repeat of the last 3. There can be no winners and losers. We all have to win. Our industry will always be just one event away from extinction. So as leaders of the Nuclear Renaissance: — Have you set the right 'end in sight' for your part of the Industry? — Have you invested
00002064	Earned Value Management: Forecasting project outcome	2014/10/10	PM Knowledge Center	In this article, the EVM forecasting approach to predict the final project duration and cost, given the current project performance, is discussed. The basic assumption of project forecasting in EVM is that the current project performance, measured by the SPI and SPI(t) metrics for time and the CPI for cost, is representative for future performance and is therefore used to predict the final duration and cost of a project.
00002063	Loss of Offsite 230 kV Synchronization Breaker Results in Actuation of Shutdown Systems and Forced Outage	2014/10/06	Bruce A	T2L27 failed as a result of degraded pressure switches and misaligned pallet switches. The station is using the lessons it learned from this transient to enhance switchyard breaker monitoring capabilities, improve operating procedures, enrich simulator training, and take action to correct a reduced trip margin deficiency.
00002062	Offsite Protection System Failure Results in Actuation of Shutdown Systems and Forced Outage	2014/10/03	Bruce A	During refurbishment, the original steam generators in Unit 2 were replaced with slightly smaller ones that have less inventory. This necessitated a change in the low boiler level trip setpoints. But due to the smaller steam generator inventory, the margin between the normal operating level and trip setpoints has reduced. This leads to an increased probability of an SDS1/2 trip should transient conditions in indicated boiler level occur after the turbine trips. The station has evaluated this deficiency and is taking action to improve its trip margin on indications of low boiler level after a turbine trip. Opportunities to enhance the reliability of switchyard equipment have been learned from this event. An upgrade of the teleprotection circuit is one initiative that is planned during an upcoming outage. This upgrade is intended to protect the circuit from adverse weather. The TSO also identified that the current 230 kV synchronization breakers are in need of replacement.
00002061	Problems during the design, evaluation and implementation phase	2014/10/03	Cernavoda	Working under time pressures may result in errors in all the stages of the design and implementation of plant modifications. Error prevention techniques should be consistently applied when time-sensitive evolutions are being planned, and the team is focusing on efficiently implementing the plan.
00002060	Revolutionising the supply chain by maximising safety operations through advanced products and services	2014/10/02	3rd Annual US Plant Safety Enhancements Conference	The Areva Group, for example, stepped up its safety operations after the events of three years ago, and the new construction projects of their EPR reactors have passed through post-Fukushima security measures, through domestic safety organisations. Another example of where this industry adaption has taken place is in Finland, where the local safety authority STUK in their final assessment of the Olkiluoto Nuclear Power Plant 3, says that the design functions on the plant are now strong enough to combat the possibility of earthquakes and flooding. At the Taishan 1&2 plants in China, where Areva is progressing well with its construction in Guangdong province no issues have been reported for the EPR designs.
00002059	D2O Overflowed Because D2O Collection Tank Level Control Valve Was Not in Automatic Mode	2014/10/01	Qinshan	Apply for a permanent modification to add audible alarm in the alarm system of main control room console for fuel handling. OPEX / INFO only NR ops. R.D.Cowley NR Ops Nov 7 2014
00002058	Failure of Partial Shutoff Rods Drop Test	2014/10/01	Wolsong	Periodic replacement plans for shutoff rod selection hand switch and micro switch of push button were established.(They will be replaced every 5 years)
00002057	Replacement of a Pneumatic Positioner with an Upgrade Causes Instability in Condensate System Level Control Loop	2014/10/01	Cernavoda	After the replacement of positioner Nuovo Pignone model TDP with the positioner Eckardt model SRP981, operating parameters of pneumatic loop were improved (faster valve response and higher sensitivity because the new positioner module has integrated booster module, with reduced response time.).
00002056	Qualification of Safety-Related Components	2014/10/01	NRC	The NRC is issuing this information notice (IN) to inform addressees of issues identified during NRC vendor inspections with the qualification1 of safety-related replacement components. The NRC expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems.

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00002055	Earned Value Management: Forecasting project outcome	2014/09/23	N/A	The basic assumption of project forecasting in EVM is that the current project performance, measured by the SPI and SPI(t) metrics for time and the CPI for cost, is representative for future performance and is therefore used to predict the final duration and cost of a project. The general abbreviations to forecast time and cost are as follows: Expected At Completion - Cost (EAC): Forecast of total project cost at the current status date, which might be different from the Budget At Completion (BAC). Expected At Completion - Time (EAC(t)): Forecast of final project duration at the current status date, which might differ from the baseline Planned.
00002054	Forecasting Support Costs	2014/09/23		When forecasting the cost of maintaining a product that is generally available, follow this advice: Learn and use this (simplified) version of Boehm's Model to forecast maintenance costs. Track your SDT. Measure your ACT. Define cost multipliers to refine your forecast. Furthermore, make sure you have a professional services team to implement change requests required by your customers, but do not treat them as costs since they are in fact a source of revenue.
00002053	Management of Shipyard Projects Lessons	2014/09/23	Fisher Maritime	The availability of these "lessons learned" will enable the readers of this compilation to avoid having to re-learn such lessons at great expense to any of the involved organizations. Several of the articles at the end of this compilation introduce the reader to the availability of the services of Fisher Maritime Consulting Group
00002051	A Project Forecasting Tool	2014/09/23	N/A	In project management, three techniques are most commonly used for forecasting. These techniques are as follows: 1.Estimate at Completion (EAC) 2.Estimate to Complete (ETC) 3.To Complete Performance Index (TCPI) In this blog post, I am going to discuss the Estimate at Completion.
00002050	Best Project Management Practices	2014/09/23	N/A	The best time to affect the scope, schedule and cost of capital projects is during the early planning stages. Therefore, a review should: • Determine whether the project is necessary for the agency to contribute to statewide results; • Assess whether existing facilities can accommodate a program without remodeling or renovation; • Establish reasonable costs for design services; • Review and make reasonable allocations for furnishings and equipment; and • Review ratios that reflect reasonableness of cost, including these factors: o Project costs in relation to standard cost per square foot for similar types of buildings o Assignable square footage as a percentage of gross square feet o Percentage of design cost as a function of the maximum allowable construction cost (MACC) o Total escalated project appropriation as a percentage of escalated MACC o Duration of project schedule as a function of the MACC and building type, and o Cost of similar investments over time and between agencies to ensure they reflect a reasonable request level
00002049	Digest of Engineering – Electrical Events	2014/09/19	COG	OE307220 – Preventative and predictive maintenance techniques recommended by the new Dry Type Transformer Working Group will be incorporated into the plant's SST transformer PM program. (Station Service Transformer, Gould, Inc., Model 24-27842) OE307565 – Stations with motor stator windings not rewound with newer class insulation during 30 to 40 years of service life should review their long term asset management plans for large motor refurbishment and rewind. Stations should not rely solely on Predictive Maintenance (Electrical Testing, Vibration, Thermography, Oil Analysis) and Preventive Maintenance data when determining large motor refurbishment and rewind schedule. (Circulating Water Pump, Baldwin-Hamilton Co., Model 72x72 FFM) OE307922 – Maintenance failed to have Engineering evaluate a PM that couldn't be completed in its entirety. When PM steps can't be completed, a condition report should be written as soon as practical to ensure timely evaluation. The lesson is that preventive maintenance actions must be completed in their entirety before returning equipment to service. (Station Service Water Pump, Hayward - Tyler Pump Co., Model 24 VSN)
00002048	Maintenance Rule Implementation Self-Assessment Guidelines for Nuclear Power Plants	2014/09/19	EPRI	The information contained in this guideline represents a collection of industry knowledge that describes programmatic and process attributes, including techniques and good practices, to assist in the self-assessment of Maintenance Rule (MR) programs to determine their effectiveness in meeting the requirements of 10CFR50.65.
00002047	Worker Fatality From Arc-Flash	2014/09/17	Crystal River	Plants are expected to review the Lesson Learned that follows and develop corrective actions applicable to the plant. This event underscores the necessity to ensure that vendors, including vendor contractors and subcontractors, adhere to site safety requirements. Adherence to a clearance process or work order process would have prevented the worker from pulling 480-volt fuses under load. Some utilities have incorporated hard requirements for supervision, training, and work package requirements into vendor contracts. Consideration should be given to establishing a site support supervisor or equivalent position for contractor support during periods of increased industrial maintenance activity, especially for the construction of site facilities.

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00002046	Degraded Pressure Regulating Valve Leads to Instrument Air Transient	2014/09/17	Bruce	This event could have been prevented by eliminating the PRV when a design change was approved to abandon equipment that the PRV supported.
00002045	Best Practices And Lessons In Projects Management	2014/09/15	N/A	Within the project management subject the main trends identified included the results based management approach, results based budgeting, knowledge management and use of management information systems that assist achieving the best results in implementation of projects.
00002044	Risk, Issues and Lessons Learned: Maximizing Risk Management in the DoD Ground Domain	2014/09/15	N/A	PREVENT failure from occurring or minimize its effect by acting PROACTIVELY. Focus your efforts on the critical few items worth pursuing. Ensure SUCCESS by minimizing cost and reducing risk.
00002043	Issue Management Guideline	2014/09/15	N/A	The goal of this guideline is a project environment that provides a communication channel from the project team to management for matters the team feels need attention; that provides a means for gathering further information on those matters, to the point where management can decide whether project change is warranted; and that provides a means for monitoring matters under consideration.
00002042	Integrating Project Communications into Lessons Learned	2014/09/15	N/A	Take a hard look at the communications plan and how well it worked. This process should include evaluating the stakeholders listed, the way the tool was manipulated throughout the project life cycle, or even the categories listed on the communications plan, such as audience, frequency and deliverables
00002041	MegaProject Decision Making - Lessons and Strategies	2014/09/15	N/A	This process should include evaluating the stakeholders listed, the way the tool was manipulated throughout the project life cycle, or even the categories listed on the communications plan, such as audience, frequency and deliverables
00002040	Creating an Effective Project Team Performance Assessment Process	2014/09/15	N/A	Allow team members to self-monitor their work performance without having to wait to hear from their supervisor whether they are performing to expectationsProvide permanent managers a dependable means of documenting performance assessments even though they may not have personally observed the employee performMake team member performance linked to project outcomes and independent of whether their supervisors change through the duration of the projectImprove project team morale and job satisfaction because they realize their good performance and that of low-performing team mates is measured objectively, fairly, regularly, and accurately.
00002039	The Project Status Report: Keeping It Simple to Communicate the Details	2014/09/15	N/A	How can a project manager establish this vehicle for communication? The answer is simple: by creating and distributing a project status report. This piece of documentation allows project managers to communicate the progress of the project while managing expectations. To ensure that the project stakeholders do not get lost in the details of the status report, I greatly recommend keeping it simple by adhering to the best practices outlined below.
00002037	Reactivity Management	2014/09/12	WANO	The analysis of reactivity management events identified several recurring themes important for all personnel to understand, particularly those who supervisor, operate and maintain reactivity control equipment. The analysed events illustrate that effective reactivity management principles must apply during all modes of plant operation regardless of reactor power level. Events have occurred during reactor start-ups, low-power operations, power ascensions and full-power operations, as well as during on-line refuelling. Although many stations have taken actions to strengthen reactivity management practices, events that result in unexpected and uncontrolled reactivity transients continue to occur. for more information click here:http://www.wano.org/OperatingExperience/WANO_SOER/Activesoer.asp
00002036	Intake Cooling Water Blockage	2014/09/12	WANO	Blockage of intake cooling water reduced safety margins and increased the potential for a common mode loss of the ultimate heat sink for many safety-related loads. In addition, some managers have not fully considered the impact of such events on the availability of cooling water for safety-related systems. Changes in environmental conditions were often not compared to the plant design bases to ensure the design supports current plant and environmental conditions. Changing environmental conditions caused unexpected or sudden increases of algae, seaweed, marine life, debris intrusion or formation of frazil ice and some design features were inadequate to mitigate these conditions. In addition to changes in the natural environmental conditions, some intake blockages have resulted from manmade effects, such as oil spills. Monitoring techniques and prediction methods did not provide sufficient early warning to manage intake cooling water blockage scenarios. Design reviews did not identify vulnerabilities in the original design of intake structures, equipment and associated systems or in modifications intended to improve the robustness of screens, screen wash systems, strainers and heat

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00002035	How to build successful BI strategy	2014/09/12	N/A	Business intelligence is a very broad topic of study, however, if you would like your business to succeed, it is extremely important to understand the factors that influence BI and learn how to design an effective BI strategy. Prior to starting work on BI strategy, you must learn and document your overall business objectives to help formulate BI vision for the growth of business. After documenting the initial list of key objectives, you should work with the key stakeholders to confirm the validity of items on the list and their prioritization. This will ensure that you start building your BI strategy with a proper foundation aligned with your business and with the buy-in from stakeholders.
00002034	Digest of Electrical Maintenance Events	2014/09/10	COG	OE301520 – The maintenance procedure was determined to lack sufficient detail to ensure the seismic clip is engaged. (ECCS Trip Unit, Control Products Div / Amerace Agastat, Model FGPBC750) OE305031 – Apply proper rigor while identifying, labeling, lifting, and landing wiring leads. OE306755 – Add verification requirements to site procedure for push pin connectors. (Feeder Differential Relay, General Electric Company Model 12IAC55A3A) OE307302 - Critical steps to be performed by vendor technician. Recording of the torque values and implement a PG&E sign off verification for all torquing of bolts and nuts that are replaced/removed during overhaul. (Startup Transformer, ABB Power T&D Company Inc. Model MLL9313)
00002033	International Safeguards in the Design of Nuclear Reactors	2014/09/10	IAEA	Effective cooperation between States, the IAEA and other stakeholders can facilitate a more cost effective and efficient implementation of safeguards that also minimizes the impact on nuclear facility operations. To this end, this guidance is intended to increase understanding of the safeguards obligations.
00002032	UPDATE: Plant Support Engineering: Counterfeit and Fraudulent Items—Mitigating the Increasing Risk	2014/09/10	EPRI	UPDATE: This report presents a multi-tiered approach that includes measures to prevent, detect, and control counterfeit and fraudulent items.
00002031	Rigorous Testing Program is Beneficial During All Phases of a Project	2014/09/09	Washington River	
00002030	Project Management - Project Reporting	2014/09/09	N/A	
00002029	Nuclear Construction Lessons - Guidance on Best Practice: Welding	2014/09/09	N/A	
00002028	Harmon Main Output - Transformer Replacement	2014/09/09	Harmon GS	The existing Harmon transformers were built by Ferranti Packard in 1965. These units were of an older style with separately mounted radiator banks piped to the transformer tanks. The scheduled deliveries were in January 2009 with the intent to transport the transformers to site over frozen winter roads. Fabrication delays pushed the deliveries until June which mandated moving the transformers over the soft summer roads shortly after the spring thaw. All of the cabling from the station equipment to the transformers was replaced along with extensively modifying the protection systems to integrate the new transformer's additional CT's.
00002027	Controlling Subcontractors with Effective Statements	2014/09/09	N/A	
00002026	Kipling headgate failure	2014/09/09	OPG	Leaving uncommissioned stuff energized and un attended is an important project lesson for all our projects.
00002025	Observations of Good People Doing Good Work	2014/09/04	N/A	

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00002024	Wasdell Mini Hydel Removal Project	2014/09/04	Wasdell Falls Generating Station (Wasdell Falls)	Manpower/Staffing ? Engineering support during the duration of the project was good ? NorEng and OPG worked well on this project with good communications ? Environmental support was good. ? Records support was good in helping with drawings need to check on obsolete drawings.. ? No safety incidents were identified during project. 2. Production/Projects Interaction ? Production was kept informed of any safety concerns upon site visits. ? Productions were very supportive on this project when required 3. Hours of work ? The estimated forecast for EPSCA appears to be consistent but further review is required ? Future projects to have a short presentation during the kick off meeting to stress the importance of submitting the Room and Board / Travel allowance applications early on in the project to avoid any surprises for the contractor. ? Lead times on EPSCA timesheets was consistent. ? Support functions hours were consistent with the original planned forecast.
00002023	Research efforts support reactor lifetime extension	2014/09/04	N/A	
00002022	During Ramp-Down and Project Closeout Lessons	2014/09/04	N/A	
00002021	The Road to Best Practices - Using Lessons Learned in Cost Management	2014/09/04	N/A	
00002020	Public Safety	2014/09/04	N/A	Such projects would be best planned in a better time of the year. With the end of year start, cold weather and freezing conditions caused delays difficulty in post installation.
00002019	Challenges and Lessons in Project Management	2014/09/04	ProjectManager.com	During the construction phase of the WTP, a formal temporary modification process is used to maintain configuration control of permanent plant equipment. This is a good practice and is particularly helpful in maintaining configuration control of electrical power to equipment for lockout/tagout purposes. However, diligence in coordination and execution is necessary to successfully apply this program in the midst of a large scale construction project where facility conditions change at a rapid pace and multiple organizations (e.g. Operations, Startup, and Construction) are involved in the temporary modification process.
00002018	Ensure Controls are provided for critical steps to ensure effective	2014/09/04	N/A	Establish clear directions in work instructions that adequately implement and record completion of critical activities, particularly when multiple organizations are involved in the execution of a task. During a quarterly verification of temporary modifications, four temporary modifications were found to be installed without the associated documentation completed and issued. This resulted in energized equipment that was not documented for lockout/tagout and configuration management purposes.
00002017	Sharing of Independent Oversight Resources Among Sites	2014/09/04	N/A	Utilization of resources currently engaged in implementation of an NNSS Program increases the quality of the audit. Exchanging resources with another site significantly reduces the costs of the audit team and resources to manage site access of visiting personnel. Observing operations at another site provides workers with exposure to alternate programs and processes that may result in identification of improvement opportunities that can be implemented when they return to their home site. When pursuing resource exchanges with other contractors a Memorandum of Agreement is required at a minimum and should be started as early as possible with timely communication updates and coordination with the DOE office.
00002016	Managing Fabrication and Delivery of Vital Time Critical	2014/09/04	N/A	Each contractor should evaluate the value of placing company personnel within a fabrication facility when vital and or time-critical items are being produced. The presence of company personnel provides a clear reminder of expectations. By performing inspections during manufacturing, issues are identified early and resolved more cost effectively than finding them during receiving inspection or acceptance testing. Firms at sites with multiple contractors should maintain an extensive knowledge of each other's capabilities. Most sites have sufficient resources to resolve issues if companies team together.
00002015	Oversight of Procured Services	2014/09/04	N/A	The helium purge system at T Plant was designed and installed without a pressure relief valve, contrary to ASME requirements. Project personnel were frustrated by not being able to hold subcontractors accountable for inadequacy of their work. The special relationship associated with FH using affiliated resources may not be clear to project or facility personnel. Project staff and procurement support staff must work closely together to ensure procurement requirements are met. By terms of our contract with DOE, FH is responsible for services performed by FH Affiliates.

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00002014	Software Configuration Management	2014/09/04	N/A	
00002013	10 Common Project Management Mistakes and How to Correct Them	2014/09/04	N/A	
00002012	P1281 East Boiler Drain Issues and Lessons Learned	2014/08/29	Pickering	See the attached document for lessons learned and recommendations.
00002011	NR DSR IP420-2 MODIFY FILTER SAMPLING LINES	2014/08/29	Darlington	See the attached document for a discussion of lessons learned.
00002010	Point Lepreau Steam Generator Refurbishment OPEX Conference Call	2014/08/28	Point Lepreau	See the attached document for a discussion of lessons learned.
00002009	Success Factors of Organizational Change in Software Process Improvement	2014/08/28	N/A	The findings of our study indicate factors that software organizations should consider when they attempt to conduct successful software process improvement initiatives. We believe the success factors discussed here give many interesting insights that will be relevant and applicable to organizational change in most software organizations. If the success factors are implemented they facilitate the success of improvement initiatives. If they are not implemented - or not implemented correctly - this makes process improvement difficult to achieve, or may even cause failure of the initiative.
00002008	The Niagara Tunnel Project - Project Execution Plan	2014/08/28	Niagara	Some important considerations for the project are health and safety, environmental protection, quality, schedule and cost, and working relationships. Lessons learned in these areas can be found in the attached document.
00002007	Lower Mattagami Cost Estimate Development & Front End Engineering Design Lessons	2014/08/26	Lower Mattagami	See the attached document for lessons learned related to cost estimating, including risk management and contingency planning.
00002006	Change Management Strategies for an Effective EMR Implementation	2014/08/26	N/A	See the attached document for a discussion of lessons learned relating to change management.
00002005	8 Successful Headlines and the Psychology Behind Them	2014/08/26	N/A	See the attached report for more information. Anyone writing articles or involved with public affairs may find it interesting.
00002004	PMO: Project Management Office	2014/08/26	N/A	Being clear about the business objectives for implementing a PMO or developing its role is essential if it is to deliver significant improvements in project performance and justify the cost. Once the problems are clear and agreed, the type and range of services required to address them can be defined. This will determine the type of PMO that is needed. Only then can the type of skill and expertise needed by the PMO staff be identified, roles defined and activities to deploy, manage and develop people to deliver the PMO services undertaken. Working in the PMO should be an opportunity for both individuals to develop their skills and knowledge and for the organisation to increase its project and programme management capabilities.
00002003	Mega Project Assessment	2014/08/26	N/A	Valuable experience being gained by the teams on WSDOT mega projects should be captured and shared statewide. Exploring rotational assignments will help cultivate new ways of doing business across the state. WSDOT should also build relationships with other state DOTs that are delivering mega projects and utilizing alternative delivery methods.
00002002	Plant Support Engineering: Counterfeit, Fraudulent, and Substandard Items	2014/08/26	N/A	Commercial nuclear licensees must implement measures to reduce the risk of counterfeit items being used by or installed in their facilities. Important existing barriers such as receipt inspection must be reinforced and new barriers implemented, such as considerations during supplier selection and clear communication with suppliers to ensure that they are aware of the issue and of our expectations. Periodic training must be provided to staff, particularly inspectors, purchase agents, and mechanics, who have "hands-on" opportunities to identify counterfeits and keep them out of plants.
00002001	Relay Service Life Testing and Evaluation—Agastat EGP Relays	2014/08/22	EPRI	This project is intended to perform additional testing and evaluation aimed at improving equipment reliability by optimizing relay replacement intervals and service life.
00002000	Engineering Desktop Instruction – Multipass Review	2014/08/22	Exelon	To provide structured guidance for performing reviews of technical products.
00001999	External Hazards related events at NPPs	2014/08/22	IAEA	The study aims at providing an overview of external phenomena affecting nuclear power plant operation, and at highlighting the main lessons learned from the past operational experience on events related to external hazards, of natural origin or human-induced.

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00001998	Implementing an Organizational Software Process Improvement Program	2014/08/21	N/A	As discussed in at the beginning of this article, process improvement can and should be viewed as an ongoing program. Once an initial set of processes has been rolled out, the program should be reviewed and adjusted at least annually. Possible sources of input to drive the future direction of the program include:User feedback. Process users should have an easy mechanism for providing feedback to the SEPG. This feedback becomes the basis for process change. It is the equivalent of change requests in a software project and should be dealt with similarly. At the meta-process level, lessons learned concerning process development and roll-out should be used to direct future PI strategies and plans.SQA and model-based assessment findings. Continuous SQA audit of process adoption and compliance provides valuable feedback to the PI program. Periodic assessments against the selected reference model highlight additional areas needing improvement. Both forms of monitoring identify problems in process descriptions and assets, as well as problems in the process improvement program approach itself.Measurement data. Analysis of measurement data across projects can help identify areas needing
00001997	Reflections on the Bruce Experience	2014/08/20	Bruce	Many lessons and recommendations came out of this presentation:Control the transition between layup and startup. The time period for this transition should be minimalised.Ensure technical drawings always represent reality. Check thisusing field assessments/inspections, and ensure they are done early.Keep your regulator updated and get them involved early.Make sure important decisions are well documented and there is a basis for decision making.The ISR (Integrated Safety Review) should be done early.Integrate documents into a governance whole, and make sure they reference and link to one another: processes have to be aligned.Specify baseline performance of components: use tests to do this. Think about what information you will want 10 years from now when the system breaks.Don't forget about commissioning plans.Engage station staff and those with specialist skills when needed.
00001996	Boston's "Big Dig" Offers Lessons in Budgeting, Management	2014/08/21	Greater Boston	See the attached articles for a discussion of lessons learned.
00001995	Sir Adam Beck G9 Rehabilitation	2014/08/21	Niagara	See the attached document for lessons learned relating to turbines, generators, logistics, and procurement.
00001994	Harmon Main Output Transformer Replacement	2014/08/20	Harmon GS	Some lessons learned from this can be found in the attached document.
00001993	Nanticoke GS – Aux Boiler Project (NTGSX870), Lessons Learned	2014/08/20	Nanticoke GS	The attached report summarizes the key lessons learned on the project as follows: 1.Provides a description of problem (or success) experienced. 2. Described the associated impact of the problem (or success) on the project. 3. Provides a recommendation for reference and consideration on future projects. Please see the attachment for more information.
00001992	Abitibi Canyon T3 Transformer Replacement	2014/08/20	Abitibi Canyon	Lessons learned from this project include: 1. A standard should be developed for high voltage disconnect switches. 2. At factory acceptance all drawings required should be provided or the product should not be accepted. 3.Key individuals should remain for the duration of the project to eliminate confusion and uncertainties. 4. Taking time for clarification meetings during the bid proposals can help ensure scope and technical specification is understood. 5. Co-ordinate schedule prior to execution. For additional details on these 5 lessons learned, please see the attached document.
00001991	Latent Errors and Systems Disasters	2014/08/20	Various	See the attached document for a thoroughdiscussion of lessons learnedpertaining tolatent system errors.
00001990	EM Earned Value Management Systems	2014/08/19	N/A	See the attached document for specific lessons learned.
00001989	BEA Configuration Management Document	2014/08/19	N/A	After the delivery of a release, Lessons Learned input is collected. If it is an Informational Release, the input is collected only from within the TI&E staff. For the major releases, it is also collected from the outside user community. A Lessons Learned template is made available so all input can be directly entered into a common spreadsheet format. This will limit the entry of repeat issues and simplify the input for review by CM. CM then coordinates with the submitters as needed and schedules a work session to create common items for discussion, the assignment of Points-of-Contact on issues and a resolution approach. Resolution will be tracked and to the extent possible accomplished at the lowest organization level. For more lessons learned, please see the attached document.
00001988	Configuration Management	2014/08/19	N/A	Consistent with the systems engineering life cycle, configuration management exists for the life of a program and system. As part of initial program planning, MITRE is involved in the establishment of systems engineering processes, one of which is configuration management. Some
00001987	Procedure Issued without Support Structures	2014/08/19	N/A	Procedures that are issued or made effective before all processes required to perform the procedure are in place cause user confusion, create the need for rework, and do not provide a clear path forward. While quality was not determined to be affected in this situation, other situations where procedures are issued but not yet usable could affect quality

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00001986	Implementation of New Requirements Management Process	2014/08/19	N/A	Communication among implementation team members and their management is essential for smooth implementation of new processes. Representatives on implementation teams serve dual roles: 1. They provide input to the process based on their knowledge and experience. 2. They are a communication link to their parent organization to position it to promptly implement and process changes. Thorough review of PHMS documents for impacts is essential to prevent inadvertent non-compliances when requirements change. Major changes to governing documents may require formal implementation plans, including training sessions for appropriate personnel. Field and cognizant functional area personnel must identify the need for formal implementation processes.
00001985	Inadequate understanding of software quality requirements by general users can lead to non-compliance	2014/08/18	N/A	Ensure controls are in place and communicated for the proper use of software and databases to the average user. A database was found in use to aid the production of the Integrated Sampling and Analysis Plan but not documented or controlled.
00001984	Managing Successful Procurement Actions is Essential for Complex Projects	2014/08/18	N/A	Early planning and regular communications with Contracts and project team members are critical to successfully completing procurement actions.
00001983	Software Verification and Validation	2014/08/18	N/A	Any software code that is significant to occupational, environmental, onsite or offsite safety or quality must be verified and validated as well as the equations or data processed by that software code. End-users of procedures should be involved in preparing, reviewing, and validating those procedures since they are accountable for complying with them.
00001982	Software for ATP Data Analysis Requires Validation	2014/08/18	K Basins	The current site QA requirements for software validation are not readily apparent to users. Users of software purchased for general commercial application should be aware it is incumbent on them to document validation of the software to their specific application on their specific hardware.
00001981	Outage Extension due to Reactivity Control Valve Degradation	2014/08/15	Darlington	Inadequate preventive maintenance on a Liquid Zone Control system Level Control Valve caused an outage extension, which incurred an economic penalty.
00001980	Human Performance in Organizations: Potential Application for the Nuclear Industry	2014/08/13	N/A	See the attached report for various case studies and their associated lessons learned.
00001979	Worldwide Licensing And Construction of Nuclear Power Plants - Lessons	2014/08/12	Various	Some significant lessons learned included in this report pertain to design completion and configuration management, project planning, major construction experience, use of new or novel manufacturing techniques, safety culture, vendor's knowledge of the country's regulatory practices, regulatory communcations, and early approval of codes and standards.
00001978	Lessons from Health Canada's Response to the 2008 Listeriosis Outbreak	2014/08/11	Canada	While Health Canada was well prepared to respond to the outbreak, some key lessons learned have been identified and point to the following areas for improvement:in more proactive and targeted communications to the public;improving laboratory surge capacity for emergency situations;reviewing departmental policies and procedures to ensure that they reflect emerging food safety issues; andstreamlining our internal processes for dealing with health risk assessments and interactions with other government departments during a crisis.
00001977	Welding and Fabrication Innovations Mitigate Reactor Pressure Vessel Embrittlement	2014/08/11	N/A	See the attached article for more information. It is recommended for anyone involved in welding or fabrication of reactor components.
00001976	NRC Issues Inspection Findings to Ark. Nuclear Following Heavy Handling Accident	2014/08/11	Arkansas Nuclear One	See the attached document for more information.
00001975	Steam Turbine Blade Reverse Engineering, Upgrade, and Structural Design	2014/08/11	N/A	Steam turbine blade cracking often suggests the need for an upgraded blade design. Follow the process of reverse engineering a failed blade to produce a more reliable and efficient design.See the attached article for more information.
00001974	The Hoisting and Rigging Handbook	2014/08/07	N/A	Additional Lessons Learned on key subject areas have been included at back of book for use at any time. See the attached document for more information.
00001973	D1321 Fleet Outage Lessons Learned	2014/08/07	Darlington	See the attached documents for a discussion of lessons learned.
00001972	Student Lessons Learned	2014/08/07	N/A	Lessons learned are discussed in the areas of Planning and Controls, SharePoint, OPEX and Lessons Learned, and Risk Management.
00001971	Mentoring Matters	2014/08/06	N/A	See the attached article for lessons learned by various project managers during their careers.
00001970	6 Obvious Budget Overruns to Avoid	2014/08/06	N/A	6 Problems that are commonly run into are: 1. Underfinancing; 2. Unrealistic cost estimates; 3. Underestimated complexity; 4. Extended project schedule; 5. Improper buffer planning; 6. Improper resource planning.
00001969	Problems, Conflicts, and Decisions	2014/08/06	N/A	Ultimately, good decision-making is firstly getting most decisions reasonably correct (luck plays a part) and then continually reviewing the consequences of your decisions to adapt, adjust and correct the suboptimal ones as quickly as possible. Generally, any considered decision made in the appropriate time frame is better than no decision or an unnecessarily delayed one.

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00001968	Resolve SPV Status of 0-67250-PRV2364	2014/08/06	Darlington	See section 4 (page 5)of the attached report for the walkdown findings. Refer to Appendix A (page 8)for reference photographs.
00001967	Resolve SPV Status of 0-67250-PRV2364	2014/08/06	Darlington	See section 5 (page 14) of the attached report for a detailed discussion of lessons learned. These lessons pertain to refrigeration units, control valves, and relief valves.
00001966	System Lay-Up Generator Stator Cooling Water System (GSCW)	2014/08/06	Darlington	The OPEX findings relevant to the lay-up of the Generator stator cooling water are included in Appendix A. A summary of the evaluation is given below: Pickering, Bruce, New Brunswick GSCW lay-up practices were reviewed; dry air purge method was used. EPRI recommended practices were reviewed; both dry air purge and nitrogen blanketing are acceptable methods for GSCW lay-up. The impact of FME on GSCW was reviewed. If proper FME procedure is not followed, it will lead to unit forced outage. Issue Tracking File has been updated to track this issue for resolution during the development of the design package. The impact of corrosion product on GSCW system was reviewed. If proper lay-up procedure is not followed, it will lead to corrosion in the stator windings and it will reduce the stator cooling water flow and plug the system.
00001965	Proposed Addition of New SDCS Pumps	2014/08/06	Darlington	See section 6 (page 15) of the attached report for a detailed discussion of lessons learned. These lessons are related to design, operations, maintenance/inspections, commissioning, andhuman performance.
00001964	STOP Modification - Rupture Discs and Relief Valves	2014/08/06	Darlington	Several lessons learned are highlighted that pertain to rupture discs and relief valves. Anyone involved in the STOP project should review these lessons to ensure previous mistakes are avoided.
00001963	Potential Electrical Contact	2014/08/05	Darlington	Investigation currently in progress.
00001962	Manual Valve for Emergency Core Cooling Heat Exchanger Stuck in Closed Position	2014/08/01	Point Lepreau	Critical Failure Ananalyis documents should be updated on a regular basis, as they provide crucial guidance on the replacement of plant equipment which may be past its service life.
00001961	Lightning rods on the roof of the Reactor Building discovered to be non-functional following an inspection	2014/08/01	Gentilly	The inspection following completion of the work was insufficient. The scope of the inspection was not clear. The work analysis did not identify the special conditions related to the refurbishment of the ring beam (lightning rods, baseboards, etc.). Ensure that after work involving the removal of lightning rods and other pieces of equipment is completed, those items are reinstalled.
00001960	Discovery of a Fuel Pencil in the Spent Fuel Bay	2014/08/01	Gentilly	The personnel assigned to dry storage fuel handling activities should be aware of the existence of such special containers and receive on how to independently and safely dispose of detached pencils.
00001959	Canadian Nuclear Safety Commission (CNSC) Feedback on Problems with 1995 CHF, Pressure Drop and Post-dryout Heat Transfer (PDO) Data Obtained at 5.1% Crept Channel	2014/08/01	Candu Energy Inc,	Inform CANDU 6 utilities that feedback from the CNSC has identified problems with 1995 CHF, pressure drop and PDO data obtained at 5.1% crept channel conditions, which have been used in deterministic safety analyses and regional overpower protection analyses.
00001958	New Brunswick Problem Identification and Corrective Actions (PICA)	2014/08/01		See the attached document for a detailed description and analysis of the event.
00001957	Bruce A Restart Project Recommendations	2014/08/01	Bruce A	See the attached document for details.
00001956	Managing Capital Projects for Competitive Advantage	2014/08/01	NA	A few asset owners are benefiting from better project designs, lower costs, and fewer delays. By standardizing engineering activities, modifying boilerplate contracting models, and ensuring that project teams collaborate across functional boundaries, these leaders are creating a significant source of competitive advantage. An examination of their methods offers lessons for asset-intensive industries of all stripes. See the attached document for more information.
00001955	Executive Summary of Project Management Checklist	2014/08/01	NA	See the attached document for project management lessons learned.
00001954	USS Nimitz - Refueling and Complex Overhaul	2014/07/30	Newport News Shipbuilding	Most aspects of the CVN 68 RCOH planning and execution processes went very well, especially considering the complexity of the project and the fact that this was the first Nimitz-class RCOH. But there certainly was room for improvement, which could help keep the RCOHs for the rest of the class within cost and schedule constraints. The Navy organizations learned many lessons during the CVN 68 RCOH and made a number of improvements during the planning of the CVN 69 and 70 RCOHs and the execution of the CVN 69 RCOH. For example, the Navy and the contractor improved methods of sharing financial data and communicating to support just-in-time decisionmaking.
00001953	Three-Way Communication	2014/07/29	Various Nuclear Stations	When problems are encountered, communications should be sufficient to ensure that the appropriate information is understood.Operators should be alert to providing pertinent information that communicates current status of critical plant parameters and potential safety concerns.A method of communication should be predetermined and available at the job site. In areas of high background noise, an alternate and audible means of communication should be established.The expectation should be clearly established where expected communications will be continuous and constant, such as performing evolutions that involve critical plant parameters.Communications should be such that the intent or meaning is clearly understood. Ensure that unique terminology has the same meaning between different work groups.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001952	Pickering B Plant Life Extension Project	2014/07/29	Pickering B	See the attached document for additional details.
00001951	Non-Compliance in Liquid Effluent Handling System Tank Discharge	2014/07/29	Gentilly	The apparent cause of this event was a lack of precise communication routines and inappropriate use of documents. While performing operations it is important to use basic error prevention tools, such as self checking, questioning attitude, and three-way communications. It would also be beneficial to remove distractions and interruptions that could adversely affect the work being performed.
00001950	ITAAC Integrated Project Team and Alignment	2014/07/29	Vogtle	Lessons Learned for the Industry: • The need for collaboration and communication between the Design Authority, Constructor, and Licensee at all levels is a key part of construction. • Integration at the working team level, including management from each organization promotes an alignment where synergies can be recognized. • Use of common processes/procedures and electronic platforms where possible increases efficiency.
00001949	Communications (Just in Time Briefing)	2014/07/29	N/A	The questions asked in this guide are based on: 1) Three way communication. 2) Effective work handoff during shift changes. 3) Communication in the field. 4) Communicating to a group. 5) Methods of communication.
00001948	European Nuclear Supply Chain	2014/07/29	European Nuclear Supply Chain Conference, Brussels	Common themes regarding cost-efficiency, growth of international supply chain models, integrating lessons learned from Fukushima and attracting new talent into the nuclear industry consistently came up in the survey. Although largely facing similar challenges, the US and European nuclear market showed clear disparities with certain priorities. In developing the most effective supply chain strategy for the imminent round of nuclear projects across the lifecycle, it's clear a real urgency is required in dealing with some of these issues to ensure a future for nuclear in the energy mix, despite your geographical location.
00001947	Explosion and Fire in Turbine Building Resulting in a Manual Scram and Emergency Declaration	2014/07/25	Beaver Valley	The failure was caused by the Husky bus cables experiencing a diminished service life due to chronic exposure to ohmic heating within the Husky bus enclosure and inadequate preventive maintenance.
00001946	Fort Calhoun Station - End of Project Report	2014/07/23	Fort Calhoun	New security requirements had a significant impact on some of the facility upgrades in progress or planned. The need to identify facility and resource needs well before the start of the refueling outage was communicated multiple times with multiple methods, but there were still requests for space up to the beginning of the refueling outage. The implementation of "yard coordinators" proved very beneficial. Digging, trenching, or setting of trailer anchors was performed on some occasions without prior underground surveys being performed. In one instance an underground pipe was damaged during trenching even though a survey had been done and workers were aware there was a pipe in the vicinity. See page 10 of the attachment 1946a for more information.
00001945	Reasons for Cost and Schedule Overruns	2014/07/23	N/A	See the attached document for specific lessons learned.
00001944	Succession Planning Lessons	2014/07/22	TVA	Lessons and actions are in the attached document.
00001943	Heathrow Terminal 5 Lessons	2014/07/22	Heathrow Airport	Despite issues on opening day, the construction side is considered a great success in UK construction.BAA took on all of the risk in the contractor model. This improved team integration and removed the chance of having a debilitating wave of legal actions and delays.BAA may not use the same model for its secondsatelliteterminal and will look to put more accountability and riskon contractors based on lessons learned from T5.Create a culture to find opportunities: seek out best practices, remove barriers, stimulate and support good ideas; leverage incentives to get exceptional behavior.Full transparency on costs.Pay for proper performance and early pay out of shared benefits (work done to plan and risks managed); no profit on below-par performance and right of termination for failure to perform.Cultural commitment to focus on partnering, trust and co-operation.
00001942	Earned Value Management Lessons	2014/07/22	N/A	The major objectives of applying earned value to a contract are to encourage contractors to use effective internal technical, cost, and schedule management control systems, and to permit the customer to rely on timely data produced by those systems for better management insight. This data is in turn used for determining product-oriented contract status and projecting future performance based on trends to date. In addition, EVM allows better and more effective management decision making to minimize adverse impacts to the project. The NASA Earned Value Management Focal Point Working Group (FPWG) was established to ensure that there is agency-wide representation in EVM implementation. Chaired by the NASA Office of the Chief Engineer, the FPWG provides the basis for developing an integrated, consistent approach for implementing EVM throughout NASA
00001941	Bruce Power Critical Decision Process	2014/07/22	Bruce	See the attached document for more information.

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00001940	Best Practice Trip to PCL	2014/07/22	Edmonton, Alberta	PCL advised that the owner should consider creating a small 'Owner Team' that communicates closely (perhaps in a joint office) with the Contractor and save money on a CM/PM layer of management.Ensure that the Engineering company listens to the input from the Contractor.PCL uses a combination of 'off the shelf' systems and in-house custom designed systems for project controls. There is no overall central 'one screen' database that is home to an integrated system. PCL stated in the project contract that Owner systems are 'optional' for PCL during the project construction managementFor more lessons learned (especially relating to project controls) pleasesee the attached document.
00001939	10 Golden Rules of Project Risk Management	2014/07/22	N/A	The benefits of risk management in projects are huge. You can gain a lot of money if you deal with uncertain project events in a proactive manner. The result will be that you minimize the impact of project threats and seize the opportunities that occur. For the 10 golden rules of risk management, see the attached article.
00001938	Unique Industrial Rennovation and Revamp (R&R) Risk Issues	2014/07/21	N/A	Please see the attached document for a detailed discussion of lessons learned.
00001937	Brown's Ferry Trip Report	2014/07/21	Brown's Ferry	See the attached notes for more information.
00001936	Point Lepreau Refurbishment Review	2014/07/21	Point Lepreau	There are 3 factors that make it difficult to arrive at a clear recommendation on the way forward at this time. These are: a) First, the uncompetitive nature of the AECL contracts and the concern that they may be overpriced and unduly expose NB Power (and thereby the province) to financial risk. b) Secondly, the information on the fossil alternativesis based on business planning information and not on contractually binding, competitive tenders. c) Finally, the significance to be attributed to the non-economic issues. Clearly there is a need for a decision making-process that is open, accurate and auditable. A proposed process can be found on page 19 of the attached document.
00001935	Siemens Notes - Lessons Learned	2014/07/21	Various	See the attached report for a discussion of lessons learned.
00001934	Participation in Complex Working Groups Provides Opportunities for Cost Savings and Avoidance	2014/07/21	LATA Kentucky	Routine participation in the EFCOG ISM/QA working group provides many opportunities to exchange best practices with personnel from other sites resulting in potential cost savings or avoidance.
00001933	Proper Use of Undistributed Budget	2014/07/21	N/A	Improper Usage of Undistributed Budget are as Follows:UB was improperly used to offset variances: Work was identified which was no longer planned to be accomplished within the contract period of performance, and the budget and scope were moved into UB to accurately represent the near term schedule. While it is required for the schedule to represent the work as it is planned to be accomplished, a BCP to remove the scope from the contractor's baseline should have been processed.Improper use of UB to replenish MR: In the event the effort associated with UB was no longer planned to occur, a baseline change was processed to remove UB and replenish MR.UB was improperly tracked: After a baseline change was implemented, there was no traceability from the UB values found in the Baseline Change Control Log to the Contract Performance Reports and CCB Log.UB was not allocated in a timely manner: UB was held for almost a year with no explanation in the Contract Budget Base Log to indicate the amount was to be removed from the contract.
00001932	RFR Study - Input to Environmental Assessment	2014/07/21	Pickering B	The details presented in this report propose that each unit of Pickering B undergo some form of chemical decontamination before starting replacement of the feeders and fuel channels. The dose to workers from Retube after decontamination is estimated to be 6.5 Sv with an expectation that OPEX from CANDU 6 would ensure a lower dose would finally be achieved. The retube operations would be undertaken by an average crew of 75 workers in a shift with a maixmum of 450 workers for one unit. Work would be arranged for two 12-hour shifts with 4-days on and 4-days off shifts.
00001931	Bruce A Restart B3/4 Refurbishment Preparations Project - Lessons Learned Program	2014/07/21	Bruce B	See the attached report for a framework of Bruce Power's LLP for Units 3&4 refurbishment.
00001930	Transforming Ontario's Power Generation Company	2014/07/21	OPG	Specific areas that are advised on in the report may be summarized as:the future role of OPG in the electicity market;the future structure of OPG;the appropriate corporate governance and senior management structure; andthe potential refurbishing of Pickering A Units 1, 2 and 3. For other lessons learned, see the attached report (attached in 4 seperate files due to the large size of the document).
00001929	Schiff-Hardin Memorandum	2014/07/21	Pickering A	The Terms and Conditions and the Alliance Agreement were the Project's key contract documents. Four separate entities were parties to the Alliance Agreement: OPG, CANEC, Babcock & Wilcox, and Siemens Westinghouse. The Alliance Agreement contained the major aspects of the pricing provisions for the project. Its most serious deificiencies were that it was created at a time when the scope was ill-defined, the estimated cost to construct was unreliable, and there was no guaranteed maximum price or other similar cap to limit OPG's exposure to contractor-caused cost overruns. The agreement failed to meet its stated objectives because of its complexity and the difficulty in administering it.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001928	CDC Unified Process Practices Guide	2014/07/21	N/A	The following best practices are recommended for the practice of projcet status reporting: Communication: incorporate project status reporting as one component of the project's overall communication management plan. Consistency: Be consistent in format, distribution cycle, distribution method, etc. Establish Metrics: Establish metrics for status reporting during the project's planning phase. Process: Establish a project reporting process with the project team based on the informationneeds of the status reporting audience. Simple: Keep status reporting simple but effective. Ensure/Verify: Ensure that all interested parties are receiving necessary information. Standards: Establish and use a standard process and template for reporting project status. Use Tools: Utilize tools when avaialable to simplify the status reporting process and to more effectively meet the information needs of the project audience.
00001927	Estimate Classifications Lessons	2014/07/21	N/A	Estimate classifications enable stage gating project evolutionEstimate classifications focus mainly on initial project costRecommended Practices (RPs) are guides, not mandatoryAACEI RPs identify minimum expectations of scope maturityBoth generic and industry specific (addenda) are requiredEstimate accuracy ranges depend on industry/ project riskChallenges in expectations may be analogous across industriesReported estimate accuracy is speculative, subject to changeEstimates may vary despite compliance with respective RPEstimating is both a science and an art that limits accreditation
00001926	Australian Government Gateway Review - Lessons Learned Report	2014/07/21	Australia	Many of the lessons learned in the second and third years of Gateway were positive. The review reports identified several agencies that delivered successful project outcomes through sound project management principles. These agencies generally share the following good practice fundamentals, encompassing many of Gateway's key themes: • senior executive and whole-of-organisation support a project management approach to delivering on government priorities; • governance arrangements are defined and agreed – especially where accountabilities are shared across multiple stakeholders - with direct links to the agency executive; • business cases outline the project scope with achievable outcomes and are routinely monitored and revisited; • benefits realisation plans are measurable to allow for ongoing tracking and reporting; • stakeholder management and engagement is ongoing throughout all phases of the project, ensuring roles and responsibilities are understood and acknowledged; and • project teams have appropriate skills and the charter to deliver on the objective. Other lessons learned in this report are relevant to the areas of project planning and management, business case and benefits realisation,
00001925	Tight Fitting Annulus Spacer Location Discrepancy	2014/07/18	Bruce	•Prior to the spacer movement observed in B8J18, it was assumed in all predictions of pressure tube to calandria tube contact for channels outfitted with Inconel X-750 tight fitting annulus spacers, that the spacers will remain in their as-installed locations as per design. •The observation of a tight fitting spacer movement necessitated the consideration of the potential for tight fitting spacer movement in the analysis of the overall risk posed by pressure tube to calandria tube contact going forward. •The consequences of the updated analysis were a reduction in the limiting operating time due to predicted pressure tube to calandria tube contact, as well as an increase in the number of channels predicted to require maintenance in future outages to reduce the risk posed by pressure tube to calandria tube contact.
00001924	International Equipment Reliability Benchmarking Report	2014/07/18	INPO	This report contains descriptions of programs and processes that can help support efforts to improve and sustain equipment reliability and nuclear safety.
00001923	Cracking on the Reactor Building (RB) Ring Beam	2014/07/18	Gentilly	•The water infiltration may affect the adherence of the Reactor Building (RB) repair mortar and freezing can cause ice strands to pull on the parging with a force greater than the parging-structure force of adherence. •When adherence of the parging is only ensured by the concrete-mortar contact, it is not sufficient to resist to temperature variations (day/night, especially in the winter) and to the combined effects of water (infiltration and freezing.
00001922	Summary Notes from the PRWG - OPEX from Others	2014/07/16	N/A	See the attached document for issues that the various refurbishment projects ran into, along with thelessons they learned.
00001921	Fort Calhoun Station - Overview of Lessons Learned of Nuclear Projects	2014/07/16	Fort Calhoun	Four key platforms used in this refurbishment were: Trust, fairness, honesty, and integrity.Be deliberate (actions under control); follow the rules.Supervisors/Managers set and continuously reinforce high standards.Do what you say you are going to do. Fort Calhoun also implemented an expanded risk management/mitigation strategy, ensured vendor accountability, andunderwent several self assessments and readiness reviews. For more lessons learned please see the attached documents.
00001920	Manley Recommendations - Pickering A RTS Unit 1	2014/07/15	Pickering	See the attached document for the 17 Manley recommendations.

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00001919	Bruce A Restart Interim Report	2014/07/15	Bruce A	Areas discussed include project type and organization, information management and project controls, documentation and configuration management (return to service), and quality assurance and procurement. For related recommendations and lessons learned, please see the attacheddocuments.
00001918	2009 Darlington VBO Lessons Learned Report	2014/07/15	Darlington	Poor quality design packages, assessed work order packages and late PSA/Contracts being awarded has led to challenges for the prerequisite work, late identification of materials to Supply Services and task scope growth. A more rigorous oversight is required for work that has been contract to an outside agency. The current practice is to allow the contractor to progress work but OPG is not providing sufficient mentoring or oversight to provide timely corrections and this has led to quality issues. Key outage Milestones need to have more rigour prior to signoffs to ensure success in the outage execution. Supply Services is able to fulfill the material requirements with a high level of confidence, if sufficient lead time is provided. A large volume of late identified material is putting a tremendous burden on the Supply Services department and the results are affecting prerequisite work, contractor work and execution work order walk downs. Although there are significant challenges ahead for the Darlington Vacuum Building Outage organization, based on the areas observed, the VBO has a reasonable change for success within the identified time schedule. The overall staff is well motivated to perform the required VBO
00001917	Manual Scram Following Reactor Water Level Oscillations	2014/07/15	Clinton Power Station	Design and operating margins have been reduced or challenged by human errors during the development of plant modifications and plant operating and maintenance activities. Contributing causes include incomplete technical evaluations and insufficient understanding of design and operating margins (to properly assess the risks associated with activities).
00001916	Use of OPEX Prevents Adverse Plant Impacts During Grassing Event	2014/07/15	Brunswick Steam Electric Plant	Ensure monitoring and predictive methods are in place to anticipate changes in site-specific environmental parameters. Periodically verify that environmental parameters do not exceed design basis assumptions or equipment maintenance strategies intended to mitigate environmental effects.
00001915	Hydraulic Control Fluid Degradation Causes Failure of a Turbine Control Valve	2014/07/15	Susquehanna Steam Electric Station	Ensure testing and preventive maintenance for turbine protection systems is sufficiently comprehensive to ensure reliable operation of each component and proper fluid qualities, including regular filter changes, fluid sampling, and verification of trip functions and backup pump operability.
00001914	Integrated Risk - Healthy Technical Conscience	2014/07/14	N/A	Several lessons learned come out of this document: Integrated Risk: While risk cannot be completely eliminated, the challenge is: how do we measure it, how do we minimize it as much as possible, and finally how do we manage the risk that remains. Managing First-of-a-Kind / First-in-a-While Projects: First-of-a-Kind / First-in-a-While projects are higher risk, requiring critical examination, highly specialized execution skills and stringent controls. Insufficient Technical Expertise: Engineering proficiency, gained through education, training and experience, is a key attribute for ensuring sound engineering judgment. Critical Design Requirements and Loss of Margin: Leaders and individuals ensure activities are conducted in a manner consistent with plant design, and that they preserve operating, design, and safety margins. Inadequate Testing: Verification testing should be mandated to verify critical design characteristics any time the operability of a new design cannot be confirmed analytically. Insights from Engineering Vendors: Well-disciplined project management requires detailed planning, collaboration, and strict adherence by all involved parties to project milestones and objectives. See the attached
00001913	Unplanned Actuation of Unit 2 Shutdown Systems After Turbine Trip	2014/07/11	Bruce A	An opportunity was learned to improve the modification planning and implementation process with details on how to search and apply relevant operating experience (OPEX).
00001912	Unit Safely Removed From Service Due to Pressure Boundary Failure	2014/07/11	Bruce A	Learned from this event was the importance of the oversight role contract supervisors have to ensure all work is completed to high standards and does not impact the station pressure boundary program. This event also highlights the value of conducting regular equipment walkdowns to monitor the condition of plant equipment.
00001911	Next Stage for Robotic Decontamination	2014/07/09	Fukushima Daiichi	Please see thewebsite article here for more information.
00001910	TVA to Manage Watts Bar 2 Project	2014/07/09	Watts Bar	See thewebsite article here for more information.
00001909	TVA Looks Again at Watts Bar Schedule	2014/07/09	Watts Bar	See thewebsite article herefor more information.
00001908	TVA readjusts Bellefonte priorities	2014/07/09	Bellefonte	The definition of a timeframe to verify remaining construction work and the rate at which it can be performed remains a priority for the project. The incorporation of lessons learned from Fukushima and the Watts Bar 2 construction project will also be areas on which efforts will be focused, Stinson noted. "Resetting priorities at this time makes good business sense," he said. See the online articlehere for more information.
00001907	Stakeholder Victory, Without Battle	2014/07/07	N/A	It is important that project teams and their managers understand what stakeholders are important, why they are important, and what they want. This understandingallows for development of a strategy to deal with these stakeholders. The strategy may then be implementedwith the help ofeffectivetactics.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001906	Public Roads - Sharing Experiences and Lessons Learned	2014/07/07	N/A	Lessons learned cover the general topics of:operating in a fishbowl (transparency);partnering;promoting innovation; andcontrolling costs. This article touches on only some of the lessons that project managers and engineers have learned by working on a megaproject. Whether lessons learned involve maintaining the public trust, making technological advancements, changing the way contracting is approached, or improving how private contractors, government, and the public work together, the end result is to continue to improve how transportation business gets done.
00001905	Getting Documentation Right Lessons	2014/07/07	N/A	Three important lessons are discussed:Know your source.Have clear, concise information.Use a repository. See the attached article for more information
00001904	Design-Build Practices for Transportation Projects	2014/07/07	N/A	7 Lessons Learned related to design-build practices are covered in this document:Select the appropriate project.Clearly define the scope of work.Consider riskallocation.Set aside traditional relationships.Select the best design-builder.Select the agency's best design-build team.Consider warranties or operational requirements.
00001903	Wisconsin Department of Transportation Best Practices	2014/07/07	N/A	Please see the attached report for specific lessons learned (best practices) for numerous aspects of project management.
00001902	Cost Estimating Guide	2014/07/07	N/A	High-quality estimates should satisfy four characteristics as established by industry best practices—they should be credible, well-documented, accurate and comprehensive. An estimate should be: 1. Credible when the assumptions and estimates are realistic. It has been cross-checked and reconciled with independent cost estimates, the level of confidence associated with the point estimate has been identified and a sensitivity analysis (i.e., an examination of the effect of changing one variable relative to the cost estimate while all other variables are held constant in order to identify which variable most affects the cost estimate) has been conducted. 2. Well-documented when supporting documentation includes a narrative explaining the process, sources, and methods used to create the estimate and identifies the underlying data and assumptions used to develop the estimate. 3. Accurate when actual costs deviate little from the assessment of costs likely to be incurred. 4. Comprehensive when it accounts for all possible costs associated with a project, is structured in sufficient detail to insure that costs are neither omitted nor duplicated, and has been formulated by an estimating team with composition
00001901	Point Lepreau - 2008 Refurbishment Outage Update (Report)	2014/07/03	Point Lepreau Generation Station	Lessons learned are covered in the areas of design, engineering, and procurement; safety, commisioning, health and safety, and the environment. Please see the attached documents for more information.
00001900	Point Lepreau - 2008 Refurbishment Outage Update (Presentation)	2014/07/03	Point Lepreau Generating Station	Some strategies that were used in this refurbishment project were:Keeping staff fully appraised of progress with letters and meetings.Having an integrated team and solid scope definition for outage activities.Ensuring oversight of all site employees and supplemental staff.Having a systematic and well documented approach to commissioning, return to service, and restart.Establishing a high level oversight committee for health, safety, and the environmentEnhancing radiation protection (see OPEX #1899). Please see the attached presentation for more lessons learned.
00001899	Radiation Protection at Point Lepreau	2014/07/03	Point Lepreau Generating Station	The refurbishment project HSE planning activities have resulted in several radiation protection program enhancements including: •the installation and deployment of additional fixed and portable radiation instruments; •the establishment of a dedicated dose control centre; •secondment of radiation protection assistants to AECL to ensure station expectations and practical experience is available to the contractor workforce. •expansion of the teledosimetry capability to minimise the number of protection assistants who have to be deployed in the field; •the development of a video and communication system to assist monitoring specific tasks and locations; •the development of tooling to enhance the ability to dry waste filters to ensure that tritium is well managed; •optimizing the use of existing change rooms by contracting out the supply and maintenance of the work and radiation area clothing; and •improvements to the dose monitoring information system to ensure relevant information is generated in a more efficient manner. These improvements should be taken into consideration by any radiation protection department.
00001898	Cernavoda Unit 1 Transient	2014/07/03	Cernavoda	Operators should always be aware of the refurbishment status of electrical station equipment. In this case, the operator did not realize that the cell A11 was not yet refurbished and therefore it is inactive in the SCADA. However the operator error would not have any direct consequence unless there was an error introduced by programmer during SCADA control program update.
00001897	Use of Contractor with Limited Resources Leads to Project Delay	2014/06/23	Oak Ridge National Lab	When a vendor is selected to accomplish a specific specialty task on a project, assure that they have adequate back-up resources available to perform the work. Additionally, as a function of risk management, assure that alternative methods, and sources, for unique applications are evaluated and available.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001896	Green/Good Work Practice - Maintaining Alignment Between Project Controls Tools	2014/06/23	WTP	There are multiple project control tools that maintain schedule dates at different levels of detail. It is important that schedule dates align between these tools and ultimately provide consistent quality reporting among different users.
00001895	Suspect Counterfeit Electronic Parts Online	2014/06/23	N/A	Many counterfeit parts can be purchased online from seemingly reputable vendors. It is important to only purchase parts from approved vendors, and to conduct tests to determine whether or not a part is legitimate if it comes from a questionable source. Counterfeit parts have the potential to seriously disrupt operations by the Department of Defense and ultimately endangerthelives of the troops. In terms of nuclear operations, counterfeit materialsare a serioussafety concern for all staff, as well as the public. As such, suspected counterfeit items must be disposed of and replaced with the legitimate parts.
00001894	Contractor Transition - Project Hanford Management Contract to Plateau Remediation Company	2014/06/23	N/A	Thelessons learned during FH's contracttransition are summarized as:The process for baseline change could have been simplified for transition planning.Interface management could have been better defined.The Transition Plan could have had improved definition of the specific tasks necessary for transition.There should be more agreement at the onset on the outgoing contractor's involvement with the incoming contractor's deliverables.Centralized interface management with clear roles and responsibilities is recommended at the start of transition.Ensure sufficient technical editing capability is assigned early to assist in preparing the transition plan.Personnel should be very familiar with Excel (or some other similar database).
00001893	Purchase of Measuring and Testing Equipment from Non-Approved Supplier	2014/06/23	LATA Kentucky Environmental Services, LLC	When purchasing critical items such as Measuring and Testing Equipment (M&TE), it is imperative that items be purchased through an approved supplier to ensure Quality Control (QC) programs are in place for the manufacture and calibration of these items.
00001892	Fuel Handling Trolley Unavailability Contributes to Unit De-Rate	2014/06/20	Darlington	This was a Human Performance error, which resulted in 6.5 shifts of unplanned unavailability for Trolley '3/4'.
00001891	Pipe Wall Thinning Beneath Ultrasonic Feedwater Meters	2014/06/20	South Texas (PWR)	This operating experience is being distributed to ensure that users of UTF for correction of FW flow measurement are aware that long term erosion of the internal piping diameter beneath the UFM brackets does occur. STPNOC uses A106 Steel for the Feedwater piping and has determined that the pipe wall wear rate is 4 to 5 mils per year. Wall thickness should be periodically measured to ensure that the assumptions made in the QA calculation remain valid.
00001890	Direct Current Circuits Challenge Appendix R Fire Analysis	2014/06/20	INPO	Extent of condition reviews can identify additional DC circuit wiring that does not meet the requirements of the Appendix R fire hazards analysis. Also, periodic monitoring of event notification reports to the Nuclear Regulatory Commission and reports entered in the INPO Consolidated Event System can aid in the prompt identification of similar design challenges at the station.
00001888	Vogtle 3 & 4 Commercial Facility Turnover - Lessons Learned	2014/06/18	Vogtle	Commercial Facility TurnoverDevelop and Implement a Plan Information HandoverPlan early including the EPC contract
00001887	Project Execution Plans	2014/06/18	Fluor Hanford	The timeframe when a Project Execution Plan (PEP) should be issued must be clearly stated.Team mustcomplete planning before executing their projects.Projects should focus on completing planning as a team and documenting that plan in the PEP rather than simply issuing a document of little value to meet a requirement.
00001886	Oversight of Procured Services	2014/06/18	Hanford T Plant	The special relationship associated with FH using affiliated resources may not be clear to project or facility personnel.Project staff and procurement support staff must work closely together to ensure procurement requirements are met. By terms of our contract with DOE, FH is responsible for services performed by FH Affiliates.
00001885	Boeing's Stumble: Lessons Learned - Risk Assessment is Key to a Successful Strategy	2014/06/18	Washington	As your company ramps up a significant new development effort, take the time to assess the risks. Take a look at threats - things that can impact you from the outside. Look for ways you can prevent the threats or reduce exposure. What are some early warning signs? Set up contingency plans and hedge your risk if you can. These are the traditional risk assessment and mitigation steps. However, often these steps are not enough. In addition - you must also look for ways you could avoid shooting yourself in the foot - as Boeing ended up doing. Boeing's problems did not just come from the outside; they were a direct result of actions taken by Boeing. Talk about the good ideas that you have, but also about the possible unexpected outcomes. For example, it was a good idea to mitigate the financial risk, but the unexpected outcome was to increase the execution risk. Identifying this upfront would have allowed Boeing to mitigate some of the execution risk or decide to keep more of the financial risk.
00001884	Excitation System Fault On Automatic Voltage Regulator Leads to Forced Outage	2014/06/16	Bruce Power	Review attached document.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001883	Use of Mockups in Demolition Planning	2014/06/16	LATA Environmental Services of Kentucky, LLC	The use of mockup in preparing to cut into insulated housing may have indicated the obstruction of vulnerable lines. Consider use of mockups for development of task plans and for training workers when tasks are complex or are performed in hazardous environment
00001882	Safety Tagging Event Results in Unplanned Trip of All Operating Condensate Booster Pumps Requiring Plant Load Reduction	2014/06/16	Ginna (PWR)	•The operations impact reviewer and SME demonstrated weaknesses in exhibiting a questioning attitude. The operations impact reviewer relied too heavily on input from the SME. •Station management did not ensure that senior reactor operators perform accurate and complete operations impact reviews for work orders and safety tagging. •The impact of a loss of power was not analyzed during the initial design and installation of a condensate demineralizer modification in 1977.
00001881	Long-Term Operations: Evaluation of the KEMA Smart Cable Guard System for On-Line Partial Discharge Detection	2014/06/16	EPRI	•This report documents an EPRI-sponsored evaluation of a commercially available system for the on-line detection of partial discharge in cables. •The information in this report is intended for use in supporting decisions regarding selection of on-line partial discharge monitoring equipment as a means of detecting degradation in extruded medium-voltage cables of the types commonly used in nuclear power plants. •In this evaluation, the on-line system in question did not demonstrate sufficient sensitivity to capture the partial discharge at levels that would indicate a cable is degraded. Such information can be of significant interest to plant operators as they look for the best ways to target valuable resources and limited funds.
00001880	Analysis of Vibration-Induced Piping and Tubing Leaks	2014/06/16	INPO	•Personnel conducting rounds or walkdowns should identify visible pipe or tubing vibration and physical conditions that could aggravate vibration effects. This is particularly important following design changes or permanent changes in system operation. •Design engineers should consider changes in vibration effects when modifying adjoining components within a piping segment. If repairs or modifications to components, such as pumps, valves or supports, affect a system's natural vibrational frequency, then connected small-bore piping or tubing should also be analyzed for possible vibration changes. This is important for locations that are inaccessible during operation. •Consider using a 2:1 taper/profile for all new socket welds that might be subject to any level of vibration. Also, consider pre-emptively replace piping and tubing near components with known vibrational problems with 2:1 weld taper profiles. •Work instructions and maintenance training should emphasize that pipe segments must not be bowed or bent to allow fit up for connections and should be aligned within welded connections.
00001879	Potential for SDS1 Trip Speed Reduction due to SDS1 Seal-in Delay	2014/06/16	Candu Energy Inc.	The seal-in delay feature, under a certain combination of conditions, could potentially reduce the SDS1 trip speed such that the SORs are slower than expected in reaching the first gate. This reduction in trip speed would occur if the SORs are out of their poised position when a channel trip clears before the seal-in delay elapses, therby resetting the seal-in timer, AND a 'real' SDS1 trip occurs before the SORs are withdrawn back to their poised position. Our analysis, which assumes the most conservative out of poised position for the rods when the above happens, indicates that there could be a delay of up to 70 ms. in reaching the first gate.
00001878	Workforce Skill Level Diversification May Lead to Cost Efficiencies	2014/06/12	Babcock & Wilcox	Work force experience and skill-level diversification may significantly reduce operating costs, while enhancing resource sustainability.
00001877	Clear Communication and Subcontractor Oversight Essential for Successful Project Outcomes	2014/06/12	Hanford	Clear communication between Hanford Site Prime Contractors prior to performance of work, ensuring correct organizational involvement, and providing close oversight of subcontractor activities is critical when coordinating complex work activities. Less than thorough attention to these details can result in misunderstandings and undesirable outcomes which create safety hazards and unnecessary additional costs.
00001876	Stakeholder Involvement is Key Component of Regulatory Success	2014/06/12	Energy Technology Engineering Center	Interactively involve stakeholders and regulators throughout the decision-making process in order to lessen regulator review time, reduce stakeholder questions, and increase stakeholder trust. Reliance on previous methods, that kept regulators and stakeholders at armslength, will likely inhibit a collaborative and efficient approach to project planning and execution.
00001875	Planning & Executing project work at an Existing Operating Facility: Potential Impacts	2014/06/12	Y-12 National Security Complex	Project planning, including cost and scheduling, for execution of work at existing operating facilities should consider the interim impacts of project modifications to the facility and potential changes in operational requirements.
00001874	Sharing of Independent Oversight Resources Among Sites	2014/06/12	Nevada National Security Site	Utilization of resources currently engaged in implementation of an NNSS Program increases the quality of the audit. Exchanging resources with another site significantly reduces the costs of the audit team and resources to manage site access of visiting personnel. Observing operations at another site provides workers with exposure to alternate programs and processes that may result in identification of improvement opportunities that can be implemented when they return to their home site. When pursuing resource exchanges with other contractors a Memorandum of Agreement is required at a minimum and should be started as early as possible with timely communication updates and coordination with the DOE office.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001873	Emergency Diesel Generator Excitation System End of Expected Life Guidance	2014/06/11	EPRI	The objective of this report is to identify the failure modes affecting the EVR system and how they impact the expected life of the overall system. The report also aims to provide guidance and recommendations for plant personnel to engage in long-term planning to preclude failures and obsolescence.
00001872	Circuit Breaker Remains Open following Grid Disturbance	2014/06/11	Darlington	Management of ageing equipment: the project to replace the UPS (including these logic modules) starts in 2016, however, components are failing ahead of this timeframe.
00001871	Transformer Temperature Gauge Failure	2014/06/11	Bruce Power	Since Unit 7 was offline when the incident occurred, the consequence was limited to an extended transformer outage. Winding resistance verified no transformer damage.
00001870	Near Miss When Construction Crane Counterweight Falls	2014/06/11	Barakah Power Plant	In this particular case there was a lack of communications between the teams and a lack of preparation by the supervisor in charge of the concrete pump boom where the normal controls for simultaneous operation of the concrete pump boom and tower crane were not in place.Communication is key during these events more lessons learned are captured on the attached document.
00001869	Analysis of Nuclear Power Plants Modifications Events	2014/06/11	COG June 11 #5	It was clearly shown that the modification process of the utility should be strong enough to ensure that all aspects of the impact assessment are covered at the design stage and, on the top of that, to allow the involvement of different entities in this process (designer, plant utility, contractor, different department in charge of concerned components and documentation). Besides the ordinary post-activity tests, the post-modification tests programme should be implemented in order to detect any deviation which may have occurred during the design stage or any negative impact which may have not be identified during the modification assessment, which means therefore that the scope of the post-modification tests should be as comprehensive as possible.
00001868	Loss of Off-Site Power	2014/06/11	Catawba Nuclear Station	Review digital equipment acceptance testing and postmodification testing processes to ensure that the full range of normal and abnormal operating conditions are included in test plans.The scrams related to digital modifications reveal a gap in the detailed depth of knowledge of the software functions and failure modes. These scrams revealed gaps between contemporary best practices in digital projects and station processes. A focus to validate design requirements, failure modes, vendor assumptions, and vendor claims was missing during design change development.
00001867	Restoring Owner Confidence in Alberta's Capital Effectiveness	2014/06/11	Alberta	Fouressential megaproject practices are identified: Clear business objectives, including clarity around cost, schedule, and operability tradeoffs.Full owner team staffing - no missing functions!Excellence in front-end loading.Stability in owner team leadership. These are the areas where most large projects fail. Their importance must be understood, and actions mustbe takenby the ownersto ensure better future performance.
00001866	Temporary Lift Assembly Failure Results in a Fatality, Loss of Off-site Power, Scram and Equipment Damage	2014/06/09	Arkansas Nuclear One	•UPDATE 4: Evaluation of the stator drop event revealed that important aspects are beyond the existing scope of SOER 06-01, Rev. 1, Rigging, Lifting, and Material Handling, and IER L4-12-67, Lifting, Rigging, and Material-Handling Concerns. •UPDATE 4: Ensure that safe work zones for lifting evolutions using an engineered temporary lift assembly encompass failure of the temporary lift assembly structure, when practical. Update procedures, training programs and qualifications to ensure nonessential personnel (those who are not required to be in the area to perform the lift) remain clear of a suspended load fall zone that includes temporary lift assembly structures should the assembly fail. •UPDATE 4: Perform an independent review of all vendor-supplied designs and calculations for engineered temporary lift assemblies to ensure that the design is adequate to lift and transport the required component and that all code requirements are met. (The independent review can be conducted by any qualified engineering organization not associated with the vendor supplying the temporary lift assembly design.) •UPDATE 4: If load testing of an engineered temporary lift assembly cannot be performed,
00001865	Reactor Coolant System Heat-up Limit Exceeded During Startup	2014/06/06	Clinton	In addition to addressing associated human performance errors, Clinton Power Station lessons learned include the following: 1. Revising the reactor coolant system leakage test procedure to include steps to ensure the main steam lines are drained following completion of the RPV pressure test. 2. Revising the preparation for startup checklist to verify that the main steam lines have been drained before entering Mode 2. 3. Identifying the need to develop and implement a standard computerized display that calculates heat-up and cooldown rates at 15, 30- and 60-minute intervals and incorporate into operating procedures.
00001864	Manual Reactor Scram during Main Feedwater Pump Changeover	2014/06/03	Clinton	Ensure procedures for managing plant modifications involving microprocessor technology mandate that all engineering judgments and unverified assumptions encapsulated within vendor software be identified and independently validated before modification completion. This includes function blocks, mathematical calculations, and modeled plant performance characteristics.Revise guidance in the station test procedure to verify acceptability of all operating scenarios and to specify actions to take when acceptance criteria are not met.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001863	Main Steam Line Hanger Disconnected	2014/06/03	Point Lepreau	Hand held accelerometers do not provide the accurate data required for main steam line vibration monitoring.Stations should have a pipe hanger ispection program in place for crucial equipment.Ensure proper knowledge and procedures are available when installing new equipment.
00001862	Delay in D2O Storage Project at Tritium Removal Facility	2014/06/03	Darlington	Less than adequate project management and risk assessment led to delays and associated economic impact.
00001861	Potentially Unavailable Secondary Control Area following Loss of Class III Power coincident with Main Steam Line Break	2014/06/03	Darlington	There was inadequate documentation of the design requirements in the technical specification and detailed commissioning specification for the replacement ACUs. This may be attributed to both a poor understanding of the requirements and failure to recognize the risk by the vendor/design agency.
00001860	Emergency Storage Water Valve Leak in the Pressure Relief Duct Resulted in Potential Shutdown of Operating	2014/06/03	Pickering	Degraded functioning of heat-tracing on the ESW valve V561 was not identified or corrected.Weaknesses in original ESW system design were not understood by Engineering, Maintenance or Operations.
00001859	Forced Shutdown Caused by Reactor Coolant System Pressure Boundary Leakage	2014/06/03	Monticello	Boiling on heat exchanger tubes or coils can lead to a concentration of chemical constituents, such as chlorides, that can produce degradation such as IGSCC in susceptible materials. Even in an environment with relatively low concentration of chemical constituents. Critical evaluation of a components operating parameters and associated potential effects and impacts need to be understood; assumptions need to be challenged; the evaluation results need to be applied to maintenance strategies.
00001858	UPDATE 2: Dual Unit Scram Following Loss of 13-kV Off-Site Bus	2014/06/03	Calvert Cliffs	•The cause of loss of 13 KV bus was because ice and snow caused a ventilation louver filter on the bus metal clad to push in, which allowed snow and water to contact the bus. •UPDATE 2: Temporary covers were installed on both outdoor 13-kV switchgear doors to minimize snow intrusion. •New filter holders were designed with two cross bars and vertical rods to prevent the filter from bending. •The turbine controls were modified to protect from high-voltage perturbations, which resulted from loading the diesel generator. •Evaluate the effects of voltage perturbations on equipment aligned per loss of coolant incident or shutdown sequencers, including 4-kV buses and lower-voltage buses/panels.
00001857	Improving Project Management	2014/06/03	DOE	According to the provisions of the 1993 Government Performance and Results Act, in addition to other financial and management legislation, DOE isrequired to meet mission and project challenges. To meet these challenges and those that will arise from the current and future portfolio of DOE projects, DOE must move beyond the legislatively mandated minimum performance. Accepting and implementing the recommendations of this committee for improved project management could result in a process in which projects receive strong support and stable funding and would be managed by professionals whose focus would be cost, schedule, and performance.
00001856	Planning of Mega-Projects: Influence of Execution Planning on Project Performance	2014/06/03	Alberta Oil Sands	The case study resulted in the sub-conclusion (6.6) that workface planning leads to higher labour productivity, and better predictability, resulting in a more efficient project environment. This leads to the following conclusions considering workface planning: Early involvement of the contractor, and more involvement of the owner, leads to better constructability of the project.Dynamic planning with work packages of one week ensures an efficient construction process.Centralized planning is better for mega-projects, as long as the foreman are involved in the planning process, and committed to the packages that they have to execute. With centralized planning the foreman has more time to supervise, resulting in higher quality of the end-product. For a more detailed discussion of lessons learned see pages 67 - 68 (section 7.3) of the attached document.
00001855	SCR No: N-2013-20078L - Discrepancies in Data Used for Refurbishment Component and Equipment Design	2014/06/03	Darlington Station	
00001854	Nuclear Refurbishment Facilities and Infrastructure Projects - Q-1 Lessons	2014/06/03	Darlington	Site infrastructures that are required to support the NR Program and continued operations are: • Water and Sewer • Site Electrical Distribution • Auxiliary Heating System • Waste Processing and Storage Buildings • D20 Storage Building • Holt Road Interchange • Project Office/Contractor Facilities The NR Program is leveraging mistakes made from the NR Prerequisite Projects and learning from them so we do not repeat them. On Wednesday, April 27, Ryan Smith, Manager of Nuclear Refurbishment (NR) Infrastructure presented a summary of lessons to be learned from the prerequisite projects to RPET. This report is presented as six main categories that break down into a number of lessons within each category. When these lessons are learned change will occur.Project Oversight Role is UnderstoodScope of Work is detailedTransfer of Risk is ExplainedIntegrated Schedule is understoodProject Estimates are clearly definedTeamwork is the only Business Model
00001853	Release Quality Estimates - Lessons	2014/06/03	DEC	12 Lessons Learned are discussed very briefly in the attached document. Please see this document for more details.
00001852	Life Cycle Management for Oil and Gas	2014/06/02	Ernest & Young	Lessones Learned in the document are: Finance and credit riskSchedule delaysIneffective cost management and lackInertia and lack of urgency responsibilitiesOperational impactNew operational challengesAsset integrityCross border controls

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001851	Personnel Expertise and the Amount of Risk Associated with a Project must be Considered	2014/05/28	National Security Complex Environmental Management	Management needs to consider the expertise and qualification of employees and subcontract personnel and the risk associated with various competing projects when allocating resources, and must evaluate and respond when new projects such as those funded by the American Recovery and Reinvestment Act (ARRA) require a large number of resources on an expedited schedule.
00001850	Execution of Oil Sands' SAGD Projects Lessons Learned	2014/05/27	Alberta - Oil Industry	Responses for each of the lessons learned were then averaged out and ranked from the highest to the lowest score. Knowledge/experience of management processes to execute large projects and communication between and within engineering, procurement and construction teams, were among the top ranked lessons learned.
00001849	How to Manage your Mega-Project	2014/05/27	KPMG's Engineering and Contruction Practices	There are six leading practices for continually improving your chances of project success. Please review the attached document.
00001848	Level of Detail Expectations Lessons Learned	2014/05/26	DOE	Schedule a meeting with subcontractors at the onset of development of "white papers," engineering studies, engineering calculations, and other documents to establish and agree upon the approach and level of detail required for contractdeliverables. When subcontractors are not clear on the approach and expected level of detail for subcontract deliverables, the cost and schedule may increase unnecessarily.
00001847	Clearly Defined Roles, Responsibilities, and Authorities are Important Even for Small Non-Line Item Projects	2014/05/26	Y-12 Site Office	Roles, responsibilities, and authorities need to be clearly defined early in the project planning process and flowed down in contract language when executing federally managed small business task order design/build construction projects.
00001846	New Construction Projects That Involve Lapses in Oversight Lessons Learned	2014/05/26	INPO	Develop a clear division of responsibility and detailed procedures to ensure effective oversight of design compliance with the licensing basis.Ensure multiple independent oversight groups, in addition to line management, routinely review and assess project performance against predetermined goals and milestones. Deviations are promptly reported to senior corporate executives.Develop and implement an oversight program for source and receipt inspections and to define the division of responsibility for owner oversight for inspecting materials used from fabrication to installation.
00001845	Supplier Oversight	2014/05/26	Savannah River Nuclear Solutions, Salt Waste Processing Facility	Nuclear Facility component supplier(s) capability verifications must include specific performance validations as well as the classical Quality Program adequacy audit checks. In addition, proactive and coordinated technical and quality supplier oversight is needed in all phases of critical procurements, from the initial qualification evaluations of the supplier through product delivery. Supplier assessments should be standards based to ensure compliance by employing both technical and quality assurance requirements, specifications and standards. Supplier assessments should focus on vendor performance and be conducted by subject matter experts in the area they are assessing, with either auditor/assessor training or the support of appropriate audit trained personnel.
00001844	Rigorous Oversight of Contractor's Supervision of their Vendors	2014/05/26	NRC	Perform rigorous oversight of suppliers to a prime contractor to ensure adequate flow-down and implementation of Technical and Quality Assurance (QA) requirements.
00001843	Reviewing Critical Path Method Schedules	2014/05/21	Critical Path Method (CPM)	CPM schedules allow better control of projects, early warnings of potential problems, andthe ability to identify where to focus efforts to avoid or solve problems. They also tell the project manager what has to be done, where, when, and by who.
00001842	Lower Mattagami Benchmarking Trip 2 - Lessons Learned	2014/05/21	Lower Mattagami Project	Please see the attached documents for more information on project planning, cost breakdown, scheduling, and the trip agenda.
00001841	Latest Lepreau costs under warranty - CEO	2014/05/12	Media Source	Status of its attempt to recoup the full cost overruns of the refurbishment.In court to recoup the insurance claim that was made by NB Power and will take other action after that. For more information please see the attached document.
00001840	Managing Generation and T&D Projects Successfully Using Enterprise Project Portfolio Management	2014/05/20	Presentation	Some lessons learned and importantconceptsfrom this presentation are:Strong engagement by PM practitioners and SMEs is important in all phases of a project.Frequent solution reviews to share solutions as they are being defined.Visible executive support.Phased onboarding of projects to the solution.Use of SWAT team to assist projects in onboarding to the solution. For more lessons learned please see page 10 of the attached powerpointdocument.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001839	Lower Mattagami Benchmarking Trip - Lessons Learned	2014/05/20	Lower Mattagami Project	Lessons learned from this OPEX are summarized in sections 3.1, 4.1, 5.1, and 6.1 of document 1839a.The following informationis taken from these sections. Project Oversight: 1)Refurbishment project should prepare a matrix describing where each of these oversight functions lies and ensure that there is adequate focus on each item (i.e not additional duties on a role already burdened with numerous other duties) 2)Refurbishment project should consider whether the Lower Mattagami budget allocation for oversight support (~2% of total budget) is achievable, and if not, why not. Note that there is additional OPG oversight on top of the Hatch oversight tasks, but in total the oversight applied to the lower Mattagami project is probably on the order of 5% of budget. QA/QC: 1)In developing a QA/QC oversight plan for the Darlington refurbishment project, we should ensure that OPG does not rely on audit methods alone, but includes a healthy measure of in-plant observations of work in progress. 2)A refurbishment QA/QC organization should develop policy regarding the use of witness points and hold points in contractor and sub-contractor ITPs to provide adequate opportunity to review work without
00001838	Ensuring Quality at Work - Pick-A Restart Design Engineering	2014/05/20	Presentation	
00001837	Hanford River Protection Project Construction Lessons Learned	2014/05/20	OPEXShare Website	(1) These events underscore the unpredictability of such hazards associated with demolition and the need to provide additional defense in depth, (e.g., enhanced cab protection) to protect against flying debris. (2) This event illustrates the importance of conducting detailed design reviews and engineering analyses of equipment and systems in order to guarantee that their design, installation, and function meet the requirements set forth in the Documented Safety Analysis and the Technical Safety Requirements. (3) The electrical circuit breaker problems identified in the NRC information notice underscore the importance of a strong circuit breaker maintenance program. Preventive and corrective maintenance can quickly identify and resolve electrical circuit breaker problems to ensure safe and reliable power delivery and equipment operation.
00001836	Managing Fabrication and Delivery of Vital Time-Critical Equipment	2014/05/20	OPEXShare Website	Each contractor should evaluate the value of placing company personnel withibn a fabrication facility when vital and/or time critical items are being produced. The presence of company personnel provides a clear reminder of expectations. By performing inspections during manufacturing, issues are identified early and resolved more cost effectively than finding them during receiving inspection or acceptance testing.
00001835	Nuclear Restart Early Lessons Learned	2014/05/20	AECON	Please see the attached document for specific lessons learned, as it provides a veryconcise summary.
00001834	Inadequate Design Verification	2014/05/20	OPEXShare Website	Documents used to verifydesign requirements must demonstrate that the requirements have been met. Documents that simply calculate what needs to be done do not verify that the design requirements have been met.
00001833	Estimated Building Inventories (waste streams) as the Basis for Project Baselines	2014/05/20	West Valley Demonstration Project	Though current, readily available estimates may be convenient as the basis forbaseline estimate, however, those estimates may not be accurate. Using those estimates as the basis for a project baseline or other project planning may result in underestimating the true cost and schedule of decommissioning work. For this reason, the wise project manager will attempt to validate volumes either by verification of the whole, or by rigorous sampling of a representative portion of the part, and comparing this with the original estimate in order to determine whether an additional quantity should be added as a margin of protection. If verification is not possible, then consideration should be given to adding generously to the volume assumed in the baseline, or by covering the estimation of quantities as an Imminent and Potentially Significant Risk.
00001832	Drilling Through Asbestos Tile	2014/05/20	OPEXshare website	Work instructions must identify all hazards in a clear and obvious manner. Workers must alsoreceive adequate training to allow them to recognize hazards before beginning work.
00001831	Cost and Time Control of Construction Projects	2014/05/20	Construction Management and Economics (May 2010)	The top five factors inhibiting time and cost control in construction practice in the UK were revealed as design changes; risks and uncertainties; inaccurate evaluation of project time/duration; complexity of works; and non-performance of subcontractors. Design change is the single most important factor considered by practitioners as hindering the ability to control not only time of construction projects but also cost.
00001830	Cost Estimate Classification System – As Applied in Engineering, Procurement and Construction for the Process Industries	2014/05/16	Faithful and Gould	This guideline reflects generally-accepted cost engineering practices. This addendum was based upon the practices of a wide range of companies in the process industries from around the world, as well as published references and standards. Company and public standards were solicited and reviewed by the AACE International Cost Estimating Committee. The practices were found to have significant commonalities that are conveyed in this addendum. Attached is the full report and is recommended that all groups involved with estimating may want to use.
00001829	Wet Scrape Failures During Testing	2014/05/15	Bruce	This incident resulted in a failure of the insert in the cutter tool during the development testing. The testing was delayed 3 days to complete the investigation. If failure of the insert were to occur during the on reactor commissioning phase, there would be a potential to leave a scrape indication with non-analyzed root radii resulting in added requirements for disposition for Fitness For Service.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001828	Irradiated Fuel Bundle Damaged during Transfer into Fuel Storage Module	2014/05/15	Darlington	Poor adherence to procedures and expectations resulted in a damaged fuel bundle, with separation of 2 pencils.
00001827	Adverse Chemistry Conditions in Shutdown Cooling Causes Delays to Unit Startup	2014/05/15	Bruce A	The station was successful at reducing copper levels by following station operating procedures and adhering to strict chemistry control requirements while the source was investigated. The station updated its chemistry control, operating, engineering and outage procedures to include specific instructions for chemistry control of the SDC system using the lessons learned from this event.
00001826	Pump Motor Brake Drum Rigging Event	2014/05/15	Bruce	No injuries occurred during this event. The brake assembly was damaged and had to be replaced.
00001825	Shutdown System 1 Shutoff Rod Adverse Trend Lessons Learned	2014/05/15	Bruce A	Analysis of these failures helped the station proactively identify and replace several SOR logic units that were reaching their end of life. The analysis also helped to identify an improved preventative maintenance strategy to calibrate new logic units on a more frequent basis to prevent SOR events.
00001824	Lessons Learned - Conventional Safety - Union Station Project	2014/05/14	Benchmark	Metrolinx are not comfortable with the "Owner Only Role" that OPG is familiar with due to a number of reasons listed here; •Not familiar with the concept, •Company culture is not comfortable with handing over projects to vendors, •Many projects are on 'live' tracks with the public in close proximity, and •Believe they have full control of the project if they remain Constructor. Key Observations: 1.We participated in a tour of Union Station track work that provided us with a few opportunities to observe the construction trades working at heights, craning and rigging, housekeeping, welding and masonry work. 2.JH&SC roles are run slightly different – each employer had their own committee and then they had the Constructor alignment meeting (weekly) to discuss issue with the Project. 3.CMO had a staff of 37 to manage Safety and Contract Execution…they considered themselves Safety Professionals. In OPG their role would be a combination of Safety and CA/CM roles. 4.We observed a number of High MRPHs event as we toured the site (a number of employers either not tied-off correctly or at all, working off the railing of a scissor lift, welding with visor up). The PM for the project that toured with us stopped each event
00001823	London Olympics Lessons for Good Management	2014/05/05	Power Magazine	Looking back at the Olympian project, Gibb said the key question is not "how" things worked out so well, but "why." In asking that question, he said, the project designers and managers concluded: "It's not rocket science, but the things we found that were making a difference were the things we all know about—respect, trust, empowering parties to work to the best effect, motivating people to achieve more than they think they can, being consistent, alignment in the supply chain, clarity, transparency, share commitment, and thinking ahead. They were good people with good processes." And, by the way, the construction project came in under budget, on time, and with extremely high quality. Review the attachment for more lessons.
00001822	Critical Path: Getting Your Outage Ducks in a Row	2014/05/05	Power Magazine	"You must have a good scope—know what you're going to do—you must have a good plan, and a good team. That's really what makes for a successful project," Starr said. "Now that sounds really simple, but there are a lot of activities that must go on to make that happen." If you've been involved in many outages, you've probably experienced maintenance periods that were run more like a mishmash of disconnected activities. Perhaps multiple contractors were brought in, each with different goals and schedules, none of which were integrated into an overall timetable. Managers who weren't used to the process or in touch with the big picture may have directed the work, which resulted in activity conflicts and ultimately outage delays.
00001821	Generator Seal Oil Leak to Environment	2014/05/07	Darlington	A lack of proper risk assessment and follow-up after previous equipment failure led to an environmental oil release.
00001820	Digest of Operations Human Performance Events	2014/05/07	COG	1. OE300917 – Revise Operating Procedure to include steps to ensure correct alignment during breaker racking and flush alignment in the breaker cubicle following racking. 2. OE304997 – There are no support processes existing for accountability of each connection for reach rods with multiple connection points, there are processes used which could have maintained accountability of connections points during the installation (i.e. Lifted lead sheets). 3. OE305042 – Weaknesses in coordination between operations and maintenance personnel and weaknesses in decision making and procedures resulted in inappropriate installation of jumpers and automatic initiation of AFW pumps. 4. OE305853 – A technical error caused by a back grounded clearance order note for the excess flow check valves associated with the individual Reactor Recirculation Pump Seal pressure sensing lines. This note caused Operations personnel to require backfilling of the pressure sensing lines, when in fact, backfilling was not required and known to carry a high degree of risk when not properly performed. 5. OE307353 – Provide guidance in EN-AA-203-1001 or station specific procedure for how to conduct the independent review of the Shift
00001819	Fire Protection Work Permit Near Miss	2014/05/07	PT Lepreau	If an event occurs be sure to understand the cause and not be to quick to conclude the event is one of which can not happen again
00001818	Nonconservative Decisions Lead to Multiple Inoperable Control Rods	2014/05/07	Pilgrim, Fitzpatrick (BWR)	- Issue resolution and decision-making processes must include both relevant and timely operating experience evaluation. - Risk-based decisions must be throroughly vetted using site-specific probabilisitic risk assessment processes. The results must be communicated to operations and other site personnel.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001817	Integrated Risk – Healthy Technical Conscience	2014/05/07	INPO	Consequential engineering errors are impacting plant safety and contributing to broader enterprise risk at a time when energy market economics, post-Fukushima public confidence, and regulatory margin remain fragile.
00001816	London's Lessons for Good Management	2014/05/05	London Olympics	Looking back at the Olympian project, Gibb said the key question is not "how" things worked out so well, but "why." In asking that question, he said, the project designers and managers concluded: "It's not rocket science, but the things we found that were making a difference were the things we all know about—respect, trust, empowering parties to work to the best effect, motivating people to achieve more than they think they can, being consistent, alignment in the supply chain, clarity, transparency, share commitment, and thinking ahead. They were good people with good processes." And, by the way, the construction project came in under budget, on time, and with extremely high quality. And, again, no one died. You can check out a time-lapse video of the growth of the London Olympic site - Please refer to attachment for link.
00001815	Clear Communication and Subcontractor Oversight Essential	2014/05/01	Department of Energy	- Ensure key reviewers/stakeholders review and provide input on designs especially when previous reviewers are no longer in the same roles. - Establish key interface points of contact. Ask, "Who else might be impacted by this?" when working on a project. By asking this question, it helps ensure that the right people are involved in the decision making process. - Put all plans in writing to be sure the plan is clear before the task is performed. - React promptly to correct mistakes – especially in the case of a safety hazard. - Perform post-job walk downs with the impacted parties. - Flag areas which might be a safety hazard. - Always have a questioning attitude and stop and ask for assistance if something doesn't appear correct (i.e., placing curbing over a crosswalk).
00001814	Trend: Fleet Fuel Handling Equipment Reliability	2014/04/30	Pickering & Darlington	An analysis of fleet fuel handling equipment reliability identified four areas of common cause.
00001813	Hand Injury during Ventilation Fan non-intrusive troubleshooting	2014/04/30	Bruce	Lost time injury; the worker's left index finger was amputated at the knuckle.
00001812	Level 1 Impairment of Emergency Cooling Injection	2014/04/30	Bruce A	Operations to assign a full time HU Advocate on days to provide strategic programmatic support to operations leadership and feedback on HU tool usage, and reinforcement to Operations Leaders. HU Advocate to establish an Operation Human Performance Committee with a charter.
00001811	Lessons Learned From New Construction Projects That Involve Lapses in Oversight	2014/04/30	INPO - Institute of Nuclear Power Operations	The lessons contained herein are relevant to commercial nuclear plants under construction and to organizations pursuing new commercial nuclear construction projects. In almost all cases discussed, oversight issues impeded project quality and schedule, and contributed to increased costs. Review the attached document for the complete story.
00001810	Estimated Building Inventories (waste streams) as the Basis for Project Baselines	2014/04/30	Department of Energy, West Valley Demonstration Project	Estimates of building inventories (waste streams), such as for length of building piping/conduit (by room or total building), or ACM, should be treated as approximations for purposes of baseline planning. If possible, estimated inventories should be thoroughly reviewed or sampled to verify their accuracy before use. If verification or representative sampling cannot be performed, then the quantity shown in the inventory should be increased by a defensible margin or addressed as an Imminent Risk. Inaccurate estimates of piping/conduit and ACM in the have had an impact cost and schedule performance of the WVDP decommissioning project.
00001809	Tailoring Communication for Top Stakeholders	2014/04/30	PMI	Enter the mutuality matrix, a useful project communications tool that starts with two dimensions: •Each stakeholder needs something from the project to further his or her interests, or alternatively, needs nothing from the project. •The project requires the active support (assistance or resources) of the important stakeholders, or alternatively, requires nothing from the stakeholder. These assumptions create four quadrants for categorizing each of the important stakeholders: •Project needs nothing/stakeholder needs nothing: Stakeholders in this quadrant are usually protesters. In this case, you have two communication options: You may be able to defuse their opposition by providing better information, but this only works if the protesting is based on false assumptions. Otherwise, you may choose to limit communication with the stakeholder whilst keeping the communication channels open. •Project needs nothing/stakeholder needs something: The stakeholders in this quadrant are the easiest to manage from a communication perspective. You are already providing their requirements as part of the project deliverables. All that's required is to provide reassurance that their needs will
00001808	Scram Analysis-Use of Operating Experience	2014/04/16	INPO	Consider performing a review during scram cause investigations to identify and document any applicable OE that would prevent the scram. This review should consider applicability and station responses to IER L2-11-2, 2009-2010 Scram Analysis, recommendations (including the additional recommendations) and IER L4-12-69, 2011 Scram Analysis, recommendations and the reason(s) the recommendation(s) did not prevent the scram. For further lessons learned, please see attachment.
00001807	Fire in 480 VAC Bus Results in Manual Reactor Scram and Emergency Declaration	2014/04/16	Harris (PWR)	Corrective action to address the root cause is to establish a life cycle management replacement preventative maintenance (PM) of Critical DryType transformers. Details for the additional correctiveactions are contained in the Root Cause Evaluation (RCE).

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00001804	Flash Report - Nuclear - Darlington - Medium MRPH - Critical Injury (14-0013)	2014/04/25	Darlington	A review of required Personal Protective Equipment (PPE) in a rubber area identified that anticontamination coveralls were not required in addition to the standard radiation area coveralls. Going forward sentrys will minimize wearing two layers while executing the oversight role. Addtionally more frequent relief breaks will be utilized when the ambient temperature can be a factor.
00001803	2012-2013 Outage Planning Review Visit Summary	2014/04/17	Twenty-three Outage Panning Review visits (OPRVs) ranging from 2012 to 2013	Risk management, shutdown safety, project management, and outage management during outages would be improved by meeting the intent of the following insights: 1. Station standards and practices for considering equipment available are clearly defined and implemented. 2. Shutdown safety contingency plans are fully developed, meet the criteria defined in procedures and SOER 09-1, and are tested if required. 3. During outage schedule development and review, periods of elevated risk are appropriately identified and managed, including minimizing the time at lowered inventory and other elevated risk periods. 4. Shutdown risk-related procedures are reviewed for gaps against fleet procedures and industry standards. 5. The outage scope/schedule change process is rigorous, and appropriate controls are in place to re-evaluate shutdown safety risk when changes are made. 6. Procedures and practices for containment closure align with SOER 09-1, Recommendation 11. 7. Procedures and practices for managing lowered inventory align with INPO 06-008 to prevent the potential for increasing the time at lowered inventory because of either an equipment failure, such as a crane, or a problem
00001802	Non-conservative Decisions Lead to Multiple Inoperable Control Rods	2014/04/15	James A. FitzPatrick Nuclear Power Plant	1. Issue resolution and decision-making processes must include both relevant and timely operating experience evaluation. 2. Risk-based decisions must be throroughly vetted using site-specific probabilisitic risk assessment processes. The results must be communicated to operations and other site personnel.
00001801	Report on Radiologically Contaminated Respirators	2014/04/25	UniTech Services Group	Respirators were not kept separate at Y-12 with respect to which were to be used in contaminated or clean areas.
00001800	Supervisory Functions Should be Specified in Contract Documents	2014/04/25	DOE Office of Fossil Energy (FE-7)	Specific required supervisory functions should be specified in contract documents
00001799	Good Work Practice for Stabilization of Highly Radioactive Contamination in Pipes	2014/04/25	River Corridor Closure Project	An epoxy product was developed and used in the 327 Building Radioactive Liquid Waste System pipes to provide stabilization, isolation and void-fill in preparation for demolition in 2008 by the Washington Closure Hanford company under the DOE River Corridor Contract. The low viscosity and long pot-life characteristics of this product allowed it to be quickly poured into the system from a low dose location to fill the small hot-cell branches, ensured penetration of dry sediment, and resulted in excellent permanent encapsulation. The low exothermic, low volatility, low flammability and non-toxic characteristics made it safe and acceptable for use within strict requirements of a DOE nuclear facility. The non-shrink, rubber-like cured product adheres well to the pipe walls and allows shearing the pipe without fallout from crushing. In shearing tests, the epoxy remained attached to the pipe, which ensures containment of contamination.
00001798	Unclear Communications Lead to Security incident	2014/04/25	Pacific Northwest National Laboratory	PMs need to provide clear, precise directions to contracted staff when projects involve classified materials. ADC Reviewers must clearly communicate classification determination, especially when multiple project documents are being reviewed.
00001797	Events related to the supply of NPP Components	2011/12/31	IAEA	Topical Operational Experience Report on events related to the supply of NPP components.
00001796	Excessive Wear discovered on travelling screens of cooling water intake channel could potentially cause loss of common water on the units	2014/04/24	Pickering	Excessive wear of the Travelling Screens increases the risk of Travelling Screen collapse, resulting in an inability to filter Cooling Water entering the Station.
00001795	Digest of Fire Protection Events	2014/04/24	COG	OE301580 – Area of fire origin had thermal detection which actuated as designed. Fixed fire suppression system automatically actuated and suppressed the fire.OE307194 – This was the result of vague guidance in the planned worked scope where no post maintenance testing was required or performed.OE307852 – Administrative controls must be in place to ensure purge flow rates are adequate to remove hydrogen and oxygen but flexible enough to support welding.OE308707 – Designate machining of combustible metals (Titanium) to be treated as hot work and be subject to Site Hot Work Procedure.OE309867 – Unburned fuel and oil products that leak from the diesel generator exhaust system joints can cause and have caused fires at these joints.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001794	Digest of Lifting and Rigging Events	2014/04/24	COG	•OE305240 – Replace the service water intake structure gantry crane dynamic breaking unit with a newer model unit less susceptible to intermittent failure. •OE305631 – Verify the cable length and reel capacities for all cable reels on refueling platforms. Ensure margin exists such that cable stacking will not cause the cable to walk over the reel guide. •OE306004 – The lessons learned from this incident, including missed communication, teamwork, and procedural barriers that could have prevented the event, were discussed with the work crews, and refueling project personnel. •OE308838 – MMD Manager to re-enforce expectation to stop work when workers find themselves outside of procedures & processes and when using tools and equipment that are not functioning correctly. •OE308875 – Ensure work planning and job briefings include the appropriate precautions for the movement of heavy loads. Pre-job-briefing discussions should include potential hazards, communication methods, and expectations for stopping work when conditions change.
00001793	How to Capture Lessons Learned	2014/04/17	Voice of Project Management	During every process of the project life cycle, data is gathered and information obtained that can be beneficial toward future projects. It is therefore essential that, as a project manager, you do not wait until the completion to gather this information, but do so with the project team on a continuous basis. At each project meeting, take time to ask a series of questions designed to draw out the various interactions and experiences from the project team. To focus the discussions, you can organize around the following three areas: People, Process and Product. The topic for this article wassuggested by Anne McIntyre, PMP, of Sacramento, California, USA. She has worked in the field of project management for nine years. People: Questions in this category should relate to team effectiveness and stakeholder interactions. Sample questions include: 1.What did we learn about staffing — skills, knowledge, experience — that will help us on future projects? 1.What are the lessons learned about the issues that caused conflict among the team, and by the manner in which we resolved the problems and took corrective action? Process: Questions in this category should relate to the inputs, tasks and outputs of the project processes.
00001792	Muskrat Falls project behind schedule, over budget	2014/04/16	Nalcor Energy Company	Please review attachments, more information will follow. We are folloing this project.
00001791	Lower Mattagami Lunch and Learn	2014/04/17	Lower Mattagami Hydro Generating Station	•The cost of oversight for the project was 5% of the overall budget •Oversight during execution means someone actually needs to be in the field overseeing the work, not just receiving reports •P6 was used for a high level scheduling program but did not break down the day to day activities that needed to be accomplished •Must clearly separate oversight from execution
00001790	Expected Condition of Reactor Cavity Concrete After 80 Years of Radiation Exposure	2014/04/16	Electric Power Research Institute (EPRI)	It appears that none of the required functions of the biological shielding will be compromised by radiationinduced material changes or radiation-induced heating of the concrete. This report also provides recommendations for testing and consideration of other issues that may be useful to supplement existing information.
00001789	Potential for Teflon Material Degradation inContainment Penetrations, Mechanical Sealsand Other Components	2014/04/16	Nuclear Regulatory Commission	General Design Criteria require among other things that reactor containment penetrations, regardless of their electrical classification, be designed so that the containment structure and its internal compartments can accommodate, without exceeding the design leakage rate and with sufficient margin, the calculated pressure and temperature conditions resulting from any loss-of-coolant accident.
00001788	Digest of Engineering / Safety and Licensing – Flooding Events	2014/04/16	COG	1. OE307441 – Station Management did not ensure proper validation of the external flooding mitigation strategy design bases commensurate with safety significance which lead to non-conservative decisions. 2. OE307918 – Inspect underground vault penetrations into safety related structures if any penetrations are below design flood basis height. Installed new penetration seals to minimize effects of flooding. 3. OE308217 – Verify adequate external flooding program elements are in place, including adequate inspection PMs for flood protection features, design basis information, and identification of flood protection features in the equipment database. 4. OE308722 - The risk associated with the changing post Fukushima environment was not adequately addressed through less than adequate OE behaviors of "it can happen here." 5. OE308985 – No effective ownership of Flood Seals as a program or a procedure. Designate responsible site engineer for maintaining overall responsibility for flooding seal program.

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00001787	Digest of Engineering / Safety and Licensing Events	2014/04/16	COG	1. OE304787 – Revision of the Surveillance Test procedures and training the Licensed Operators andShift Technical Advisors on meeting Emergency Core Cooling System flow requirements. 2. OE305256 – A high level of technical rigor is needed to ensure surveillance testing methodologies are adequate to meet testing objectives required by Technical Specifications. 3. OE306456 – When UFSAR related conditions adverse to quality were identified, station personnel did not demonstrate a bias for action to ensure that the operation and description of the facility was accurately reflected in the UFSAR. 4. OE309108 – Revise procedures to capture traceability information for Amptector trip units and CTs and require an MDIR to be initiated in those instances when these parts are not withdrawn from the warehouse. 5. OE309129 – The need to resolve issues in a manner commensurate with their inherent importance to the operating facility utilizing the Corrective Action Process.
00001786	Adjuster Rod Ageing Impacts Neutron Over-Power Trip Set-Point	2014/04/16	Darlington Station	Ensure adjuster rod aging is accounted for in future safety analysis.
00001785	Management of Third-Party Contracts - Replace Lighting and Upgrade HVAC Controls	2014/04/11	Los Alamos National Lab	Asbestos-containing insulation should be expected and accounted for in subcontracting for demolition or renovation of buildings constructed before the use of asbestos in building materials was suspended. It is advisable that subcontractors should be made fully responsible for their safety and health support as well as the remediation of any potential hazards in the workplace. Third-party funded projects require special diligence to ensure that these complex contractual agreements do not impede effective project execution. Unclear or unenforceable lines of authority and responsibility can lead to execution inefficiency and increased total project cost.
00001784	Why Do We Care About Scope of Work?	2014/04/10	Oak Ridge National Laboratory	The first thing we ask when creating a Work Order, Work Plan or a Research Safety Summary is "What's the scope?" You may have asked more than once, "Why do you care?" The scope of work is a description of the work activities that is in sufficient detail and clarity so that the hazards associated with the work can be identified and controls can be selected to protect the workers from the hazard. A well-defined scope can also help those planning an activity to appropriately schedule, assign resources and set priorities. Here's a somewhat simple example. A coworker asks you to help him move some equipment between two areas. He says there's not much and it probably wouldn't take more than an hour. You agree and follow him to the area where the equipment has been packed into ten copier paper boxes. Do you still agree this is something the two of you can do with no further resources? You look into the first box and realize that it contains some sizable metal parts. You attempt to lift the box just enough to get a feel for how heavy it is and guess it's at least fifty pounds. Do you still agree this is something the two of you can do with no further resources? You look into the next box and note that it
00001783	#UPDATE# Dual Unit Scram Following Loss of 13-kV Off-Site Bus	2014/04/09	Calvert Cliffs (PWR)	•The cause of loss of 13 KV bus was because ice and snow caused a ventilation louver filter on the bus metal clad to push in, which allowed snow and water to contact the bus.
00001782	Potential Manufacturing Defect in Replacement Masterpact Cradles	2014/04/09	Nuclear Logistics	•Notification of a potential manufacturing defect concerning primary disconnect assemblies used on Masterpact replacement cradles. These assemblies are used in the replacement of the circuit breakers in low voltage switchgear. •NLI will submit NLI Technical Bulletin TB-14-001 to all facilities where the potentially impacted Masterpact breakers have been installed. The technical bulletin provides a summary of the issue and provides instructions for inspection and testing of the cradles.
00001781	Initial Development of Virtual Sensors for Vertical Pumps	2014/04/09	EPRI	•This report is intended for plant owners and managers, as well as maintenance and plant engineers. It describes the proof-of-concept work accomplished to develop a virtual sensor for vertical pumps, along with a justification for continuing to the next phase of the project, which will involve additional feasibility trials
00001780	Unacceptable OSHA Recordable Injury Rate	2014/04/09	Arkansas Nuclear One (PWR)	•A culture change to improve industrial safety behaviors requires a consistent approach for action across the organization using multiple elements. To achieve success the organization must maintain a focus on industrial safety behaviors and the actions must be sustained over a prolonged period of time.
00001779	Digest of Supply – Material Quality Events	2014/04/09	COG	•OE305631 – Verify the cable length and reel capacities for all cable reels on refueling platforms. Ensure margin exists such that cable stacking will not cause the cable to walk over the reel guide. Hoist: Par Systems – PAR1 •OE307152 – Cause of the issue was a bolt not tightened during manufacture/assembly. Proper torquing of connections can prevent arcing. Transformer: Areva – 345KV custom fabricated. •OE308243 – when modifying critical safety related equipment, all details of all work affected by the modification need to be understood and correctly documented in the work instructions. In the absence of this specific knowledge, research and collaboration may be required to develop the proper work instructions. Pump: Goulds Pumps, Inc. – 3415-DV •OE308692 – Revise the Procurement Engineering procedure to incorporate the same walkdown criteria used by Design Engineering when performing plant modifications. Specific emphasis will be placed on existing motor identification since this issue was common to several events. Generic issue. •OE308996 – Areva has been requested to revise its purchasing documentation to add QA test requirements for acceptance of new cables.

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00001778	Generate Action in Project Status Reports	2014/04/09	Project Management Institute	As it stands, the current status of a project or task either gives a call to action, which creates further productive activity, or it leaves things as they are. For example, a task status might say, "Completed the requirements document." While it's a valid update on the task, it only tells us something that is already in the past. Rewording your updates to generate a vision of current action is more helpful. Consider if the status update said, "Reviewing the completed requirements document with the business owner." By including the present tense, the status presents the same information, but it adds an action-oriented, current, activity-based standing. As a result of using present tense, I've noticed that the action of simply reporting on status has generated further action. It actually put me directly into the doing part of action, rather than talking about the action. Let's say I receive a status update that says, "Kim is getting the screenshots of the system alert message," or, "John is reviewing the requirements document with the business owner." From this, I would know to follow up with Kim on whether she got the screenshot and set a reminder to connect with John and find out how the review went. Review one of
00001777	Keep the Schedule Plan Strong -- and Constraint-Free	2014/04/07	Project Management Institute	Projectstakeholders will want to see your project schedule and understand whether you are on track to deliver it on time. The beneficiaries of your project will want to see it to understand your next deliverables or key milestones. Your core project team will seek it out to find out how work activities are planned and relate to one another, and how resources are allocated. And, probably most important, you as the project manager will need it to be your map throughout the project, guiding you to drive the project to its target. If your project schedule is incomplete or flawed -- for example, it's missing work tasks or it features wrong dependencies between project tasks -- you will most likely steer your project into a wall. And even if you put everything right into it (i.e., all work activities, the right durations, right resources assigned, right dependencies), that still might not be sufficient for a successful delivery. That's because, as you know, a project schedule is not a linear sequencing of work tasks that perform exactly as initially planned. ? In addition, your project schedule will be subject to the project's challenges and constraints, such as resources scarcity, work overload, aggressive milestones or delays. It's these
00001776	3 Techniques for Breaking Constraints - Schedules	2014/04/07	Project Management Institute	Schedule crashing This technique focuses on the tasks on the critical path. Shortening them reduces the total duration for meeting a given deadline or milestone. And delivering a project in its entirety, with no scope change, in a reduced time can only be achieved by increasing or improving the resources allocated for that task. As an example, let's take a software project aimed at creating a new system, and migrating functionality and data from an older system. You could reduce task time by allocating more programmers to develop in parallel the functionality of the new system. Similarly, to shorten the data-migration time, you could replace a regular computing machine with a more powerful one. Be aware that crashing the schedule will generally increase costs. And sometimes, there will be tasks that will have the same duration, no matter how efficiently they can be performed (e.g., monitoring the stability and reliability of a component for a fixed time). Fast-tracking Chronologically reversed, programming the new functionality (task number one) depends on designing it first (task number two), which depends on a gap analysis task (task number three). By applying fast-tracking to these
00001775	SCR- Condenser Waterbox Vacuum Breaker Failure Risk to Generation Production	2014/04/08	Darlington Energy Centre	1. Recommend that the 4 component groups (Vacuum breakers, RVs, SVs, and PRVs) associated with vacuum priming system be re-assessed for criticality to N-PROC-MA-0077 criteria. (Aside: Recognizing that the vacuum breakers are CC2 and that the other 3 components must function correctly for the vacuum breakers to function, then these other components should also be CC2 per criterion P7 of MA-0077. Following the recommended simulation per 3 below, a case may be made that these 4 component groups should be CC1/Single Point Vulnerability (SPV) under criteria P1 and/or P4 should it prove the consequences to be more significant.) 2. Recommend that the vacuum breaker failed open be simulated to determine the likely unit response with a possible operating procedure update to follow. 3. Recommend preparing/revising CCAs for the 4 component groups to reflect any changes in the criticality codes that come out of 1/3 above consistent with N-PROC-MP-0060.
00001774	Refueling and the Complex Overhaul of the USS Nimitz	2014/04/07	Newport News Ships	-Many similarities can be drawn between this project and the refurbishment project when it comes to management of budget, schedule and the general scope of work -All stakeholders must have the opportunity to provide sufficient input into the project -A strong understanding of the budget available to a refurbishment project must be attained before the scope of the workpackage can be accurately developed -Stronger front end planning would have greatly assisted the success of this project
00001773	Expectations for Walkdown/OPEX Reports Developed Refurb Modification Definition Packages	2014/04/04	NR Engineering	-P.Eng will no longer have to apply the P.Eng stamp to walk downs performed for Darlington Modification Definition Packages

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00001772	Nuclear Regulator's Role in Assessing Licensee Oversight of Vendor and Other Contracted Services	2014/04/04	NR Engineering	- Many challenges exist between Licensee and Contractor -Through any contract, The licensee must always maintain ultimiteresponsibility for the quality of work performed - Licensee must not only ensure quality of work from the contractors, but the chain of sub-contractors as well -Licensee must also ensure the contractor and sub contractorare complying with allcodes and regulations
00001771	WANO 2013 Operating Experience Annual Report	2014/04/02	WANO	•Event reports and trends in 2013 indicated several issues that challenged nuclear safety, personnel safety and plant reliability. •The most significant issues and weaknesses, according to OECT trending and analysis, were those associated with the following functional and cross-functional areas of the WANO PO&Cs (2005 version) and the effectiveness of implementing SOER recommendations: •Equipment Performance and Condition, Work Management, Conduct of Maintenance, Conduct of Engineering, Conduct of Operations, Plant Status.
00001770	Cyber Security Procurement Methodology, Rev. 1	2014/04/02	EPRI	•Research has shown that a standard set of cyber security control requirements with a standard set of procurement specifications is not feasible for the multitude of equipment types, vendors, and use cases that exist. Therefore, a methodology has been developed for determining the appropriate cyber security requirements for each use case as informed by a number of factors.
00001769	Low Channel Flow after M09 SFCR	2014/04/02	Darlington	•The impact of Single Fuel Channel Replacement (SFCR) on Primary Heat Transport (PHT) coolant flow through channel M09 was not anticipated.
00001768	Emergency Diesel Generators Opposed Piston Engine Exhaust System Leakage Corrective Action	2014/04/02	Prairie Island (PWR)	•Maintenance personnel indicate loose bolts are being identified on the exhaust system. The loosest bolts identified are at the exhaust manifold connection to the side of the engine. A modification was performed to address the identified design issues. The need to periodically remove the exhaust piping and manifolds to address leakage to prevent a potential fire have been eliminated (based on approximately 15 months of inservice time since modification installation).
00001767	Pickering A RTS- Ensuring Quality at Work	2014/04/01	Pickering A	1. Organizational responsibilities will be defined and understood. 2. Personnel will be competent at the work they do. 3. Individuals will be held accountable for their work. 4. The right people will have the right information at the right time. 5. Relevant experience will be sought and used. 6. Work will be planned and controlled. 7. The right items, processes, and practices will be used. 8. Work will be verified to confirm that it is correct. 9. Deficiencies will be identified and remedied. 10. The root cause of deficiencies will be identified and corrected. 11. Changes to accepted items, processes, and practices will be controlled. 12. The preparation and use of documents will be controlled. 13. Essential records will be maintained. 14. Periodic assessments of program effectiveness will be conducted.
00001766	Wrong Unit Event U-2 Moderator Cover Gas Inadvertently Depressurized	2014/04/01	Darlington	- Always self-check your work before you perform anything, especially if you have stopped the work for any reason and returned to it.
00001765	Procurement: A Project Manager's Best Friend	2014/04/01	Project Management Institute	- Always share details of the project with the procurement team, they likely dont know the exact scope and expectations as well as you do. - Clearly delegate responsibilities, this will allow for a better flowing team effort - Engage the procurement team, they should be as involved with the project just as much as anyone else including being a part of the status updates
00001764	Start with an Audit	2014/04/01	SoftChoice	- Always find one singular collaboration tool and ensure that everyone is satisfied with it
00001763	Inspection Notice - Chest Strap Adjusters on Delta and Exofit Harnesses	2014/04/01	Capitol Safety	- Always inspect harnesses before use and keep in touch with any recall news from any of the safety equiptment suppliers
00001762	Red Wing Shoe Company Work Boot Recall	2014/04/01	Red Wing Shoe Company	- Be sure to check your own work boots against the list of affected products
00001761	Nylon insert in quick connect buckles on Exo-Fit NEX full body harness found to have cracks.	2014/04/01	Atikokan GS	- Handle all harnesses with care and always inspect the harness carefull before usage.
00001760	Yoke Industrial Corporation - Product Notification - Missing or defective rivets on snap hooks	2014/04/01	Yoke Industrial Equiptment	-Always ensure to look over your safety equiptment thoroughly before use. Many people assume that if it has been used before, it will be okay.
00001759	Quality plans not approved by OPG prior to execution of work	2014/03/26	Darlington Refurbishment	•Accountabilities need to be clearly defined regarding Quality Assurance (QA) between Contract Management, Supply Chain and Quality Engineering for Master Service Agreements (MSAs).
00001758	Design Quality Issue – Total Residual Chlorination (TRC) Sampling Flow Inadequate – Pickering B Reactor Building Service Water (RBSW) Dechlorination and Effluent Monitoring Project	2014/03/26	Pickering B	•Piping configuration issues combined with filters that were clogged with silt resulted in inadequate flow to allow for reliable readouts of chlorine residual concentrations. The pump couldn't deliver the required flow.
00001757	Annulus Gas Unavailable for Primary Heat Transport System Leak Detection	2014/03/26	Darlington	•A Failure Mode Effect Analysis (FMEA) should have been completed for the original flow indicator/transmitter, as it was identified as a Single Point Vulnerability (SPV).

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00001756	Blocking of the Path of Cooling Down During the Change of Manipulation of the Configuration of the Circuit Cooling Down	2014/03/26	Mochovce (PWR)	•Elaborate new instruction "Manipulations on the Secondary Circuit during the Unit Outage" with the attention paid to ensuring the heat removal from the reactor and the spent fuel pool and use of the "labelling tool" in the case of the configuration change.
00001755	Container Storage Pad	2014/03/27	NR Engineering	Unsafe working practices lead to accident. Excessive noise level is a contributing factor in accident. Safety aspects of task not emphasised.
00001754	Startup-Commissioning	2014/03/27	CII	Planning for startup is a critical phase in retruning from a project to a operating plant this 163 report walks you through many scenerios and details concerning procurement, detailed design, engineering and operations lessons learned.
00001753	Steam Generator Feedwater Flow and Pressure Transient While at 100% Power	2014/03/12	Turkey Point (PWR)	•Instructions for the conduct of independent reviews of all extended power uprate-issued engineering changes will ensure that product risk and consequence assessments and associated conclusions are brought forth into design change prejob briefings on critical parameters of the task. •Independent reviews should determine whether sufficient industry and vendor operating experience is considered and discussed within the respective engineering change's conceptual design phase meeting. •The independent reviews should determine the extent of participation and review of any/all conceptual design phase products by site engineering staff. Any subsequent actions or assignments will be issued within conclusions from this independent review.
00001752	Low-Voltage Circuit Breaker Refurbishment Project	2014/03/21	Bruce Power	Lessons Learned: Delays and extra costs to projects can be avoided. Stations considering future LV circuit breaker refurbishment projects must ensure project scope is led by the Station and embedded within their work management process. The following must additionally be considered when designing a circuit breaker refurbishment project of this magnitude: -Anticipating there will be additional panels outside of original scope -Availability of qualified resources to provide clearance order support -Use of contingency planning to manage new work evolutions
00001751	Improper Setting of Electronic Alarming Dosimeters	2014/03/19	INPO	•Inappropriately high EAD setpoints pose the greatest vulnerability to unplanned doses during worker entries into high radiation areas. •The cause of unexpected dose rate alarms should be thoroughly investigated and actions should be established to prevent recurrence. •Expected or anticipated EAD dose rate alarms should be planned, documented, and discussed with workers before entry into the area.
00001750	Program on Technology Innovation: Approach to Transition Nuclear Power Plants to Flexible Power Operations	2014/03/19	EPRI	•Information to support the utility decision makers and project management staff in evaluating a plant's existing capabilities to operate in a flexible manner and then, based on projected local market needs, in developing a long-term flexible power operation transition strategy and an associated change management plan to increase the plant's maneuverability.
00001749	Failure of a Heat Transport Pump with the Redundant Pump Unavailable Required a Forced Outage of the Unit	2014/03/19	Pickering	•Based on the forensic examination of the seal from 7-33120-P5, Pickering Units 1 and 4 Operating Experience, and discussions with the OEM, it is recommended to implement a time based seal replacement strategy for the Units 5 to 8 HT pump mechanical seals.
00001748	A Review of Advanced Welding Technology and Applications for Nuclear Power Applications	2014/03/19	EPRI	•This paper is the first of a two-part series that examines advanced welding applications and issues for their use in the nuclear power industry. It focuses on primary nuclear welding applications and advanced welding processes/applications that can address industry weldability issues.
00001747	Engineering / Preventive Maintenance – Instrumentation & Control Events	2014/03/19	COG	•OE307673 - Several temperature switches were found degraded during the maintenance outage were replaced. Additional work has been scoped into the refueling outage to replace degraded wiring identified. Switch: General Electric Company, Model 12HFA151A9-F. •OE308159 - The station has not implemented a program for metallic whiskers or a preventative or predictive maintenance program for the CW Pump Bailey auxiliary relay cards. Relay: Bailey Controls, 6624266A2. •OE308638 - Field Programmable Gate Arrays have requirements for periodic reflashing and should be worked into the Preventative Maintenance program per the system technical manual. The date of reflash should occur in relation to the last time the board was programmed. FPGA: Generic. •OE308815 - Equipment aging is the primary threat to the heat tracing/freeze protection system, which is why set point drift is the primary cause of most maintenance preventable functional failures (MPFFs) associated with the system. Heat Trace Cable: Thermon Mfg, HTP-6. •OE308997 - Moisture intrusion can cause the microswitches on Rotork Model 16NA actuators to fail due to corrosion. When leakage is discovered, review of the potential impact
00001746	Loss of the Steam Generators' Safety Valves Operating Control Due to the Leakage During the Pressure Test	2014/03/19	Mochovce (PWR	•Gripping devices did not secured the safety valves from water leakage due to unsuitable thickness of coating on the gripping devices.

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00001745	Principles for Maintaining an Effective Technical Conscience	2014/03/19	INPO	•This document should be used in conjunction with other principles documents. For example, Principles for a Strong Plant Operational Focus ensure the appropriate balance of priorities for resolution of near-term operational issues and the appropriate level of technical review to support effective operational decisions. •Traits of a Healthy Nuclear Safety Culture, including Addendum I and II, addresses the unique nature of nuclear technology and many of the engineering and technical behaviors necessary to support a healthy nuclear safety culture.
00001744	Fluor-B&W is overseeing cleanup operations at the former gaseous diffusion plant at the DOE Portsmouth Site in Piketon	2014/03/12	Portsmouth Site in Piketon	-Ensuring that employees do not have access to the filesthat may be sensitive to the company is imperative. -With todays technology thereare many ways to makeback up records and this shouldbe a regularpractice.
00001743	Increased Trend of Criticality 1 Equipment Functional Failures Impacting on Safety and Production	2014/03/12	Pickering	•A large proportion of equipment failures have existing strategies in place, either through implementation of a pending design change or pending procurement of replacement parts. Timely implementation of the long term fixes, as well as more robust bridging strategies, would reduce the number of these repetitive events.
00001742	Summary of Mechanical Maintenance Events	2014/03/12	COG	•OE30754 – A leak path can be created by allowing the weld passes each start and stop at the same location. •OE302562 – The procedures are to be updated to give clear direction on how to install the governor drive coupling. Pump: Sulzer Bingham Pumps, Inc./frmly Bingham-Wilamette – MSD-D. •OE307324 - Maintenance to determine why there were numerous deficiencies with the actuator (leaking glycol, loose bolting, etc). Maintenance to issue further corrective actions to prevent re-occurrence. Valve: Copes - Vulcan Inc – D-100-160-2.5. •OE307369 - Revise the Pressurizer Spray Valves Maintenance Procedure to reference the revised requirements of General Instructions for Valve Packing for packing consolidation. Valve: Copes - Vulcan Inc. – D100-160-2.5. •OE307507 - Implementation of the correct tolerance in the requirements for valve repair, and development and implementation of requirements for inspecting the nozzle ring for wear. Valve: Crosby Valve & Gage Co – HB-65-BP.
00001741	North Trolley Rail System Structural Flaw/Discontinuity	2014/03/12	Darlington	•Fuel Handling system PMs for trolley rails and wheeels need to be broadened to prevent equipment degradation.
00001740	UPDATE: Radiation Levels Exceeded Radiography Boundary Limits	2014/03/14	Bruce	•The root cause of exceeding the radiation boundary gamma dose rate limits was less than adequate expectations set for preparing and review of radiography shot plans. •The assumption of the concrete floor thickness for shielding was inaccurate.
00001739	Fall from Height through an Open Grating in the Fuel Building	2014/03/12	Saint-Laurent	•Thoughts on how to improve the floor grating with regard to ergonomics (colour and shape) and attachment methods so as to guarantee a safe position that links with the guard rails.
00001738	Breakage of a CANSTOR module safeguards seal	2014/03/12	Gentilly	•Develop a procedure for draining and cleaning the CANSTOR module cylinders and sampling piping and installing the CANSTOR sampling valves. • Include in the preparation of the dry storage activity the procedure for draining and cleaning of the cylinders and sampling piping and for installing the sampling valves, as well as OPEX. • Raise awareness among the personnel concerned over the importance of the criteria requiring the immediate submittal of reports to the CNSC. • Raise awareness among the Maintenance personnel over the importance of the Operating Experience (OPEX) and of procedures to be followed to perform dry storage activities. • Raise awareness among the personnel about the importance of IAEA safeguards seals, the potential consequences of their violation and the actions to be taken following the discovery of a breached seal.
00001737	Nuclear Power Plants Digital I&C Systems-Related Events	2014/03/12	IAEA	•The aim of this report is to present an analysis of NPP events caused by digital I&C systems in various phases of the lifecycle, starting with design-related issues and ending with operational and surveillance aspects.
00001736	Failure to identify Design Guide Exceptions as Gaps during Integrated Safety Review Conducted for Darlington Refurbishment Project	2014/03/11	Darlington Energy Center	-We must identify 30 remaining DGEs as ISR Gaps and resolve in accordance with the approved Gap Resolution Process -Confirmation that all parts of an ISR are thoroughly analyzed and all Gaps are identified
00001735	Modifaction Design Requirement Lessons Learned Report - Darlington Refurbishment	2014/03/11	Darlington Energy Center	- lack of information resulted in key stakeholders and team members not performing to the expectations of the issued contract - Misalignment between the project organization and the functional organization resulted in the unclear accountabilities and support to executea particular contract within the project -The schedule must be monitored at all times, where status reports are against the current schedule/milestones to identify any risks. - Face-to-face at regular intervals between OPG and the Vendor should be the most preferred method of communication

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00001734	D2O Management West Annex Lessons Learned	2014/03/11	Darlington Energy Center	Strongly recommend to Design Agency that discipline DECs progress in parallel.Lay down ground rules for disposition of "General" commentsEnsure EPC constructors are engaged before design approvalProvide Oversight with EPC procedures, design descriptions, participation in all design reviewsEnsure Design Agency is aware that EC Packages without Vendor info will be rejectedDo not omit key steps in process (e.g. DCA/CCD)Use personal checking/guide sheet to keep notes when reviewing packages for acceptanceMake Design Agency aware of expectations regarding qualityLook for evidence of adequate verificationLearn how to ask questions constructively. Ask for clarification or more detailed explanation. Point out apparent gaps in procedure, requirements, understandingInsist on thorough dispositions up frontPlan to meet with Design Agency to discuss comments *before* they provide formal disposition.
00001733	Design Authority (DA) rejection of NK38-MDR-41890-10001 due to misalignment with Nuclear Instruction N-INS-00700-10007 R001A	2014/03/10	Darlington Energy Center	-MDR preparers must ensure that MDRs are in full alignment with N-INS-00700-10007. -Unsolved issues must be documented in ITF (Issue Tracking File) and if needed, must be escalated for resolution.
00001732	D-2013-21147 - Project 16-31555 – D2O Storage Project – Non-Compliance with Modification Process (COMS)	2014/03/10	Darlington Energy Center	-Must always ensure that all stake holders have signed off in all parts of a Detailed Design Phase Stakeholder Declaration
00001731	NK38-MDR-33110-10003 provided with Design Modification Option rejected by DA	2014/03/10	Darlington Energy Center	-MDR's must be decisive and provide clarity to the EPC vendor to avoid any confusion or delays
00001730	Update 4: Operating Experience (OE) Program and Construction Experience (CE) Program Descriptions	2014/03/05	N/A	•This document revises INPO 10-006, Operating Experience (OE) Program and Construction Experience (CE) Program Descriptions, Revision 3, dated August 2012. •The revision emphasizes the industrywide effort to use Must-Know Operating Experience to prevent events and also eliminates the INPO IER/SOER select list. Substantial changes were made to update the Level 3 INPO Event Report (IER) document function and to address station expectations for responding to both Level 3 and Level 4 IERs.
00001729	Failures of the Modification Process During the Modernization of the Pressurizing System	2014/03/05	Loviisa (PWR)	•Lessons learned by the Licensee: The findings and results of the analysis of the causes of this event revealed need for improvements in several issues related to the design modifications, in particular when they involve replacement of original I&C systems by modern digital systems. •Lessons learned by the Regulatory Body: Whenever design modifications involve several engineering disciplines, the regulator should create a project or nominate a responsible officer for appropriate coordination of the regulatory oversight. •There is room for improvement in the communication with the licensee. There was a misunderstanding between the licensee and the regulator on how to handle the faults of spray control limits and the operability of pressurizer relief valve. In the future the hold point – procedure in such modifications and testing must be clear and communicated broadly to both sides at an earlier phase.
00001728	Low Pressure Feedwater Heat Exchanger Tube Degradation Resulted in Unit Derating and a Forced Outage	2014/03/05	Pickering	•The Units 1 and 4 LPFW HX tubes are degrading at a rate which does not support operation until Pickering's end of life. This creates financial and production risks that may result in unplanned Unit Outages and/or HX replacements.
00001727	Hydrogen Detection in Nuclear Power Plants: Comparison of Potential, Existing, and Innovative Technologies	2014/03/05	EPRI	•This report is intended for plant engineers and designers as well as individuals interested in new sensor technologies and their potential application within nuclear power plants. It provides a very thorough overview of available hydrogen-sensing technologies, along with a look at power harvesting options within containment. •It can be used as an initial reference when considering direct replacement options for existing hydrogen sensors at nuclear utilities, as well as an initial guide for examining the application of self-powered, in-containment hydrogen sensors as a means of a more direct hydrogen measurement method.
00001726	Emergency Diesel Generator Digital Control System Upgrade Requirements	2014/03/05	EPRI	•This report will help NPP operators design, license, and implement digital upgrades to the station EDGs.
00001725	Notification of a Potentially Safety Relevant Non-Conformance for Hilti HSL-3 M24 Carbon Steel Expansion Anchors	2014/03/05	Hilti	•Although we do not currently have any customer complaints regarding HSL-3 anchors, our Hilti brand promise of quality and trusted product performance gives us a clear obligation to handle this topic proactively. Therefore we are initiating a program to notify customers and begin a process to evaluate and, if necessary, rectify the installed product. •We would like to bring to your attention that at the same time we will also inform all other customers that have purchased such items in the affected time frame without safety relevance and/or traceability via our national sales network with the goal that potential risks are discovered and appropriately mitigated.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001724	RFRISA and WSOB+LCR	2014/03/05	Darlington Energy Center	-Experienced personnel should be more involved in the development of Design Requirements, either as authors or to guide those less experienced. -Personnel should be qualified for the work they are doing or be guided by someone that is. Job coaches could aid in the development of strong DTLs and DEs. -MDR and Design Package development time should be detailed and accounted for accurately. There should be a commitment to the completion dates agreed upon, for all work groups associated with the work. - Relationships between working groups should be nurtured to develop a good working relationship. In this way pitfalls can be avoided or worked around progressively. Success demands that work should not be done in isolation, but completed as a team effort to ensure all is accounted for.
00001723	Large glycol spill from SDG#2 due to premature aging of a rubber hose installed on cooling water	2014/03/05	Cernavoda	Thermal insulation between the cooling water degassing hoses and exhaust galleries should be installed and verified periodicaly in order to prevent the premature aging of ruber hoses.
00001722	Discrepancies in Data Used for Refurbishment Component and Equipment Design	2014/03/04	Darlington Energy Center	- Conduct an independent third party validation of the new report received October 9, 2013 to confirm accuracy - Review the current D-RWC/DSO designs in light of the corrected data from the October 9, 2013 report and advise of any impacts to the D-RWC/DSO designs - Complete a review of the above two actions to determine the requirements to re-commence the procurement process. - Perform an extent of condition review to determine what other RFR component and equipment designs also utilized the incorrect data in the 2008 report and what and if there are any impacts as a result of the new 2013 report data inputs. - Inform other DN Refurbishment projects of the discrepancy in the 2008 Analysis report 00044-REP-03460-00002
00001721	OPEX Lunch and Learn: Point Lepreau Refurb-Roy Brown	2014/03/04	Darlington Energy Center	•Having a quality Mock-up is not imperative but it comes down to how you make use of it, train, practice, train and practice some more. •Practice the exact same work you will perform on the reactor during the training on the mock-up (i.e. Actually perform the cutting and other such activities, not just practice getting prepared) •Ensure you provide the suppliers with accurate specs since the pressure tubes that were ordered for the Point Lepreau refurb were of incorrect spec. •Never assume that the vendor you have used in the past will continue to produce quality equipment/materials. •Some current CNSC requirements and codes are non-obtainable •Must not approach CNSC with parts already installed looking for exemption from particular standards •Keep the end in mind at all times
00001720	D2O Management West Annex Lessons Learned	2014/03/04	OPG - D2O Storage Project	Integration/Co-ordination Strongly recommend to Design Agency that discipline DECs progress in parallel. Lay down ground rules for disposition of "General" comments. Ensure EPC constructors are engaged before design approval. Information Provide Oversight with EPC procedures, design descriptions, participation in all design reviews. Ensure Design Agency is aware that EC Packages without Vendor info will be rejected. Process Do not omit key steps in process (e.g. DCA/CCD). Use personal checking/guide sheet to keep notes when reviewing packages for acceptance.
00001719	Bruce Power Refurbishment Lessons Learned From AECON	2014/03/04	Bruce	• Allow the contractors to strategically procure some material • OPG's approach in terms of procuring all material itself would prolong a refurburbishment project • Aecon and other major contractors are certified to procure material. • Contractors can't order material on speculation, so owner should pre-order common bulks and contractors can draw from this. Use the MSA contractors to do infrastructure and pull-ahead work well in advance of the refurbishment project • Select direct work contractors early, promote collaborative involvement for constructability and planning • Involve contractors in the work management arrangements for constructability input to save time and money in the project stage • Plan the refurbishment more like an outage; meaning that planning must begin well in advance to be effective. o Requires contracts to be established early in the process o Preparation intensive o Contingency planning • Planning group must advise the commercial group on realistic project timeline o Be prepared to make early investments in strategic areas to maintain critical path o Allow at least a 6 to 9 month period from project approval to finalizing the refurbishment contracts. • Initiatives to plan
00001718	Progress Reporting	2014/02/28	Project Management Institute	Keep the report brief and sum up the key points in the project. I recommend this simple format on a maximum of 2 pages: 1.Report Date. 2.Overall Status. 3.Project Summary. 4.Key Issues. 5.Identified Risks. 6.Tasks and Next Steps. 7.Decisions Needed. 8.Key Future Dates. 9.Budgeted Cost. 10.Spend to Date.
00001717	Nuclear Power Plant Operating Experience (2009-2011)	2014/02/26	IAEA/OECD-NEA	(a) Design basis quality control in construction and modifications (b) Maintaining operating knowledge (c) Monitoring facility conditions and resolution of issues (d) Oversight of vendors, contractors and subcontractors (e) Focusing on human performance and safety management (f) Radiological control (g) Applicaiton of operating experience (h) Assessment of, and preparedness for, external hazards

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001716	Single Fuel Channel Replacement (SFCR) Program – Overall Program Delays	2014/02/26	Darlington	•Process weaknesses resulted in a delay to the planned outage. There were weaknesses in the planning/preparation stage of SFCR. Managed defenses, including training, pre-job briefings and oversight, were not able to prevent two events causing the largest delays: feeder clearance, pressure tube extension tool failure. •The transition to OPG pressure boundary Certificate of Authorization resulted in delays as pressure boundary questions arose. The level of oversight did not evolve as the demographics and in-house capability changed. •Lack of experienced resources and the need for assigned resources to multi-task between projects during critical planning stages de-stabilized the planning process and training and resulted in lack of ownership and lack of trust between peers.
00001715	Human Factors Engineering (HFE) Training Course for Operating Nuclear Power Plant Personnel	2014/02/26	EPRI	•The course is intended for utility personnel involved in modifications to operating plants and is also useful for suppliers, plant owners/operators, and other stakeholders, both in the US and internationally. •It fills a need for HFE training of operating plant personnel to help ensure that plant reliability and availability are maintained as modifications are made and as control rooms and other HSIs are modernized over time; to reduce human error rates, especially given that human errors have been a contributing factor in a majority of events at operating plants; and to meet regulatory requirements regarding HFE. •The HFE principles and methods described in this course represent good engineering practice that has been widely accepted, and should be followed in the design of any modification that could impact human performance.
00001714	Derate to 90 percent Reactor Power due to Deaerator Level Control Valve	2014/02/26	Bruce	•The failure of the plug/stem assembly in LCV3 required a reactor power reduction of 3 percent to 90 percent due to the availability of only one flow path to the DA. •A Station Equipment Reliability Clock Reset has been declared for this event.
00001713	FirstEnergy Nuclear Operating Company Improves Circuit Card Reliability with EPRI-Inspired Technical Guidance	2014/02/26	EPRI	•Responding to increased industry instances of circuit card failures, the EPRI guidelines offer recommendations for preventing circuit card and power supply failures, thereby extending component lives and improving reliability.
00001712	Collapse of Self Erecting Tower Crane during Dismantling	2014/02/26	Barakah (PWR)	•Communication of standard policies, administrative controls (SPAC) needs improvement. •Standard policies, administrative controls (SPAC) were confusing or incomplete. •Employee communication needs improvement. •Enforcement needs improvement.
00001711	PRELIMINARY: Hand Injury during Ventilation Fan non-intrusive troubleshooting	2014/02/26	Bruce	- Although a fan may be de-energized, the air flow may create an environment in which the fan spins freely at high speeds
00001710	Risks and Opportunities	2014/02/24	Project Management Institute	It's mandatory, in the end, that the determined strategies are implemented to: - avoid that a risk could become an issue; - to obtain that the events triggering opportunities will happen. During the execution phase of the project, at every progress meeting, the Project Manager will have to: 1) check the whole list of already opened project risks; 2) analyze other risks not already taken into account.
00001709	Darlington Refurbishment Program	2014/02/20	Darlington	Lessons Learned from Pickering: - Scope of work not adequately defined. - Regulatory approvals (Environmental Assessment) not foreseen. - Engineering poorly planned, procured and developed. - Assessing, scheduling and project controls were either absent or ineffective. - Construction work started prematurely. - Project status was not accurately reported. - No independent oversight of project preparations or execution. Key Principles: - Trust through verification - Data fidelity - Use multiple sources for validation - Inspect quality - Labour numbers/quality - Owner responsibilities - Contractor scope/interface
00001708	Lost-Time Accident at Pickering	2014/02/19	Pickering	Use the tools available to prevent these types of events from occurring and keep you safe: •CORE 4 Error-Prevention Tools •Pre-job briefings •Situational awareness •Two-minute job site drill •Focus on your fundamentals
00001707	Loss of Off-Site Power and Dual Unit Scram	2014/02/14	LaSalle County Generating Station	Test ground grid systems periodically as part of the preventive maintenance program to ensure degradation is identified and corrected. 2. Verify that the existing lightning protection system in the switchyard is sufficient to protect connected systems. Also, verify adequate preventive maintenance is in place to detect degradation of lighting protection equipment.
00001706	Flashover During Pressure Washing of 500-kV Insulators by Supplemental Personnel	2014/02/14	Diablo Canyon	- Conflicting procedure guidance and less than adequate execution of the on-line maintenance risk management procedure caused employees to categorize the hot-wash activity as a nontrip risk - Personnel should recognize high-risk events and include additional oversight to ensure the risk is properly managed - Electrical maintenance personnel did not fully implement the interface requirements for transmission and distribution facilities. - No process was in place for company-related/nonnuclear operating experience. Develop a process to share and evaluate company operating experience from Transmission Operations per the station operating experience procedure.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001705	Maintenance Oversight Shortfalls Contribute to Bearing Failure	2014/02/14	North Anna Power Station	1. Ensure critical main generator/exciter maintenance steps are captured in procedure guidance and have appropriate verifications to ensure vendor oversight. 2. Ensure that unsatisfactory as-left measurements are properly documented and dispositioned by station personnel. 3. Clearly define roles and responsibilities for oversight of supplemental subject-matter experts and ensure personnel providing oversight receive proper training.
00001704	Improper Control and Monitoring of Secondary Chemistry Results in Exceeding Action Level 3 Limits	2014/02/14	ANO	1. Resin trap differential pressure (D/P) instrumentation was not maintained and could have helped diagnose the defective mesh screen before the resin intrusion. 2. The demineralizer D/P alarm setpoint was not lowered to an appropriate value following a design change, which could have provided early warning and directed personnel to investigate failure of the resin trap. 3. An inaccurate and unverified assumption was made that iron loading/fouling and use of different resin were the reasons behind the elevated demineralizer D/P, which resulted in personnel not investigating other possible causes promptly.
00001703	Improper Setpoints Lead to Generator Trip and Reactor Scram	2014/02/14	R.E. Ginna Nuclear Power Plant	1. Rigorous adherence to processes is important in preventing events. Informational procedures can have as much impact as continuous use procedures if not followed. 2. Supervisors need to insist on following rigorous engineering processes for setpoint changes.
00001702	Nuclear Refurbishment OPEX gathering from Point Lepreau Generating Station April 2013	2014/02/14	Point Lepreau	-Station staff had to become embedded into the contractor organizations -General contractor should not have been the sole owner of the schedule -Scope of refurbishment grew exponentially as issues were encountered -Use of plant system specialists produced the best oversight -Understanding the schedule and hold pooint is very important -Resource needs are important and must be noted -Have an outside source or station experts perform QA -Vendors corrective action plan was less than adequate -Several major issues with the refurb has left the plant still working to get up to full power
00001701	Loose Solenoid Valve Terminal Connection Leads to Forced Unit Shutdown	2014/02/12	Bruce A	- A loose termination at a solenoid valve (MV2H-SV1H) connection of a junction box for helium injection valve (MV2H) led to an unplanned partial SDS2 injection.
00001700	Unit Turbine Trip Due to Boiler Water Level Very High	2014/02/12	Bruce	1.Automatic reactor power reductions occurred due to the automatic turbine trip. 2.Discretionary Station Human Performance Clock Reset due to latent Organizational Weakness.
00001699	Plant Engineering: Thermal Performance Engineering Handbook, Volume 1	2014/02/12	EPRI	- Essential elements of a thermal performance program at a nuclear power station, providing guidance for plants establishing a new program or seeking to make improvements to an existing program.
00001698	Motor Control Center End-of-Expected-Life Guidance	2014/02/12	EPRI	•The overall objective is to aid the identification of precursors of failure for MCCs and internals to support life cycle management and investment planning.
00001697	Failure of CAN8 Mechanical Seal Stator if Exposed to Freezing Conditions	2014/02/12	CEI	•Increased awareness for the the product owners that CAN8 mechanical seal stators will be damaged when exposed to freezing conditions
00001696	Diaphragm Leads to Level 1 Impairment of Shutdown Safety System	2014/02/12	Bruce A	•The event investigation revealed that MV3J had a small tear in its actuator diaphragm causing MV3J to fail open. Inadequacies with the valve actuator diaphragm used and the qualification process applied to select a suitable replacement were identified as causes for this event.
00001695	Malfunction Risk in the Safety Classified Relays (ABB Type NF62E and Type NF44E)	2014/02/12	Loviisa (PWR)	•Other nuclear power plants should check if ABB Type NF62E and Type NF44E relays are used and confirm the production dates of their relays with regard of this information.
00001694	Single Person Genie Lift Falls From Pick Up Truck While Unloading	2014/02/11	Bruce Power	- Take precaution when moving objects onto a power lift tailgate of a pick up truck that have a high center of gravity - Make use of flaggers and/or physical barriers
00001693	Unit 2 Forced Outage- Feeder Cabinet Door Opened	2014/02/10	Darlington	-Use of OPEX helps shorten outages and assist in determining the cause of an issue/resulting actions to be taken -Several Feeder cabinet doorsdid not pass the opening forcecriteria
00001692	Management Systems Requirements for Nuclear Facilities	2014/02/07	Mississauga	- The conclusion of the condition assessment was that most nuclear businesses were being required to carry programs to comply with as many as ten different management, management system, or quality assurance standards. Most of these standards were directed at the same purpose, but requirements were not harmonized. - This led to the conclusion that a single standard would be more effective with the purpose of establishing a single management system standard that integrates the requirements from management system standards for health, safety, environment, security, economics, and quality.
00001691	Outage Critical Path Impact Due To Supplemental Work Delays	2014/02/05	Bruce	• There was an 82 hour delay to the return to service of Unit 6.
00001690	Ground fault alarms caused by a design deficiency of alarming circuit	2014/02/05	Cernavoda	-Alwyas keep the wiring for different channel circuits seperate
00001689	Reactor Trip on PHT Pressure High Due to SUT Trip on Differential Protection	2014/02/05	Kaiga (PHWR)	•The probable cause of LA failure before expected appears to be aging or deterioration of the Zn O pellets due to internal water leakage.
00001688	Failure of Clutch Power Supply to Primary Shutdown System Group-1 Rods	2014/02/05	Kakrapar (PHWR)	•It was decided to replace all the fuses of safety related instruments with defined frequency for remaining power supply units at both KAPS-1 & KAPS-2 at the earliest available opportunity.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001687	Engineering Human Performance Events	2014/02/05	COG	•Vendor information and external OE provide information that the Eaton HMCP breakers are faster acting when compared to earlier vintage breakers. It does not appear there was adequate consideration of the potential consequence or adverse condition the faster acting breakers may create on the operation of existing, aged plant motors. (OE302044) •Revise vendor manual to include instructions for trip valve assembly to assure that the valve opens completely until the spindle is on the back seat. Include a caution that that the H-Link pins can be overloaded by the actuator if the valve does not open to the back seat. (OE304940) •Copper Alloy Heat Exchanger Tubes, which somewhat resistant to microbiological growth, can still be susceptible to MIC attack if the proper conditions exist; specifically low flow and warm conditions. (OE306542) •Monitoring valve stem for galling did not provide adequate early warning of the guide condition. (OE305677) •Ensure the technical rigor exists to ensure compliance with all regulations during the modification process. (OE307173) •The procedure instructions do not adequately constrain the zero-degree scan speed to assure that small cross-section, low-angle flaws are
00001686	Unit Auxiliary Transformer Fire Causes Loss of Backfeed and 13.8 kV Electrical Bus	2014/02/05	Callaway (PWR)	•Consider establishing a Preventative Maintenance task to replace transformer surge capacitors if not already established. •Consider revision to the work instructions which determ/reterm the transformer surge capacitors to prevent manipulation of the short conductor which is directly attached to the capacitor bushing.
00001685	PRELIMINARY: Unposted Radiation Hazard	2014/02/05	Bruce	•Although dose rates were higher than expected in the vicinity of the work area, no personnel received unexpected dose.
00001684	UPDATE: Industry Cumulative Impact Summary Report	2014/02/05	INPO	•Initiative Objective: Improve industry standards, processes, and behaviors to better enable station leaders to lead their staff in the safe, reliable, and efficient operation and maintenance of the plant. •UPDATE: The "Industry Cumulative Impact Short-Term Actions" report is attached, covering the following areas: Management and Leadership, Human Performance, Corrective Action Program and Work Management.
00001683	Project Off Track? Regroup, Reengage, Reset	2014/02/03	Project Management Institute	-Never panic during project slippage, just remember to regroup, reengage and reset
00001682	5 Things You Never Want To Hear On A Project	2014/02/03	Project Management Institute	-Do not hesitate to "get the ball rolling" before the project kick-off meeting -Deal with the issue causing a schedule/financial slip, not justalter the scope -Do not try to use CEO as sponsor -Just because you have the green light in your end of the project, does not mean all is going perfect
00001681	Air Extraction Pump Trip	2014/01/29	Pt Lepreau	•Electrical cables should not be intenially wetted.
00001680	Reactor Recirculation Pump Seal Degradation Resulted in Planned Outage	2014/01/29	River Bend (BWR)	•Galvanic corrosion of the Nickel (Ni) binder in the Tungsten-Carbide (WC) rotating faces (nickel leaching) resulted in Ni removal and weakening of the WC matrix. The material selected for recirculation pump seal rotating seal rings (Tungsten-Carbide) was less than adequate for the application.
00001679	Automatic Reactor Scram	2014/01/29	Ginna (PWR)	•Rigor in process execution is vital. Lack of rigor can result in significant results including plant trips. Supervision needs to fully leverage existing touchpoints to fully understand changes they are approving and identify deviations from process.
00001678	Significant Losses Due to Poor Condenser Performance at Bruce A	2014/01/29	Bruce A	•Environmental changes can cause significant problems for stations, systems, and equipment. Monitoring and response to environmental changes is required in order to anticipate and prevent risks to the operation of the plant. •Site programs for monitoring and responding to environmental changes must stay on top of available internal and industry operating experience (OPEX).
00001677	Specific Gravity Impacted by Lowered Electrolyte Level During Shipment	2014/01/29	Nine Mile Point (BWR)	•Vendor supplying batteries with lower than expected fluid level, to prevent spilling of the battery fluid during shipping. Adding water to cells shipped with lowered electrolyte level will reduce capacity of battery.
00001676	PRELIMINARY: Boiler Feed Suction Line Pressure Boundary Failure Results in Forced Outage	2014/01/29	Darlington	-Welding techniques must me of consistant and reflect a high degree of skill
00001675	Summary of Operations Human Performance Events	2014/01/29	COG	•Operations when restoring control power to running device, the plant impact should be understood. (OE306112) •Modified the Control Room Operator Tour checklist to include monitoring the operability of power supplies P/S-0101BB or P/S-0101AA. (OE305391) •Initiate revision to Standard Management Operations Procedure 2-01 to place Protected Equipment signage on appropriate Reactor Coolant Pumps before the Unit enters Mode 3 for a planned plant cool down. (OE305642) •Add clarification to procedures identifying sensitivity and vulnerability of backflowing water into the RCP seals. (OE304742) •Failure to properly use human performance error prevention tools and inadequate supervisor review process for sealed components. Revise sealed component checklists such that an independent verification of completion is required. (OE306131)
00001674	Generator Made Unavailable by Fire System Test	2014/01/29	Pt Lepreau	•New operational tests should receive proper review prior to use, preferably by licensed operators
00001673	Falling welding gun affected a nitrogen pipe	2014/01/29	Cernavoda	The welder must ensure that when performing an operation, the tools he used in the preceding stored in secure conditions which do not allow slipping or falling over.

ID	Title	Date Identified	Source of Event	Specific Lessons Learned
00001672	Emergency Stop Valves Slammed Shut	2014/01/29	Pt Lepreau	•Work Clearance holders do not always understand the job hazards by reviewing the paper work related to the work clearance. Face to face conversations with the work clearance center ensure the maintainers are educated on the job hazards. •The gaurds installed in power plants during construction may not meet the safety standards of today. Stations should not always assume original contructions is safe and should ensure they always have a questioning attitude.
00001671	Summary of Industrial Safety Events	2014/01/29	COG	-Always maintain a safe distance from a load that is being carted and could potentially become losse and out of contol. -Alwyas maintain situational awareness. -Be sure to perform consistant self-checks
00001670	SCR-Discrepancies in Data Used for Refurbishment Component and Equipment Design	2014/01/30	Darlington Energy Center	-Always validate data before moving forward as changes/discrepancies may exist - Ensure accuracy of any information that may be used in later refurbishment procurement
00001669	Refurbishment – Conventional vs. nuclear… why is nuclear so much more challenging?	2014/01/30	Darlington Energy Center	1.OPG needs to ensure that contractors are trained and ready prior to work. 2.OPG and contractor must be aligned on schedules. 3.OPG and contractors must be able to react to challenges work on them while still moving forward with the project. 4.OPG must maintain/exert/ensure control including proactively managing and informing regulatory and industry watchdog oversight. 5.Tooling needs to have integration testing and training. 6.Alignment of oversight committee, vendor and customer expectations.

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May 1, 2015 File: NAW130-00120 T5

D. Reiner
Senior Vice President, Nuclear Projects
Ontario Power Generation

Re: Niagara Tunnel and Lower Mattagami River Projects – Lessons Learned

Hydro-Thermal's Niagara Tunnel and Lower Mattagami River Projects held Lessons Learned meetings in July 2013 and December 2014, respectively, to discuss and document project lessons learned. The Lessons Learned documents from each meeting are attached to provide OPEX for the planning of OPG's Darlington Refurbishment Project.

Sincerely,

R. Jessop
Project Director, Hydro-Thermal Project Execution
Ontario Power Generation

Enclosures (2)

Cc: B. Reuber (no enclosures)

Niagara Tunnel Project – Lessons Learned

ID	Category	Issue	Problem/Success	Impact	Recommendation	Additional OPG Comments/Actions
1	**Schedule**	Time-way (linear) schedule.	Success - Excellent tracking and communication tool for a linear project.	Allowed the project team, stakeholders, and sponsor to understand both progress and performance.	Although OPG carries out a limited number of linear projects, it could consider employing this format on other types of projects. Project team should document the Time-Way Scheduling process and any lessons learned to share with other project teams.	None.
2	**Cost**	BCS cost broken out by month in a defined work breakdown structure.	Success - Able to monitor against the baseline.	More accurate tracking/forecasting.	Projects should have a detailed cost broken out by month in advance of project release.	None.
3	**Cost**	Forecasting model.	Success - Development of a detailed forecasting model.	Ability to forecast final completion cost quickly after month end.	Projects should have a forecasting model developed in order to forecast final costs based on current month actuals.	None.
4	**Scope**	Disposal of surplus goods.	Problem - Unclear language in the ADBA with respect to: 1) Owner/Contractor roles in the Disposal of Surplus Goods Process, and 2) Method of disposal.	Inefficient use of resources (OPG, Owner's Rep, & Contractor) with numerous revisions of plans required.	Clear contract language that identifies OPG's expectations to optimize the net value recovered. Use of an unreserved auction was effective for a project of this size.	None.

5	**Scope**	Identification of Plant Group wants/needs.	Problem - It was difficult for the Plant Group to identify all of their requirements from the concept drawings	Uncertainty about the end product (i.e. intake fencing, parking lot, fall arrest, etc.).	Involve appropriate stakeholders early in the project. The Plant Group needs to be provided sufficient time and resources to document what they want and the rationale. Dedicated resources should be considered.	None.
6	**Quality**	Owner requirements/ expectations and inadequate division of responsibilities.	Problem - Owner has limited input on Contractor's resource allocation to: QA, QC, Health & Safety, and Environment (i.e. production employees were responsible for quality control).	Owner requirements/ expectations in these areas not met. Production overrides quality - conflict of Contractor's priorities. Quality control was impacted.	Design-Build contracts should contain Owner's requirement for Contractor site positions, numbers, disciplines, and qualifications. If quality control is to be properly enforced by the contractor, a clear division/separation of the role must be made. Having production employees responsible for quality typically does not work. Independent management (i.e. 3rd party) of Quality is a better (recommended) approach for priority management.	Further assessment of OPG contracting model/terms - emphasize inclusion of project-specific and/or OPG standards in the areas of safety, environment, & quality (SEQ).
7	**Quality**	Issue management.	Problem - Reactive approach taken by Contractor to resolve technical/construction issues. Root cause analysis not performed by Contractor.	Cost and schedule impact.	In tunneling, the premise to battle through existing situations/conditions is the norm. Fixing a problem when it is encountered should be given greater consideration (i.e. over break, excessive construction water).	A more robust contingency planning process (by the contractor) to incorporate root cause techniques to support problem resolution of construction/technical issues.

					Also, proceeding with work that does not have a submittal nor has a submittal without an 'acceptable status' should not occur (i.e. overbreak restoration).	
8	**Quality**	Method Statements.	Problem - Contractor did not utilize method statements effectively.	Education by OR required.	Method Statements are an effective tool if taken seriously and prepared with the intent of being utilized and not just to satisfy a Project/Contract requirement.	Provide Method Statement templates/examples that clearly outline expectations of Contractor.
9	**Human Resources**	Consistent staffing.	Problem - There were significant staff changes in the plant group engineering and management ranks as a result of the long duration of the project.	No real buy-in/alignment from Plant Group staff to review/comment on any drawings circulated.	No recommendation - it is difficult to allocate OPG production and engineering staff on a project for 8 years.	None.
10	**Human Resources**	Team building.	Success - A team-building event held at the beginning of the project allowed all parties (Contractor & key subcontractors, OPG, OR) to get to know each other on a personal basis.	This opened the lines of communication and assisted in building trust between parties which allowed resolutions to be achieved on a shorter timeline.	Whether it is an organized team building event or simply a summer barbecue, these events should be held on a regular basis throughout the life of the project.	None.
11	**Human Resources**	Dedicated core project team.	Success - core OPG/OR project team remained dedicated to the project.	Consistency and limited knowledge transfer loss.	Start out with key players and bring on people as needed.	None.

12	**Communications**	Use of tables and bullets in the monthly report.	Success - Although making the monthly report somewhat longer, the use of table and bullet formatting in various sections of the report made the detail contained in the monthly report more visible and comprehensive.	Improved communications.	Share NTP monthly report template with the HTO PMO to make it available for other projects	None.
13	**Communications**	Community Impact Agreement (CIA) & Liaison Committee.	Success - Forecast impacts of the project on the host communities were proactively addressed.	Compensation payments permitted host municipalities to address significant local concerns in advance and the Liaison Committee promoted ongoing dialogue to limit community issues throughout project execution.	Adopt similar agreements & procedures with host communities where warranted by project scale & potential community impacts.	None.
14	**Communications**	Communication management.	Problem - Information was not consistently being cascaded to the site-level. Miscommunication with external stakeholders.	OPG reputation. Project cost and schedule.	Ensuring the most recent/accurate information is available to those that require it. Too often information is not shared and by the time it reaches the level where it is required it is either too late or inaccurate. Sharing information is a key to success.	Incorporate contractor into overall project communication matrix. Contractor discipline / management system issue.

15	**Communications**	Partnering approach / teamwork.	Success - All parties eventually 'bought into' the partnering concept even though the Contractor was very silo'd (internally).	Effective teamwork and cooperation by external stakeholders.	If a partnering concept is established early in the project, it can be extremely effective. Effective partnering requires 'give-and-take' on both sides. Having divided sectors which may have individual needs that are put above completion as a whole are harmful and not in the spirit of partnering. Recognizing/considering the thoughts/ideas of others is a part of this.	OPG's code of conduct and expense policies may restrict team building opportunities with external contractors and forego the benefits.
16	**Risk**	Comprehensive risk review meetings.	Success - The diverse attendance of key project management and construction staff allowed for productive risk review meetings (monthly reviews and analysis meetings).	Proactive risk management with risk definition and risk response actions evolving over the life of the project.	Commercial terms and conditions with installation contractors, design contractors, and owner's engineer should stipulate involvement of all parties in co-operative risk management activities.	Emphasize 'shared' risk register approach.
17	**Risk**	Combined risk management process was required by underwriters of the Builders All-Risk Insurance.	Success - It promoted collaboration between the contractor, owner, & owner's rep in the identification and management of the majority of the significant project risks.	Strong communication amongst all parties concerning design & construction risks ensuring clear understanding of risks, appropriate mitigation, & clear establishment of accountabilities.	Where warranted by project scale & risks, adopt combined risk management process ensuring owner / contractor collaboration on risk management during execution of future OPG projects.	Share this practice with other HTO PMO Clients at a future quarterly PMC meeting.
18	**Risk**	Format of the risk registers.	Problem - Original risk registers were populated in Excel format. Became cumbersome to review.	Less efficient meetings.	Populate risk registers in a database format to allow for easier sorting / review of risks and tracking of changes.	Look at using established commercial software for this on future projects.

19	**Risk**	Attempt to transfer risk through fixed price.	Problem - Design-build lump-sum contract model gives the Owner the expectation of risk acceptance by the Contractor even though the risk has not been adequately assessed or priced. Risks that are not identified and allocated become disputes.	Project may not have had sufficient overall cost allocation (contingency) to cover risks. False sense of security in reporting to corporate oversight.	Risk assessment must start before the contract stage, be thorough and documented. Allocation of risk must be addressed in the Contract.	None.
20	**Procurement**	Contracting strategy - Fixed-price contract inappropriate for projects with significant site-specific underground or geotechnical risks.	Problem - Significant geotechnical risk that Design-Build contractor never accepted. Conditions were more adverse than the baseline which resulted in claims / disputes. Contractor cannot absorb significant losses (without potential for recovery on future work).	Increased costs and schedule delays due to significant work/time to: (i) resolve disputes, and (ii) renegotiate the contract.	Forego fixed price where geotechnical risks are high and match contracting strategy to risk profile. Use target cost approach with incentives/disincentives to optimize risk transfer to contractors.	Consider utilization of the CII PDCS tool.
21	**Procurement**	Contract renegotiation.	Success - Renegotiated Target Price Contract was accurate with no cost or schedule overruns over a period of four years.	There was a shared ownership of cost and schedule and more awareness of Owner's risk.	Better model for underground works than fixed price.	None.
22	**Integration**	Owner's Rep. and OPG (Project Management and Law) co-ordination of project changes and risk	Success - Very successful integration of Owner's Rep. and OPG (Project Management and Law) efforts related to the drafting, review, and signoff of PCD's.	Well-defined roles resulted in effective management of project risks and changes - best practices in team integration employed.	Project management teams employing external Owner's Rep.'s should reference NTP - reflects an excellent use of personnel and resources and effective time management as	None.

		management.			well as risk mitigation practices. Best practices employed with very successful results.	
23	**Technical / Design**	Original contract did not require full-time design representative at site. Requirement added when Amended Design-Build Agreement (ADBA) was negotiated.	Problem - Initial problems with construction QC and interpretation of design when design rep. was not on site.	QC and engineering issues leading to delay and rework (cost and schedule impact).	When using the Design-Build project delivery model, the Contractor should be required to have a design representative on site full-time during construction.	None.
24	**Technical / Design**	Lack of technical and procurement expertise allocated to the project by the Design-Build contractor.	Problem - Design-Build contractors tend to focus resources on the areas of the work where the company has expertise (i.e. contractor focus on tunnelling to the detriment of structures, gates, mechanical equipment, etc.).	Lack of management and coordination of subcontracts leads to cost over-runs, quality issues and schedule over-runs.	Design-Build contracts should contain Owner's requirement for site positions, numbers, disciplines, and qualifications.	None.
25	**Technical / Design**	Resolution of problems.	Success - Major problems were overcome by OPG, the Owner's Rep., and the Contractor working together harmoniously and pragmatically	Timely resolution of problems.	In part this was made possible by scoring and choosing the correct Contractor during proposal evaluations.	None.

26	**Business Processes**	Signing authorities for contract changes - same level of signing authority for changes as in the original contract.	Problem - Difficult to obtain executive level signatures. Numerous change orders over life of contract and some were of insignificant value or had no impact on cost or schedule envelopes.	Slows down the change management process; requires unnecessary legal input because of 'high level signature'.	Reconsider OPG OAR policy given success with revised DBA precedent that permits flexible contract administration - low cost (under $100K) and no schedule changes within approved cost and schedule envelopes do not require signing by EVP levels; set-up specific Project authorities tailored to the project.	Include detailed descriptions on PCD's.
27	**Project Controls**	Inadequate inventory management by the contractor.	Problem - Difficulty in substantiating the value of goods in inventory at the time of contract conversion to target-price and substantiating the value of surplus goods at disposition (i.e. scrap/write-off, transfer or sale).	Reputational risk for OPG concerning inadequate controls, risk of inability to recover unsubstantiated project costs, etc.	Ensure that future contracts stipulate OPG expectations on robust inventory management to facilitate substantiation of procurement activities and control of OPG-owned project assets.	OPG also needs to have proper project controls infrastructure in-place to support target-price contracts.
28	**Project Controls**	Inconsistent use of cost, schedule, and resource tracking tools.	Problem - True schedule position not well understood by all stakeholders. Each stakeholder had difficulty in assessing true cost, schedule, and resource position.	Ineffective resource allocation. Schedule and cost impact.	Decide on standard tools (project-specific) early in the process and allocate resources to ensure consistency and compliance with standards. Utilize simple forms (i.e. inspection, audit, or summary forms) to accurately capture and report on daily progress.	Common scheduling approach required - contractor tracked progress outside of P3 and had to report using P3.

29	**Project Controls**	Subcontractor management.	Problem - Subcontract submissions and claims were a straight pass through by the contractor without any review.	Negotiations more difficult and time consuming. No language in Contract to force the Contractor to review for reasonableness.	More of a relationship issue - Emphasize requirement for a subcontractor management plan and OPG expectations. There are limited opportunities to update our contract T&C's.	None.
30	**Project Controls**	Dispute Resolution processes - OPG's use of a DRB composed of 'professional arbiters'.	Problem - Original DRB process did not result in a streamlined, satisfactory resolution of the major overbreak claim. In particular, usual protections of legal proceedings (like arbitration or litigation) were not available resulting in significant risk to OPG.	A decision that required a "compromise" and ultimately a renegotiation of the DBA. Significant additional legal costs and management time expended in a process with an 'unknown' outcome.	Limit use of DRB's in DB agreements (possibly to technical issues only). Before any 'new' process is used or considered for use as a dispute process, ensure it has been practically evaluated in (a) OPG; or (b) industry. Where speed of resolution outweighs risk of a finding against OPG, consider more informal resolution processes (such as an advisory committee of executives or technical panels of experts) and write the process into the agreement. Arbitration and litigation for significant issues remains the preferred approach.	None.
31	**Health and Safety**	Owner-Only execution.	Success - The Owner's Rep. and Plant Group did a very good job separating Strabag's work from the Plant Group's work.	Minimal risk of OPG assuming constructor role for the entire project.	Requirement to establish clear, consistent boundaries between the contractor and OPG.	None.

32	**Environment**	EA commitments (made several years prior) constrained opportunities during detailed design & construction.	Problem - Limited creativity on design and construction that prevents incorporation of contractor experience and innovations that could reduce project cost and shortens the duration of the project.	Prevented potential cost & schedule savings such as tunnel alignment through St. Davids Gorge (above problematic Queenston shale), multiple workfaces, excavation methods, construction logistics, etc.	Throughout the EA process on future OPG projects, retain as much flexibility as possible to accommodate subsequent (contractor) experience & innovations during detailed design & construction.	None.
33	**Environment**	Environmental Management Plan	Problem - Although this was a comprehensive document and a very good planning tool, it needed updating as the project proceeded into construction. Tendency was for the document to be more theoretical than practical. Also, the actual Contractor environmental staff numbers were much less than initially defined.	Increased Regulatory compliance risks.	Insufficient resources - Probably one manager and 2 assistants would have been the appropriate level of environmental staffing, especially in the initial stages. The use of third party consultants, rather than on site specialists, proved to be the manner of addressing many of the technical issues (e.g. water treatment, storm water management plan).	None.
34	**Environment**	Water treatment requirements.	Problem - Plant as initially sized was too small for the amount of water and sediment to be processed. Specifically, the sediment/total solids loading was considerably more than anticipated. The first retention pond was poorly	Sedimentation plans had to be developed and then amended as the project proceeded. Also, process water had to be discharged at the Intake, after the FOG, this water should have been treated in the same manner as that being discharged at the	The addition of the more robust sedimentation pond upstream of the initial pond with the cells operating on a rotating basis greatly alleviated the problem. Use of the sediment, combined with organic matter, proved to be a useful material for site restoration/revegetation.	None.

			designed/constructed.	Outlet or the piping system within the tunnel should have been restored much more quickly to route the water back to the Outlet.		
35	**Stakeholder Management**	EPSCA Labour Relations	Success - Contractor used a single union (labourers) employed under the EPSCA agreement.	EPSCA prevents major strikes (however does not stop inter-union squabbles over jurisdiction).	Note: This approach required the contractor to resolve disputes at the labour board and may have prevented expertise from other skilled trades. This is a project-specific LR approach.	None.
36	**Stakeholder Management**	Relationship with Regulatory Agencies	Success - Good Relationship with Regulatory Agencies. Upfront consultation and ongoing meetings with key agencies (e.g. MOE, DFO, MNR) and local municipalities – greatly assisted.	Issues could normally be directly addressed.	Upfront consultations and meetings with Regulatory Agencies. Development of working relationships.	None.
37	**Records Management**	Project mandated to use OPG's SCI system.	Problem - No explanation/description provided for each SCI number which left room for misinterpretation in numbering/filing of documents, drawings, correspondence, etc.	Many submittals/documents have been given the wrong SCI number; NPG will need to cross-reference to correct the SCI number.	Provide detailed descriptions and examples for each SCI number mandated to be used on a project managed by an outside consultant.	None.

38	**Records Management**	Project database.	Problem - Multiple databases were used to track project information.	Provided ability to locate various information quickly. Using multiple databases required double entry at times. The submittal database was secure which limited the flexibility to make required changes.	An all-inclusive database program to track all project information, which provides program flexibility. Note: These types of programs were not very common at the time this project was initiated.	None.

Internal Use Only

2014 LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

SAFETY

LMRP Lessons Learned Meeting

Kiewit-Alstrie, A Partnership

What have we done at LMRP?

✓ Communication

What Went Well:

- Focus on PTI meeting and make it interactive
- Provide clear expectation and be supportive (JHA's, Work Plan, etc.)
- Always maintain an honest and transparent communication with external parties (i.e. MOL & OPG)

Opportunity:

- Relationships and building trust early (make safety personal) with craft and sub from the start of the project. (H&S Reps, JHSC, Worker Trades Committee)
- Communicate our new org chart to avoid miscommunication.
- In 2014, we decided to share the minutes of the 3:30 meeting (coordination between managers) with the entire site.
- In 2014, we've improved our incident review awareness (sitting with supervisors and share Incident Alert with the 3:30 minutes)

LMRP Lessons Learned Meeting

Kiewit-Alerie, A Partnership

What have we done at LMRP?

✓ Craft & Subs Engagement

What Went Well:

- In 2014, we've engaged craft through continuous training and support from our Craft Voice In Safety (CVIS) members (craft and sub) and trainers.
- Educate and train personnel (Craft, Sub, Staff) to take over additional responsibility
- Participation from craft and sub into our safety program (i.e. Safety Walk with management and or staff)
- Establish a safety culture where the people truly feel proud and embrace the safety program

Opportunity:

- Improve on-boarding and communication of policies and training
- Improve pre-activity meeting with our subs
- Improve the visibility/publicity of our subs on photos, magazine, banners, etc.
- Increased engagement of JHSC and Worker Trades Committee through CVIS

LMRP Lessons Learned Meeting

Kiewit-Alerie, A Partnership

What have we done at LMRP?

✓ Health & Safety Program

What Went Well:

- Maintain a clear and consistent policy,
- Used Web based and hands on training (i.e. KiewitSafe, Mission Possible, etc.)
- Educate and train our people in supervisory roles,
- Assign specific responsibilities and defined expectation.
- Designated trainers – maintaining a consistent message to the craft and supervisors

Opportunity:

- Having the Health and Safety Procedures prior to the mobilization,
- Orientation specific to the work from day one
- Health and Safety training based on risk assessment at the beginning of the project (i.e. fall protection, access & egress, etc.)
- Senior Project Management and CVIS member participating in site orientation (personally or by video) demonstrate commitment

LMRP Lessons Learned Meeting

Kiewit-Alaris, A Partnership

What have we done at LMRP?

✓ **Supporting and believing in the Safety Program at all levels**

What When Well:

- Participate in walk down and audit (Provide some opportunities of improvement)
- Consistency and adherence to our policies (Meeting KAP and OPG safety expectations)
- Focus on the reduction of repetitive hurts (i.e. eye and hand injuries, etc.)
- Monitor and hold accountability
- Regular communication from senior project management to field supervision and the craft reinforcing rules and expectations (Weekly Safety Meeting, CVIS Meeting, Weekly Safety Walk, etc.)

Opportunity:

- Improve the Integrated Observation and Intervention Program (IOI) (i.e. set expectation, do we want to have one ?, can we find another way to get feedback from craft ?, let the CVIS lead the program)
- Early engagement of the CVIS member with the safety program

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

What have we done at LMRP?

✓ **Emergency Preparedness**

What Went Well:

- Early engagement with municipal resources (Fire and Ambulance)
- Emergency response plans were shared with all and gave people on site a sense of responsibility when called upon (Crane Operators, Riggers, First Aiders)
- Adequate time, resources and equipment were allocated to ensure the ERT functioned
- Reliable people were able to be obtained despite the fact it was a volunteer team

Opportunity:

- We could have maintained a key group of people to stay throughout the project, instead of having to re-train
- Improve costs by choosing a designated trainer who could provide discounts and understand our needs as a company and project site

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

What have we done at LMRP?

✓ **LOTO**

What Went Well:

- LOTO Procedure issued early in the project and trained personnel after first revision.
- LOTO Procedure was well enforced throughout the Project and administered by KAP. Did not allow Sub-Contractors to administer their own procedures.
- Currently up to Rev. 6 (only minor changes in all consequent revisions).
- Third party and Kiewit other District audits were incorporated in LOTO revisions.

Opportunity:

- Utility Work Protection Code Training needs to be increased for various responsible personnel earlier in the Project, if working within OPG Boundaries.
- Adapt the latest version of the LMRP LOTO on our next project

LMRP Lessons Learned Meeting

What We Should Remember

✓ **PLAN YOUR WORK – WORK YOUR PLAN**

(Be Prepared In Advance)

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

What We Should Remember

- ✓ **COMMUNICATION IS THE KEY**
  (From The Bottom To The Top)

LMRP Lessons Learned Meeting

What We Should Remember

- ✓ **ENGAGE YOUR PEOPLE**
  (Craft + Sub+ Staff= 1KAP)

2014 LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

SAFETY

LMRP Safety Lessons Learned

Kiewit-Alarie, A Partnership

✓ Memorandum of Understanding (MOU)

What Went Well:

- KAP and OPG's requirements to share the lands and roadways to isolate construction activities from operating facilities.
- Identification of construction island boundaries
  - Drawings posted throughout the project
  - Barriers implemented where required

Opportunity:

- Orientations are to clearly identify the requirements of maintaining separation between construction activities and operations.
- Continuous communication with workers throughout the project lifecycle.
- CI boundary changes agreed to by site representatives.
- Qualified escorts available to accommodate access requirements

LMRP Safety Lessons Learned

Kiewit-Alaris, A Partnership

✓ Transfer of Control Document

What Went Well:

- Good for equipment transfer
- Ensures conditions are documented and accepted by the owner and constructor at the time of transfer

Opportunity:

- Reduce paper work generation
- Reduce the requirement for multiple signatures
- Use of walkdown sheet to identify and document hazardous energies during the transfer of real-estate from the owner to the constructor

LMRP Safety Lessons Learned

✓ **Owner's assets in operation**

What Went Well:

- Management understanding of the plant operations
- Outage requests submitted when required
-

Opportunity:

- Workers training / communications
  - knowledge of the generating facilities
  - Associated hazards
  - Strict adherence to not touch owner's equipment
- Cancellation of outages
  - Leads to regulators frustrations
  - Ensure schedules are achievable

LMRP Safety Lessons Learned

✓ Terminal Points & Condition Guarantees

What Went Well:

- Request sheet developed to ensure requirements are understood
- Walkdowns completed to ensure requirements were understood
- Dedicated owner site representatives to support implementation and any changes required to support the schedule.
- Isolating Officers and LOTO desks established at sites

Opportunity:

- Ensuring adequate competent resources are assigned to process the requests
- Dedicated resources assigned to administer LOTO at the sites
- Worker training – Utility Work Protection Code

LMRP Safety Lessons Learned

✓ Identification of Hazards

What Went Well:

- Workers reporting real or potential safety hazards / issues throughout the project areas
- Quick response from project management to correct any deficiencies or undesirable behaviors.
- Speed limits reduced and enforced
- Escort through high traffic areas

Opportunity:

- Continue to encourage workers to report all safety issues to their supervisors.
- Hazard assessments need to account for other workgroups in the vicinity

2014 LMRP Lessons Learned Meeting

Kiawit-Alarie, A Partnership

QUALITY

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Spreading the word

Firms that collect and distribute "lessons learned" to everyone create a wealth of intellectual capital.

Keeping secrets about past problems helps no one. It just leads to repeating the mistakes. Find out what happened, both good and bad, and get the word out to everyone.

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Quality-Expectations

Matching expectations is the foundation of project quality.

Every client develops expectations of the quality attributes for his project. If the expectations of the client and the contractor are in total agreement, all the contractor has to do is deliver its own expectations. If the expectations are different, the loser is always the contractor—a lost client and lost profit.

LMRP Lessons Learned Meeting

Kiewit-Alario, A Partnership

QC Checklist-People & Process

Project quality control doesn't rely on checklists—it relies on the people and the process

Quality isn't inspected into a project—it's designed into it. The normal work process that should be followed is to control the quality, not the QC checklists. The QC checklists should be used to identify problems in the process and then to make improvement.

LMRP Lessons Learned Meeting

Kiewit-Alaris, A Partnership

QA

The overall goal of quality assurance **is *to prevent, not correct errors.***

QA is an oversight (or audit) function to ***make sure that QC is being properly conducted***.

A QA/QC program is not an option—it's a requirement, regardless of whether the client expects to pay for it or not. It is better to have no quality plan at all than to have a plan that you create but then never implement.

LMRP Lessons Learned Meeting

6 Ways to Build Project Quality

1. Know Your Team

- To overcome the quality problems often associated with a less-than-perfect project team, Contractor should review each individual and identify his or her strengths and weaknesses, then use these traits to the project's best advantage.

- OPG/Hatch working as a team.
- Hatch's team understanding of our role.

LMRP Lessons Learned Meeting

6 Ways to Build Project Quality

2. Plan the work in a logical sequence

Every project has a natural sequence of activities that leads to the greatest efficiency and quality on the job. Deviations from this natural sequence introduce quality errors that cost time and money to correct.

- e.g. Concrete preparation improved at Kipling (see scroll case with less linear repairs)
- Fast tracking risks

LMRP Lessons Learned Meeting

6 Ways to Build Project Quality

3. Anticipate Problems

Ask your team members the following question: "What can go wrong that will hurt the quality of the project?"

- OPG/Hatch team had to intervene in some cases, helping KAP's quality team.

LMRP Lessons Learned Meeting

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6 Ways to Build Project Quality

4. Stay Close to the Work

Site visit routine observation uncovers quality problems as they occur and allows for correction before major rework becomes necessary.

- OPG/Hatch noted that KAP's Field Engineers could have spent more time on site.
- Care and Preservation.

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

6 Ways to Build Project Quality

5. Quality Assurance

Quality Assurance involves auditing QC performance.

- People naturally tend to focus more on QC.
- The Contractor could have improved his own quality processes by doing more QA.

LMRP Lessons Learned Meeting

6 Ways to Build Project Quality

6. The Principle of Single Statement

By carefully planning where to show each item of information, you can make the information easier to find.

- Keep a reliable **M**aster **D**rawing **L**og
- Avoid using C3 Drawings for construction

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

End

Thank You

Merci

Obrigado

2014 LMRP Lessons Learned Meeting

Kiewit-Alario, A Partnership

QUALITY

LMRP - Lessons Learned Meeting

Quality Challenges

Quality Plan - did not fully encompass:

- Industrial scope of work - needs to have this aspect integrated into it fully.
- Commissioning scope - procedures / processes did not follow actual processes.

Subcontractor quality management:

- NCRs - Centric workflows make it difficult to put an NCR against a Subcontractor
- Accountability - involved subs in KAP/OPG Hatch quality meeting - evolved to separate weekly meetings with each sub, issues minuted / tracked / resolved
- KAP continuity with SUBS (Canmec , Andritz, Harris) was an ongoing issue of concern - KAP needed to have a consistent KAP representative.

Owner walkdowns before construction completion:

- Punchlists / construction work completion processes required better communication between KAP and related parties.
- Not recommended to perform walkdowns on some sub-systems (ie - piping after hydro) until nearly complete.

LMRP - Lessons Learned Meeting

Operational Challenges - Quality focus areas

- Powerhouse water leakage issues - design changes to unlined scroll /draft cases resulted in leakage from concrete shrinkage & construction / design matters. Sealing program scope and budget aggressive. NCRs and customer dissatisfaction with water leakage a result.

- Piping conformity - ensuring that piping work was fully compliant to requirements under regulation. TSSA approval can delay the job if not understood correctly.

- Cable / lighting damages - creation of 'logs' for damage tracking / inspection.

- Electrical - cable tray status and requirements simplified with simple flagging / tracking systems.

LMRP - Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Cable Tray Status Tagging Process 2014/01/26

This is the process that cable tray will be tagged in the field to serve as a visual aid for tray inspection status. The processes for checklists and inspection / witnessing and notification remain the same.

Installed ribbon to be clearly visible from the ground and at least 300mm of flagging to be hanging from bottom of tray. Ribbon to be placed at the start and end of each cable tray run in the working shift.

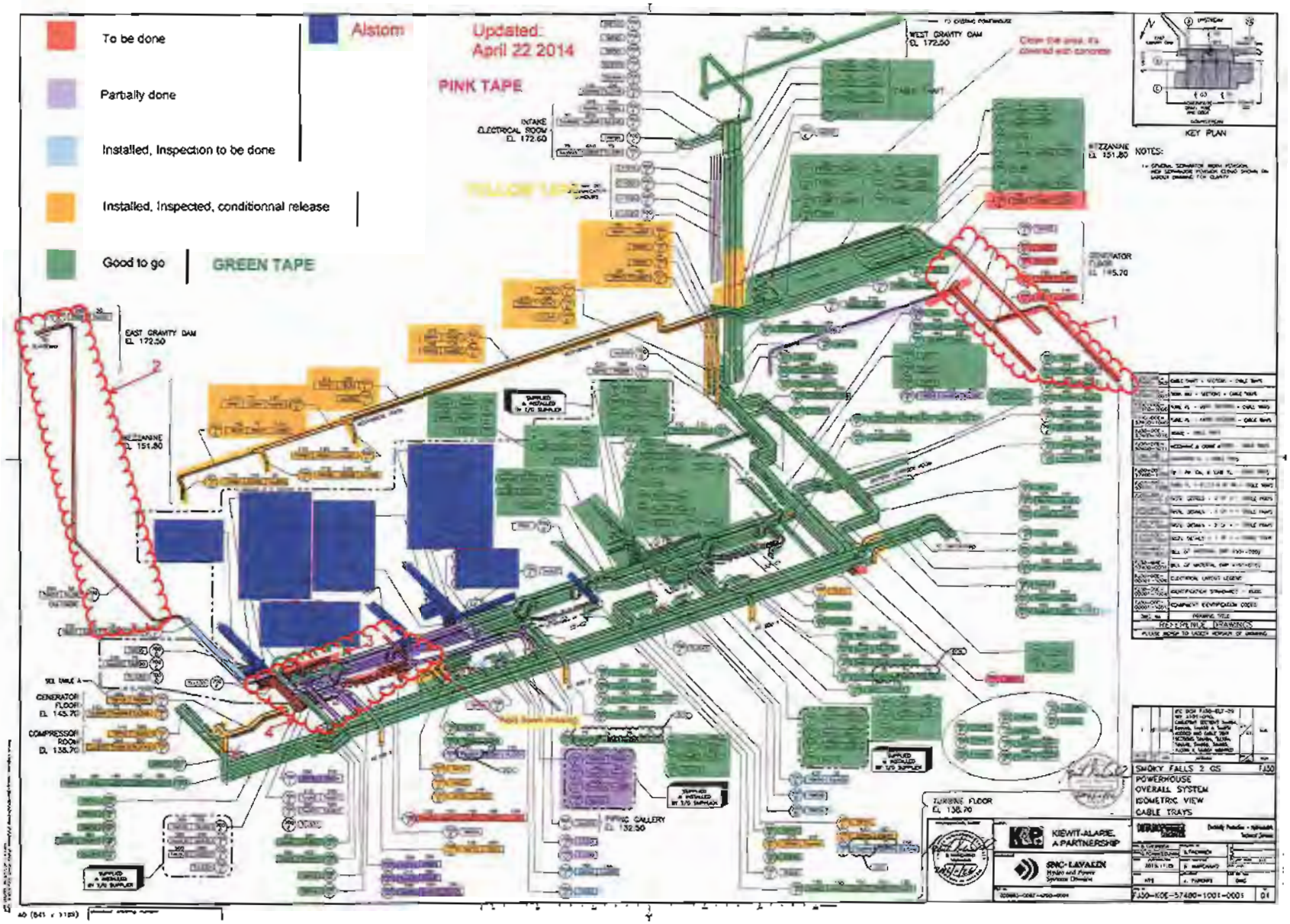
Color codes:

PINK - **Not Inspected**. DO NOT RUN CABLE IN TRAY

FE/Supervisor is responsible to make sure workers install this tape after installing tray – start and end of shift runs.

Yellow - INSPECTED by Quality – **Conditionally Released (worklist of outstanding items attached to checklist to be completed before acceptance).** FE/Supervisor is responsible to install tape at point of inspection following inspection and replacing the Pink tape. Cable can be pulled.

LMRP - Lessons Learned Meeting



LMRP - Lessons Learned Meeting

Kiewit-Aecon, A Partnership

2014-05 Gallup - Largest +/- change in Quality for last 8 months

Gallup Poll Gap Analysis		2012		2013		2014		2013-2014 Change		
		Jul-12 Mean	5 - polled 5's %	Oct-13 Mean	8 - polled 5's %	May-14 Mean	7 - polled 5's %	7 mos Delta	7 Mos % change	Gallup Questions
Client Engagement	C01	4.20	20	4.00	13	3.86	14	-0.14	-4%	How satisfied are you with Kiewit overall?
	C02	4.60	60	4.38	50	4.14	29	-0.24	-5%	How likely would you be to consider Kiewit for your next contract?
	C03	4.80	80	4.25	38	4.14	29	-0.11	-3%	How likely are you to provide a favorable recommendation for Kiewit as a reference for future contracts?
	C04	4.40	40	4.25	38	4.43	71	0.18	4%	Kiewit is a name I can always trust.
	C05	3.80	0	3.75	25	3.86	14	0.11	3%	Kiewit always delivers on what they promise.
	C06	4.40	40	4.25	38	4.43	57	0.18	4%	Kiewit always treats me fairly
	C07			4.38	50	4.29	57	-0.09	-2%	When a problem arises, I can always count on Kiewit to reach a fair and satisfactory resolution.
	C08			4.25	38	4.29	43	0.04	1%	I feel proud to be a Kiewit customer.
	C09	4.80	80	4.38	50	4.71	71	0.33	8%	Kiewit employees always treat me with respect.
	C10			3.75	0	4.00	29	0.25	7%	Kiewit is the perfect company for people like me.
	C11			3.50	0	3.57	14	0.07	2%	I can't imagine a world without Kiewit.
	Avg.	4.43		4.10		4.16		0.06	1%	
Client Relations	C12	4.40	40	3.88	25	3.71	0	-0.17	-4%	Kiewit is easy to do business with.
	C13	4.20	40	4.13	25	4.57	57	0.44	11%	Kiewit is willing to listen and consider others' input throughout a project
	C14	4.20	20	4.00	25	4.14	57	0.14	3%	Kiewit creates an environment of mutual openness and transparency.
	C15	4.20	20	3.63	13	4.14	29	0.51	14%	Kiewit addresses my key concerns effectively.
	C16	3.80	0	3.88	13	3.86	0	-0.02	-1%	The project team's/management team's performance exceeds my expectations.
	Avg.	4.16		3.90		4.08		0.18	5%	
Project Admin	C17	4.20	20	4.00	25	3.71	29	-0.29	-7%	Kiewit is fair in interpreting the contract.
	C18	4.20	20	4.13	25	4.17	33	0.04	1%	Kiewit is fair in negotiations/negotiating change orders.
	C19	3.40	0	3.38	0	3.14	0	-0.24	-7%	Kiewit keeps project overall costs in line with the budget.
	Avg.	3.93		3.84		3.67		-0.16	-4%	
Quality	C20	4.40	40	3.75	13	3.57	0	-0.18	-5%	The project team/management team at Kiewit takes immediate action to correct issues that don't work/that doesn't meet our requirements.
	C21	3.80	0	4.13	25	3.86	14	-0.27	[illegible]	The project team/management team at Kiewit possesses detailed knowledge of the plans and specifications.
	C22	3.80	0	4.00	38	3.43	14	-0.57	-14%	The project team/management team at Kiewit effectively plans their own work.
	C23	4.40	40	3.50	0	3.14	0	-0.36	-10%	The project quality plan is effectively implemented.
	C24	4.00	20	4.00	13	3.17	0	-0.83	-21%	The project team/management team at Kiewit identifies quality issues with the work as they occur.
	C25	4.20	20	3.25	0	3.83	17	0.58	18%	The project team/management team at Kiewit assigns appropriate personnel for quality.
	C26	4.25	25	3.75	13	3.67	0	-0.08	-2%	Kiewit delivers high quality construction.
	Avg.	4.12		3.77		3.52		-0.24	-6%	
Overall Average		4.20		3.94		3.92		-0.03	-1%	

> +/-50%	> +/-50%	> +/-10%
Fans	Fans	Positive
Not Fans	Not Fans	Negative

LMRP - Lessons Learned Meeting

Kiewit-Alarie, A Partnership

2014-05 Gallup Results - Quality trends over last 8 months

-14%	The project team/management team at Kiewit effectively plans their own work.
-10%	The project quality plan is effectively implemented.
-21%	The project team/management team at Kiewit identifies quality issues with the work as they occur.
18%	The project team/management team at Kiewit assigns appropriate personnel for quality.

Actions Taken:

- Met with OPG/Hatch Sr. mgmt. to discuss trends and drivers - July
- KAP management examined all NCRs for accountability / prevention - July
- Refocus on planning and engagement with OPG/Hatch involved in process
- Quality plan effectiveness driven by care and preservation issues - corrective actions and program to support took place - KAP supervisory - July
- "Zipper tours" and work lists done with OPG/Hatch on a weekly basis - solving issues at lowest levels and accountability to change in a planned manner, all disciplines, all sites, all Subs. In place in May - reduced concerns in July talks

LMRP - Lessons Learned Meeting

Zipper tours - applying the basics

	Hatch Management	KAP Management
Management	Flavio DeCampos - Res. Eng. Emile Chidiac - Site PM	Jean-Pierre Gauthier - Project Mgr. Simon Gagne - Asst. PM
Quality Mgmt.	Peter Kesseler - QA All Rob Hill - QA Xshift Elec. Jason North - QA Xshift Mech.	Norm Smith - PQM Mario Piette - Asst. PQM PA Garneau - QAM

		CIVIL		MECHANICAL		ELECTRICAL	
		Hatch	KAP	Hatch	KAP	Hatch	KAP
	Disc. QA Eng. / KAP Equiv.	J. Bielenberg Peter Kesseler	Marc Bergeron - Civ/Lab Marius Negrut - Xshift	Oleg Belashov Ivan Castano	Alain Doyon - T&G R. Babic - Can/Metals Ed Eisele - Pipe/Weld	Kelley Qui Leonardo Chacon	Ken Vienneau - Subs Kim Stewart - Xshift
Discipline Monitors & KAP Inspect.	Smoky	Doug Strickland	N. Boulianne - Struct. Peter Valee - Embank Miquel Claveau - Xshift	Jason North Hilbert Bookma	Ulric Poirier - T&G Viorel Borcea - Can/Met Roger Therrien - Pipe Martin Cyr - Weld / NACE	Rob Hill	Kurt Scheid Harold Cruz -Xshift
	Smoky / Ext.	Rafael Palaez	Marius Negrut - Xshift	Josh Friedlich		Alvero Valdebenito	
	Extensions		Violet Cheena - Civ/Lab Mireille Lesiege	Hans Engelberg		Grant Michener	Ed Traer JMarc Savard - Xshift

- Solving issues at lowest level - stopped email / pictures culture to all OPG/Hatch/KAP mgrs
- Worklists (capturing / preventing issues) were done for corrections and accountability
- Management focussed on the 'bigger picture' items at weekly meetings.
- Relationships improved, results were evident, accountability established.
- Key was OPG/Hatch management support - increased satisfaction and product delivery.

LMRP - Lessons Learned Meeting

Zipper Tours - Weekly Accountability - KAP/OPG/Hatch

ZIPPER TOURS / WEEK ENDING	08-03		08-10		08-17		08-24		08-31		09-07		09-14	
→ HATCH MON / KAP INSP.	H	K	H	K	H	K	H	K	H	K	H	K	H	K
CIVIL: MC 1 - SF STRUCT.	PK FD	SRW MB	PK	VC	RP	MC	RD ALL	MC ALL	PK	M.S	PK	MC	PK PK/SBE	MC PK/SBE
MC 2 - SF EMBADE/ARC	JN GTR	MC	E.C SBW-RACES	M.B	RP	MC	RD ALL	MC ALL	D.S	M.B	PK	MC	D.S	MC
VC 3 - KG ALL	X	X	MK	VC	RP	MC	C.B KG	P.A.G KG	X	X	X	X	X	X
MECH: AD/UP 1 - T&G - ANDRITE	X	X	G.M. GS3	A.D. GS1	G.M. GS3	A.D. GS2	X	X	X	X	X	X	X	X
AD/UP 1 - " - ALSTOM	HB 2-3	UP 2-3	HE GS2	A.D. GS2	J.F SF	U.P SF	H.B. H PLT3	A.D.	H.B. DR. LIFER	A.D. GS-3	JV SF3	UP	JF SF3	UP
RB 2 - CANMEC/AFI/MCC METALS	PK CANMEC	VB MCR'S	HANIS Misc. metal	U.B.	X	X	H B SF	P.A.G SF		RD	OPG Hoist	UP House	OPG Hoist	UP structure
RT/MC 3 - PIPING-SF/ALSTOM	JD Piping	MC	HE Piping	RT	JOSH	MC-RT Fire protection	H B Alstom	MC Piping	H B I.P.A	R.T. WELDING	J.F GENERAL	R.T.	J.F Mechanical	MC building
RT/MC 3 - " - KG/ANDRITE														
ELEC: KV/BH 1 - SUBS - ALSTOM	X	X	X	X	KDS GJ	LR TRAV	X	X	RB	MC	RC GT	NIGHT	RH STATOR	BH NEUTRALS HEM??
KV/BH 1 - " - ANDRITE	GM GTTER	BH	X	X	BH	GM	GM GEN ENCLOSURE	BH	X	X				
KV/BH 1 - " - CANMEC	RH	BV	HAROLD	JOCELYN	KDS El 172	AV GENERAL	X	X			KDS OLD	AV SMOKY	NOT ON	SITE
KDS/MC 2 - KAP - SPALLS			KDS EMERGENCY	RH LIGHTS	KDS El 172	AV GROUNDING	RH	MC	RH	RC			PK CL 1	BH
KDS/MC 2 - KAP - KG	KK	BH IPB'S	GM PAC AEO.	RJ	X	X	GM MET'L EQUIP/WORK	BH	RH/RM GT		GM CRANE/TAL	BH RACE	GM IPB	BH HERE

LMRP - Lessons Learned Meeting

Quality Organization / Personnel / Interaction with Client/Reps

- Defragmented the Quality Team in 2014 - joined into one team.
- Simplified quality organization chart - flattened.
- Individual empowerment / accountability - assigned to functional areas, accountable for all quality aspects to OPG/Hatch counterparts. Results - increased quality performance and reduced number of inspectors.
- Evolved the team with better qualified personnel into the inspector roles - ie - electrical, piping.
- Above netted a more effective team and reduced quality headcount / costs.

LMRP - Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Quality Recognition - Craft engagement / KAP alignment is key.

QUALITY RECOGNITION

DOING IT RIGHT WHEN NOBODY IS LOOKING

Ed has a quality of work and a good safety practice ethic for himself and his fellow workers—Proper PPE, calibrated equipment, LOTO and the right procedures.

Ed awarded for ensuring others 'get it right the first time' - in this line of work—there are no second chances!

Ed Johnson—Electrical

October 20, 2014

QUALITY RECOGNITION

DOING IT RIGHT WHEN NOBODY IS LOOKING

On the spot quality award given to Gaetan for ensuring that the tool used was calibrated before using it.

In this case, it was not. Thanks for taking the time to verify your tools so that the work was "Right the first time" !

Gaetan Cote—Iron Worker

October 20, 2014

Right THE FIRST TIME QUALITY

RIGHT THE FIRST TIME

2014 LMRP Lessons Learned Meeting

Kiewit-Alstrie, A Partnership

COST/PRODUCTION/CONTRACT MANAGEMENT

LMRP - Lessons Learned Meeting

Cost / Production / Contract Management

Rob Cornell

Michel Paquette

Ginny Ly

Lucas Chen

LMRP - Lessons Learned Meeting

Kiewit-Alaine, A Partnership

Production

LMRP - Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Opportunities on the Next Project

1. Batch Plant

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

Batch Plant

- Many subs involved as opposed to one knowledgeable sub
- Ordered cheaper silos which needed more setup requirements
- Equipment came with European standards. Some work needed to be redone
- Batch plant operating software

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky

    - Need a full time LEADER

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp

- Many issues related to camp not being built in North America
- Higher standards
- Better inspections

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp

LMRP - Lessons Learned Meeting

Kiewit-Alario, A Partnership

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

Misc Metals

- Engineering
  - Drawings missing embedded components
  - Not having separate package for misc. metals. We had to resort to Civil Drawings

- Procurement
  - Lack of communication
  - Not ordering items ahead of time considering Procurement Process durations
  - Schedule Changes
  - Setting up contracts
  - Onsite material inspections

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker

   - Having the decision maker on site

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker
6. High Level planning team

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker
6. High Level planning team

- Having a senior person Zooming Out

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker
6. High Level planning team
7. Union Relations

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

Union Relations

What did we do wrong:

- Lack of communication
  - Early in the process
  - During the work
- Collaboration with union on win-win solutions without going to labor board

Actions that helped:

✓ CVIS
✓ Visiting Union Hall, and Union visits on Camp
✓ Stewards involvement
✓ Union involvement in decision making

The Hand That Will Rule the World—One Big Union.

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker
6. High Level planning team
7. Union Relations
8. Same Rotations – Rotation Teams

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker
6. High Level planning team
7. Union Relations
8. Same Rotations – Rotation Teams

- One Rotation – 2:1
- 3 Identical Teams – A, B, C

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker
6. High Level planning team
7. Union Relations
8. Same Rotations – Rotation Teams
9. Extreme Housekeeping and Access in Bid

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Batch Plant
2. Camp
3. Start New Year with a lack of leadership at Smoky
4. Misc. Metal Management
5. SLI Decision Maker
6. High Level planning team
7. Union Relations
8. Same Rotations – Rotation Teams
9. Extreme Housekeeping and Access in Bid
10. Scaffolding – Management – Self-Perform vs. Subs

LMRP - Lessons Learned Meeting

Must do on the Next Project

1. Challenged the designer by bringing our experience forward

LMRP - Lessons Learned Meeting

Must do on the Next Project

1. Challenged the designer by bringing our experience forward
   a) Combining Pours
   b) SF Plug Removal
   c) Fish Window
   d) Cofferdam

LMRP - Lessons Learned Meeting

Must do on the Next Project

1. Challenged the designer by bringing our experience forward
2. Rolling Platform – Concrete Pours

LMRP - Lessons Learned Meeting

Must do on the Next Project

Rolling Platform

- ✓ Safer to work with
- ✓ Reduced Access Installation/Removal
- ✓ Accelerated pouring rate

LMRP - Lessons Learned Meeting

Must do on the Next Project

1. Challenged the designer by bringing our experience forward
2. Rolling Platform – Concrete Pours
3. Superstructure design to be used before completion

LMRP - Lessons Learned Meeting

Must do on the Next Project

Superstructure

- ✓ Temporary braces were added to allow the usage of Overhead crane
- ✓ Mezzanine and tailrace deck pours advanced to act as diaphragms to stabilize the superstructure
- ✓ Allowed usage of crane for Units 1 & 2 with small limitations only

LMRP - Lessons Learned Meeting

Kiewit-Alstrie, A Partnership

Must do on the Next Project

1. Challenged the designer by bringing our experience forward
2. Rolling Platform – Concrete Pours
3. Superstructure design to be used before completion
4. Grouping of Departments

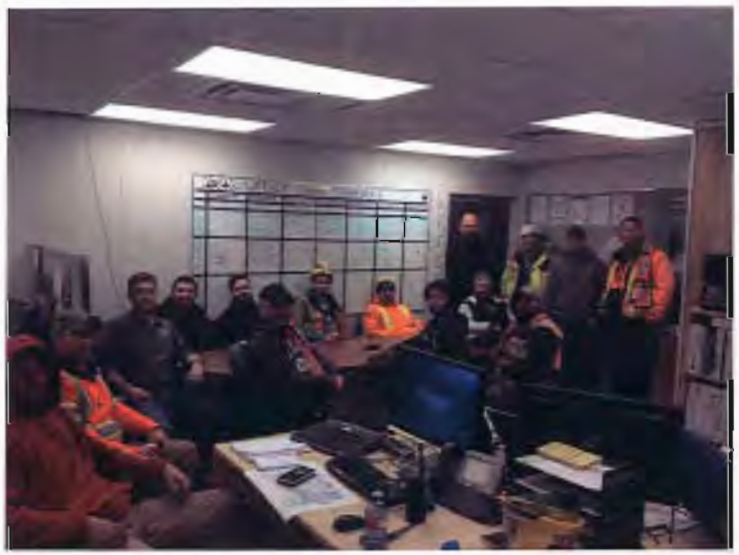
LMRP - Lessons Learned Meeting

Must do on the Next Project

Grouping Departments

✓ Merged multiple departments in office trailers
✓ Share Resources

- Hub: management, Safety, Environment, HR, Controls, Electrical, and Commissioning
- Fabshop: Demob, Misc Metals, Site Services, Earthworks



LMRP - Lessons Learned Meeting

Must do on the Next Project

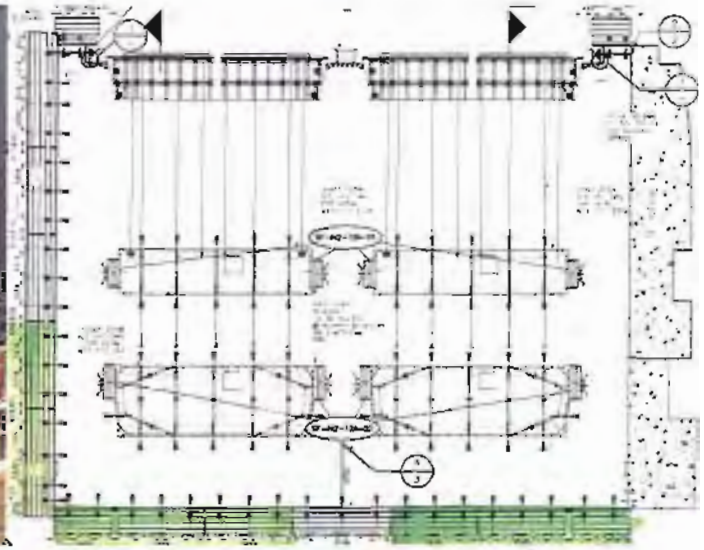
1. Challenged the designer by bringing our experience forward
2. Rolling Platform – Concrete Pours
3. Superstructure design to be used before completion
4. Grouping of Departments
5. Intake Formwork

LMRP - Lessons Learned Meeting

Must do on the Next Project

Intake Formwork

- ✓ Combined 3 panels to create one 30m2 panel
- ✓ Eliminate repetition of erect and strip
- ✓ Accelerate maintenance on formwork before re-use



LMRP - Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Must do on the Next Project

1. Challenged the designer by bringing our experience forward
2. Rolling Platform – Concrete Pours
3. Superstructure design to be used before completion
4. Grouping of Departments
5. Intake Formwork
6. Steel Shaft Forms

LMRP - Lessons Learned Meeting

Kiewit-Aecon, A Partnership

Must do on the Next Project

Shaft Forms

- ✓ Easy to erect/strip
- ✓ Minimal treatment for re-use
- ✓ Durable and doesn't require much maintenance

LMRP - Lessons Learned Meeting

Must do on the Next Project

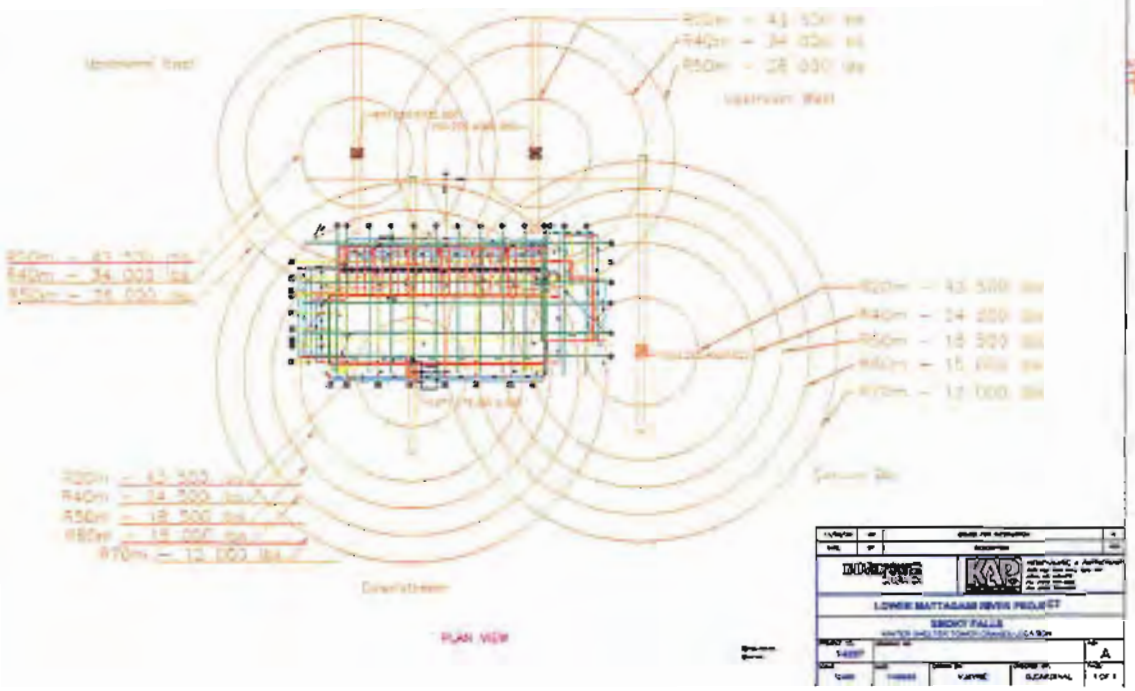
1. Challenged the designer by bringing our experience forward
2. Rolling Platform – Concrete Pours
3. Superstructure design to be used before completion
4. Grouping of Departments
5. Intake Formwork
6. Steel Shaft Forms
7. SF Tower Crane placement

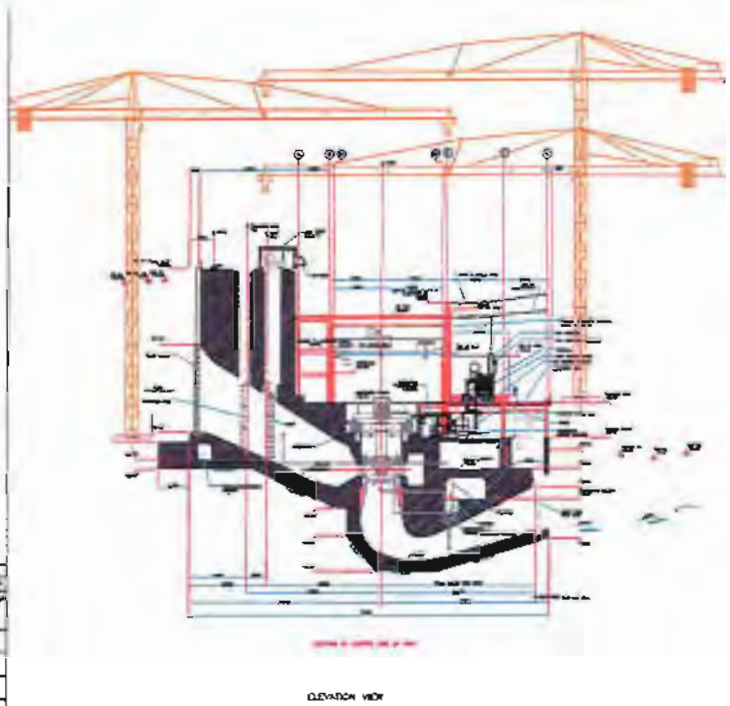
LMRP - Lessons Learned Meeting

Must do on the Next Project

Tower Crane Use / Placement

- ✓ Optimum reachability for construction and material handling
- ✓ Advancing schedule
- ✓ Reduce Rentals





LMRP - Lessons Learned Meeting

Must do on the Next Project

8. SF - Dewatering System

LMRP - Lessons Learned Meeting

Must do on the Next Project

8. SF - Dewatering System
9. Platform over the guides – Canmec Work

LMRP - Lessons Learned Meeting

Must do on the Next Project

8. SF - Dewatering System
9. Platform over the guides – Canmec Work
10. Hydrotite around pipes

LMRP - Lessons Learned Meeting

Must do on the Next Project

8. SF - Dewatering System
9. Platform over the guides – Canmec Work
10. Hydrotite around pipes
11. Draft Tube formwork

LMRP - Lessons Learned Meeting

Must do on the Next Project

Draft Tube Forms

- ✓ Built off-site – Minimizing space allocation on site
- ✓ Arrived in modules – East to install and strip
- ✓ Used for multiple pours

LMRP - Lessons Learned Meeting

Kiewit-Alarie, A Partnership

COST /

CONTRACT MANAGEMENT

LMRP - Lessons Learned Meeting

Kiewit-Alerie, A Partnership

Must do on the Next Project

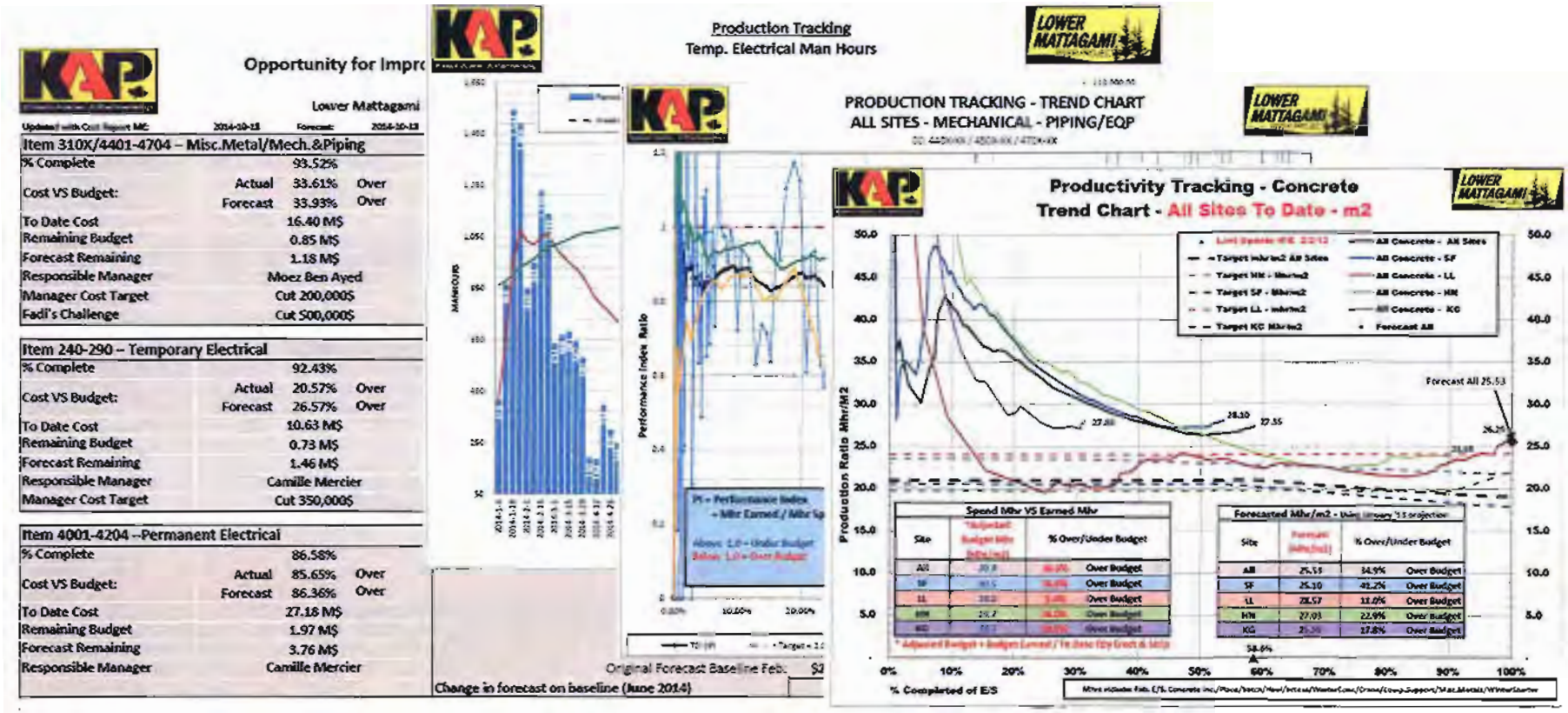
1. Trend Charts/Top Opportunities for Improvement

LMRP - Lessons Learned Meeting

Must do on the Next Project

Trend Charts/Top Opportunities for Improvement

- Cost Tracking & Reporting
- Challenge Ownership & Productivity in the Field



LMRP - Lessons Learned Meeting

Must do on the Next Project

1. Trend Charts/Top Opportunities for Improvement
2. Cost & Schedule Review/Quarterly Meetings

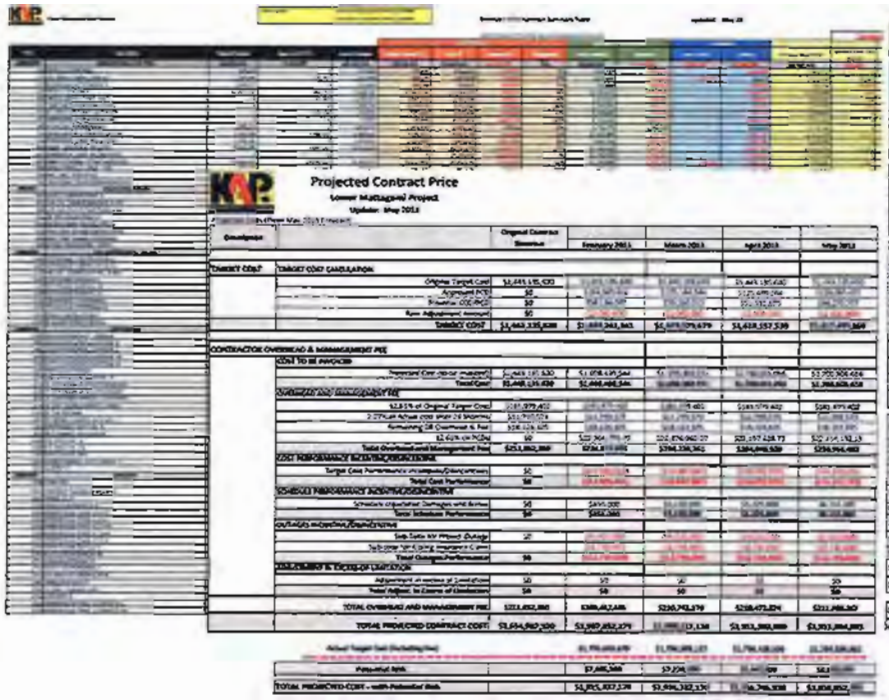
LMRP - Lessons Learned Meeting

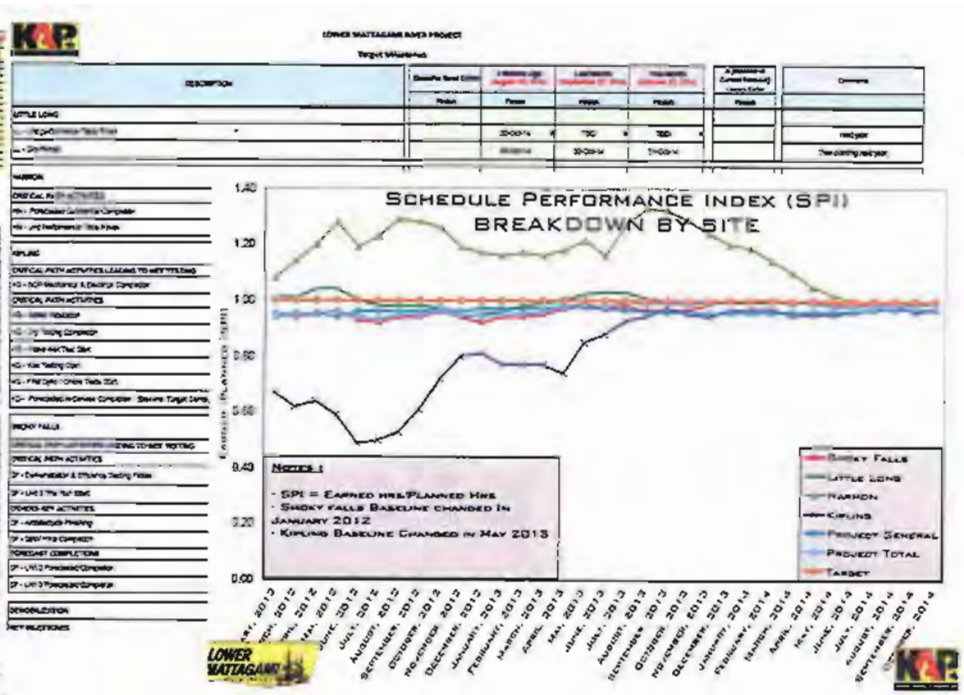
Kiewit-Alstrie, A Partnership

Must do on the Next Project

Cost & Schedule Review Meetings

- Monthly/Quarterly Reporting
- Open Book Contract
- Communication/Collaboration OPG/Hatch & KAP





LMRP - Lessons Learned Meeting

Must do on the Next Project

1. Trend Charts/Top Opportunities for Improvement
2. Cost & Schedule Review/Quarterly Meetings
3. Contract Administration & Management

LMRP - Lessons Learned Meeting

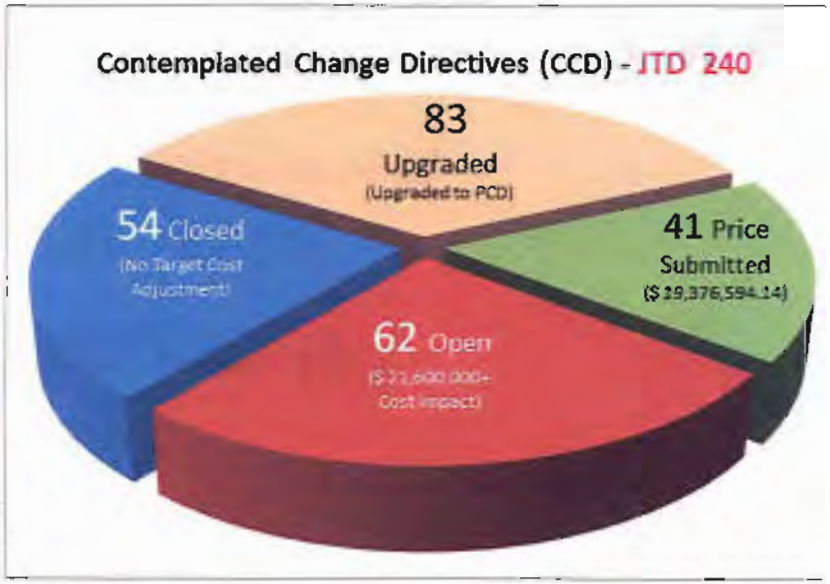
Kiewit-Alarie, A Partnership

Must do on the Next Project

Contract Administration & Management

- Efficient with Small team
- Collaboration OPG/Hatch & KAP
- CCD/PCD backup Defendable
- Organization/Grassroots Communication

Contemplated Change Directives (CCD)		
Job To Date (JTD)	240	
Closed	54	No Target Cost Adjustment
Upgraded	83	Upgraded to PCD
Price Submitted	41	Submitted price to OPG to issue a PCD (Value **$ 19,376,594.14**)
Open / To be Re-submitted	62	KAP to price and submit to OPG (Estimated Cost ≈ **$ 21,600,000+**)



**** Major Open Contemplated Change Directives (CCD):**

1. CCD # 053C Road Upgrades/Repairs - July 15, 2012 onwards (Estimate ≈ $ 2,000,000+)
2. CCD # 053D Road Maintenance - April 20, 2014 onwards (Estimate ≈ $ 1,500,000+)

LMRP - Lessons Learned Meeting

Kiewit-Alstrie, A Partnership

Must do on the Next Project

1. Trend Charts/Top Opportunities for Improvement
2. Cost & Schedule Review/Quarterly Meetings
3. Contract Administration & Management
4. Offsite Project Controls/Business Dept.

LMRP - Lessons Learned Meeting

Must do on the Next Project

1. Trend Charts/Top Opportunities for Improvement
2. Cost & Schedule Review/Quarterly Meetings
3. Contract Administration & Management
4. Offsite Project Controls/Business Dept.

- Huge Cost Saving but Communication Challenge

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Subcontracts Management

LMRP - Lessons Learned Meeting

Kiewit-Alario, A Partnership

Opportunities on the Next Project

1. Subcontracts Management

- Onsite Administration Presence
- Kickoff Meetings with Subcontractor
- Safety Indoctrination & Involvement
- Back charges & EPSCA Procedures

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Subcontracts Management
2. Emphasis New Hires on Cost from Start

LMRP - Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Opportunities on the Next Project

1. Subcontracts Management
2. Emphasis New Hires on Cost from Start

- Increase Knowledge on Cost
- Take Ownership & Accountability
- Tracking & Forecasting

LMRP - Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Opportunities on the Next Project

1. Subcontracts Management
2. Emphasis New Hires on Cost from Start
3. Equipment Management Plan

LMRP - Lessons Learned Meeting

Kiewit-Alario, A Partnership

Opportunities on the Next Project

1. Subcontracts Management
2. Emphasis New Hires on Cost from Start
3. Equipment Management Plan

- Mob/Demob Plan
- Equipment Flow Tracking
- Optimization of Utilization

LMRP - Lessons Learned Meeting

What we did well

- Open book contract between OPG/Hatch and KAP Project Controls
- Organized team for Cost Management
- Effective Cost Systems and Tools in place
- Field Ownership of cost codes/budgets
- Concurrent Design with Fast tracked project
- CPI and SPI, and Monthly Reporting

2014 LMRP Lessons Learned Meeting

Kiewit-Alario, A Partnership

TURBINE & GENERATOR

LMRP - Lessons Learned Meeting

Kiewit-Alstom, A Partnership

Opportunities on the Next Project

1. Quality Surveillance

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Quality Surveillance
2. Detailed operation mode in W2W specification

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Quality Surveillance
2. Detailed operation mode in W2W specification

- Speed No-Load
- Condense Mode
- Rough Zone
- Operation mode/habit (Peaking station, Condense during night…)

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Quality Surveillance
2. Detailed operation mode in W2W Specification
3. Management weekly conference call

LMRP - Lessons Learned Meeting

Opportunities on the Next Project

1. Quality Surveillance
2. Detailed operation mode in W2W Specification
3. Management weekly conference call

- Held weekly
- T&G Project Manager, Contractor, Owner & Owner Rep. mangers only
- Follow-up and address any upcoming issues

LMRP Lessons Learned

Opportunities on the Next Project

1. Quality Surveillance
2. Detailed operation mode in W2W Specification
3. Management weekly conference call
4. T&G Engineering Representative at site

LMRP Lessons Learned

Opportunities on the Next Project

1. Quality Surveillance
2. Detailed operation mode in W2W Specification
3. Management weekly conference call
4. T&G Engineering Representative at site

- Having an engineer present at site to help resolve issue quicker (NCR, DCN…)

LMRP Lessons Learned

Opportunities on the Next Project

1. Quality Surveillance
2. Detailed operation mode in W2W Specification
3. Management weekly conference call
4. T&G Engineering Representative at site
5. Optimized Schedule (Extensions)

LMRP Lessons Learned

Opportunities on the Next Project

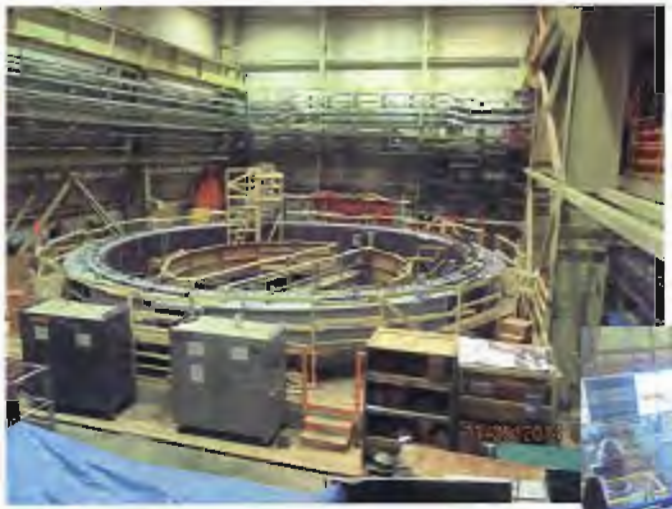
1. Quality Surveillance
2. Detailed operation mode in W2W Specification
3. Management weekly conference call
4. T&G Engineering Representative at site
5. Optimized Schedule (Extensions)

- All embedded component installed with the tower cranes
- Rotor and Runner assembly done in parallel with Stator assembly
- Advanced the schedule of +/- 2 months

LMRP Lessons Learned

Opportunities on the Next Project

5. Optimized Schedule (Extensions)



LMRP Lessons Learned

Opportunities on the Next Project

1. Design
   - Runner vs Discharge vs Unit Efficiency
   - Evaluate Cavitech needs on future project

2014 LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

ELECTRICAL

LMRP Lessons Learned Meeting

Kiewit-Alaris, A Partnership

Brownfield vs. Greenfield Construction

- Develop an understanding of the complexities involved in working in close proximity to and interfacing with owner assets.
- Provide training on owners work protection and safety programs to all workers.
- Acknowledge limitations of KAP staff and empower individuals with expertise in hydraulic operations to plan & to manage stakeholder interactions.

LMRP Lessons Learned Meeting

SCADA FAT's and Equipment Staging

- Off-site fully stage and test all of the SCADA system complete with network components, PLCs and third party monitoring equipment.
- Early on develop a comprehensive I/O data base to facilitate SCADA programming and implementation.
- Align priorities between turbine / generator systems and BOP systems to allow for units and auxiliaries going into service together.

LMRP Lessons Learned Meeting

Scheduling and Coordination

- A realistic schedule rather than an aggressive schedule should be used for interactions with stakeholders.
- Plan and schedule in advance then communicate scheduled events to all parties.
- Consider owner and other stakeholders when scheduling events and set priorities accordingly.
- Due consideration and planning must be made to avoid inadvertent transmission line trips.

LMRP Lessons Learned Meeting

QA and QC on Electrical Work

- Make a greater effort to avoid deviations from the specifications and to avoid poor workmanship.
- Enhance the KAP QA and QC efforts.
- Improve clarity and details of ITP's in order to improve effectiveness.

LMRP Lessons Learned Meeting

Kiewit-Allaire, A Partnership

Turn Arounds

- Have adequate resources to ensure a meaningful handover and smooth transition between rotations.
- Ensure work doesn't stop when key personnel are off site.

LMRP Lessons Learned Meeting

Commissioning & Documentation Requirements

- Implement the commissioning plan and assure alignment of subcontractor deliverables with the plan.
- Improve quality control on the documentation packages.
- Ensure that the owner expectations for the documentation packages are known and communicated to all KAP and subcontractor groups generating documents.

LMRP Lessons Learned Meeting

Owner Functional Requirements

- Refine the DB specification to capture and detail owner functional requirements.
- Ensure that the contents of the specification are communicated to all designers and installers including subcontractors.

LMRP Lessons Learned Meeting

Scope of work and Resources

- Develop a better understanding of the scope of work to create a more accurate schedule and to enhance resource planning.
- Evaluate and align documentation generation with owners T.O.C. expectations (Commissioning Plan) to ensure adequate resources are provided.
- Improve outage management and reduce resources by detailed work planning.

LMRP Lessons Learned Meeting

Rework

- Work should only commence after receipt of IFC drawings and proceed only with the latest versions.
- Improve coordination and field supervision in order to reduce rework.
- Schedules should be managed to allow all stakeholders an opportunity to attend inspections/walkdowns without duplications.

2014 LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

ELECTRICAL

LMRP Lessons Learned Meeting

ELECTRICAL COST

- Because the Contract is Design-Build, any Engineering changes that identified additional Scope and Quantity Increases needed to be tracked, cost assigned to it, and communicated to the Owner in a timely manner.
- Claiming Rules for Cost Control were established but not consistently followed at all four sites. This resulted in over-claiming for one Cost Period and earned hours with no quantities to claim for the next period.
- Cost Codes should have been more clearly defined as to what was included in the specific quantities.
- Unit Rates on certain activities should be reviewed. KAP brought in another Contractor, Moreau Electrical, to perform Permanent Work at Kipling, but with similar results.

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

SITE EXECUTION

- Engineering Firm assigned to specific sites should have been responsible for a complete Design, such as completion of Tray Routings.
- The "Just in Time" Engineering generated numerous Field Instructions and Field Change Requests.
- All Electrical Sub-Contractors need to be responsible for all aspects of Electrical Work and their Contracts should be written this way. Items such as Off-Tray and Grounding should be in Sub-Contractor Scope and not KAP directly.
- Operational Shutdowns should have been used more frequently for Cost and Quality and enforced earlier in the Project. Once the completion of Operational Shutdowns was being tracked, KAP started doing them more frequently and benefits were observed.
- KAP Site Contracts / Administrators were looking after Mechanical and Electrical. Any Contracts that had multiple discipline components should have been assigned to more than one Site Engineer. Canmec work was a perfect example of this.
- Early in the Project, Little Long Site was not set up and workers were travelling from Hub Area to Little Long (Embedded Grounding – excessive travel time). This was improved upon for the other Sites.
- KECO came to site in the Fall of 2013. One of the major improvements was to split up Permanent Work crew and Temporary Power crew. Then, Requests for Temporary Power were introduced to allow scheduling of Temporary Power requirements site-wide.

LMRP Lessons Learned Meeting

LABOUR FORCE (IBEW)

- Aluminum Welding of IPB should have been assigned differently in the Jurisdictional Mark-Up. Too many resources were wasted trying to select and train IBEW Electricians that were not qualified to perform the work. Hire FIPOE Welders from Quebec for all future Aluminum Welding.

- Workmanship of some IBEW workers was sub-par but was not addressed properly by Site Supervision. Numerous Punch Items were a direct result of poor workmanship, some of which involved our Sub-Contractors.

- KAP should have insisted on regular Site Presence from local IBEW Business Manager throughout the Project to address KAP and OPG concerns. KAP had to deal with too many unnecessary grievances.

- The IBEW Business Manager should have been reinforcing the Code of Excellence with his members.

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

QUALITY

- Better use of the RFI process would have eliminated many NCR's, and better interpretation of the Design-Build Specification.
- The Design-Build Specification contained ambiguity and sometimes the intent was missed. The WTW portion of the DB Specification was reserved for the major equipment not consumables in KAP opinion.

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

TEMPORARY ELECTRICAL

- Not well planned by all stakeholders during the initial design stage (SF was designed for 2 Tower Cranes and actually installed 5 Units, etc.)
- The initial installation on site was adequate, but there were numerous and constant changes during the construction phase due to poor planning
- Formalized "Breaking The Surface Permit" during the early construction phase, due to extensive underground cable installations

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

SAFETY

- The Supporting Guarantee process both with OPG and Hydro One worked well. Need to ensure that Senior Electrical Personnel are assigned these duties for all future projects, and that they receive the proper Work Protection Code Training.

- Develop an upfront relationship with local ESA Inspector

2014 LMRP Lessons Learned Meeting

Kiewit-Alario, A Partnership

COMMISSIONING

LMRP Lessons Learned Meeting

Things to do on the next project

- Have better balanced group of experienced commissioning resources
- Start building the commissioning binders early (build knowledge of the systems)
- Be present at the construction planning meeting and walkdowns
- Plan for an OPG operator (Interface beyond NECC).
- Integration of the packages early in the process (HEMI scope VS others)
- Keep the daily meeting to coordinate activities.

LMRP Lessons Learned Meeting

Opportunities for the next project

- Better define the milestones expectations
- Clarify the major operational requirements of the DBA
- Clarify the sub contractors commissioning scope VS the contractor (AFI, Alstom, etc)
- Optimize the document control system (Centric, multiple copies)
- Budget for a 24/7 coverage support
- Try to have the same client

2014 LMRP Lessons Learned Meeting

Kiewit-Alstom, A Partnership

COMMISSIONING

LMRP Lessons Learned Meeting

Lessons Learned #1-Communications

Recommendations:

- Implement Communication Plan
- Develop & maintain good open communications

LMRP Lessons Learned Meeting

Lessons Learned #2-Site Relationship between OPG & KAP in 2014

Recommendation:

- Very successful, stay the course

LMRP Lessons Learned Meeting

Lessons Learned #3-Safety & LOTO

Recommendation:

- Continuous & ongoing training, including Owner's Work Protection
- Continuous updating of LOTO & Safety Policies & Procedures
- Establishment of Construction Zones & Islands was successful
- OPG to improve Terminal Point tracking system
- Execute a successful staffing plan to avoid overloading staff

LMRP Lessons Learned Meeting

Kiewit-Alaris, A Partnership

Lessons Learned #4-Transfer of Control

Recommendation:

- Allow appropriate P6 Schedule task duration for TOC process before Unit-In-Service date
- Contractor and Owner to reach agreement on when this best suits all needs and avoid repeating work
  - (eg) Demo / Load Verifications
  - Understanding of ToC Requirements

LMRP Lessons Learned Meeting

Lessons Learned #5-Common Goals of Site Staff & Senior Management

Recommendation:

- Alignment of objectives between site staff and senior management is required

LMRP Lessons Learned Meeting

Lessons Learned #6-Outage Planning

Recommendation:

- Contractor to hire experienced Operators
- Contractor staffing using ex-OPG resources is valuable
- Improve KAP Work Planning, knowledge of OPG requirements for the Outage Management Process

LMRP Lessons Learned Meeting

Lessons Learned #7-Planning for Resources

Recommendation:

- Recruit more experienced staff, in particular for Electrical and P & C
- Avoid significant number of new Grads
- No continuity during KAP Personnel's turnaround absences
- Seeking external expertise worked well (BBA & ex-OPG)
- Have buy-in to Commissioning Plan/Execution and Philosophy from Senior Management & Site Staff
- Execute a successful staffing plan to avoid overloading staff

LMRP Lessons Learned Meeting

Kiewit-Alstrie, A Partnership

Lessons Learned #8-Walkdowns

Recommendation:

- Better planning required for Commissioning Activities
- Postpone Walkdowns until planning and work is complete

LMRP Lessons Learned Meeting

Kiewit-Alaris, A Partnership

Lessons Learned #9-Onsite/Offsite Quality

Recommendation:

- Follow the process and procedures related to Punch Items
- Follow the Turnover Procedure
- QA Audits require better scheduling

LMRP Lessons Learned Meeting

Kiewit-Alario, A Partnership

Lessons Learned #10-Construction Completion

Recommendation:

- Construction should be complete before Commissioning Activities commence
- BOP should be complete prior to Unit Commissioning

LMRP Lessons Learned Meeting

Lessons Learned #11-Owner's Requirements in Contract Specifications

Recommendation:

- Needs to include detailed Commissioning Process & Procedures
- Needs to include the Transfer of Control Procedure

LMRP Lessons Learned Meeting

Lessons Learned #12-Contracting Strategy

Recommendation:

- Sub-Contractor's scope should be from Runner to Disconnect Switch - W2W

LMRP Lessons Learned Meeting

Kiewit-Aldrie, A Partnership

Lessons Learned #13-Design-Build Agreement Clarity

Recommendation:

- Require more supporting details
- Document to be more clear

LMRP Lessons Learned Meeting

Kiewit-Alstrie, A Partnership

Lessons Learned #14-Project Schedule

Recommendation:

- A Contract Deliverable should be a complete, detailed, accurate P6 Schedule, delivered monthly
- All other schedules such as 3-week, 6-week, and 120-day should be derived from the PS6 schedule

LMRP Lessons Learned Meeting

Lessons Learned #15-Triple Constraints (Cost, Schedule, Quality)

Recommendation:

- Find the balance between Quality and Schedule
- Focus on Quality when Project is ahead of Schedule

LMRP Lessons Learned Meeting

Kiewit-Alarie, A Partnership

Thank You Everyone

AMPCO Interrogatory #53

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-4 Page 4 Chart 1

a) Please complete the following Table to compare the nuclear stations reviewed by OPG to DRP.

Nuclear Station	Total # Units	# of Units Refurb	# Full Time Staff	Annual MW	Start Date	Planned/Actual Duration	Planned/Actual Costs	Planned/Actual LUEC cents/kWh
DRP								

Response

OPG has completed Chart 1 below with the requested information where it is available. OPG does not have information on Full Time Staff, Planned/ Actual LUEC and Annual MWh. Please see Ex. L-4.3-1 Staff-52 for a summary of similarities and differences between the DRP and the CANDU plants which have undergone refurbishment.

While OPG has provided planned and actual costs for some refurbishments, the costs for the projects are not directly comparable. The details of what is included in the other utilities' costs are not available to OPG. While the core scope for the projects in Chart 1 included replacement of the fuel channels and all or most of the feeder pipes, the remainder of the scope is not comparable across projects. Even with the core scope, the different reactor designs result in a significant difference in the number of fuel channel replacements at Pt. Lepreau and Wolsong. A further limitation when comparing different projects is the differing operating constraints of the execution of refurbishment work.

Some of the known differences between the DRP and the Bruce 1 and 2 units are:

- Bruce Units 1 and 2 were "cold and defueled" at the start of refurbishment. In addition, the two units under refurbishment were adjacent units which simplifies defueling and islanding.

- Costs are not directly comparable because of the timing of expenditures.
- It is unclear whether interest costs are included in the Bruce Units 1 and 2 final cost of $4.8B for 2 units.

Station	Total # Units	# of Units Refurb	Start Date(1)	Planned/ Actual Duration (per unit) (months) (2)	Planned/ Actual Costs
Darlington	4	4	2016	39 per unit/not available	$12.8B/ not available
Bruce A(3)	4	2	2005	25/84 for 2 units in parallel	$2.75B / $4.8B
Pt. Lepreau	1	1	2008	18/55	$1.0B/$1.4B(4)
Wolsong	8	1	2009	22/28	not available
Gentilly	1	1	N/A	35/not available(5)	$1.9B/not available(5)

Notes:

(1) Timing of Darlington, Pt. Lepreau and Bruce Units 1 and 2 refurbishments are different, therefore costs cannot be directly compared (different year's dollars)

(2) Pt. Lepreau and Wolsong are for CANDU 6 designs with 380 calandria/pressure tubes and a dedicated fuelling machine versus the Darlington and Bruce designs of 480 pressure tubes and a shared fuel handling system.

(3) Refurbishment of Bruce Units 1 and 2 commenced in October 2005 with Unit 1 complete in September 2012 and Unit 2 in October 2012, for a total of 7 years (84 months). The cost estimate publicly quoted is from November 2010; it is uncertain whether this cost estimate included capitalized interest costs.

(4) An additional $1B in replacement energy costs, operations and maintenance costs, and incremental financing for non-project related costs was incurred by NB Power.

(5) Refurbishment of Gentilly 2 did not proceed after a cost re-assessment concluded in 2012 that the cost would be $4.3B.

AMPCO Interrogatory #54

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: EB-2013-0321 D1-2-1 Att2 Project Execution Plan R03, The Niagara Tunnel Project, Project Execution Plan January 2013, Page

Preamble: Section 20.9 of the Project Execution Plan titled Project Completion Report states the following:

"The Project Completion Report will be prepared by the Project team under the direction of the OR Project Manager and will:

- analyse Project performance relative to the PEP
- identify problems in Project execution and their solutions
- record the Project history focusing on those things the Project team would do again or do differently on another similar project. This information would be of particular importance to OPG should the fourth tunnel ever be built, and may also prove useful as OPG pursues other generation projects.

The "Lessons Learned" part of the report will address, among other things, the following:

What contributed most to the success/failure of the Project?
What worked well? What did not work well?
What constraints limited our performance? How could those constraints be removed in future?
Where did we have problems? Should these have been foreseen? If so, what indicators were missed? What innovations did we introduce on this Project? What were their impacts?

What other things could we have done to improve Project performance and success?
Is the client (NPG) satisfied with the facility as delivered?
How effective was the Risk Management Plan in eleminating, avoiding, transferring, or mitigating risk events?

The OR Project Controls Manager will document all Project controls issues arising from the management of the Project, including cost, scope and schedule variances."

a) Please provide the Project Completion Report prepared by the Project team under the direction of the OR Project Manager.

b) Please discuss how the lessons learned have impacted the planning of the DRP.

c) Please provide the project control issues documented by the OR Project Controls Manager.

Response

a) Please see Attachment 1 for the requested Project Completion Report. The format and content of the Project Completion Report ultimately differed from what was contemplated in the Niagara Tunnel Project Execution Plan. Instead of reporting on lessons learned and project controls within the Project Completion Report, this information will be included in the Post-Implementation Review. Please see Ex. L-1.2-5 CCC-008 for more information on the Post-Implementation Review.

b) Please see Ex. L-4.3-2 AMPCO-52 and L-4.3-15 SEC-21 for the integration of lessons learned into the Darlington Refurbishment Program, including lessons learned from the Niagara Tunnel Project.

c) Please see part a, as well as L-4.3-2 AMPCO-052, Attachment 4 on the lessons learned relating to project controls.

Prepared for

ONTARIO POWER GENERATION

Niagara Tunnel Project

Completion Report

April 2014

NAW130-00121.05, ID0056
R-NAW130-00121--0002

Prepared by

Hatch Mott MacDonald
in association with HATCH™

Filed: 2016-10-26
EB-2016-0152
Exhibit L, Tab 4.3
Schedule 2 AMPCO-054
Attachment 1
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Appendix 13	Project Management Documents

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1 Introduction

The **Niagara Tunnel Project** included the planning, design, construction and commissioning of a 10.2 km long, 12.7 m internal diameter tunnel and associated facilities to divert an additional 500 m^3/s of water from the Niagara River upstream from the Horseshoe Falls to the existing Sir Adam Beck hydro stations near Queenston.

At depths to 140 m below the City of Niagara Falls, the tunnel alignment is in sedimentary rocks of varying competencies and under high horizontal stress. The host rocks, particularly the Queenston formation at the tunnel's deepest section, contain very corrosive pore water and will swell in the presence of fresh water. Big Becky, the world's largest hard rock tunnel boring machine (14.44-m diameter) was used to excavate the tunnel.

Construction of the tunnel included initial support provided by steel ribs, wire mesh, rock bolts and 150 mm (nominal) of shotcrete, and final lining comprised of an impermeable polyolefin membrane and 600 mm (nominal) of cast-in-place, unreinforced concrete. The concrete was cast in 12.5 m long sections using moveable steel forms with separate invert (lower one-third) and arch (upper two-thirds) operations.

Subsequent grouting operations lock the concrete liner into the host rock and ensure that the tunnel lining remains in compression under all operational conditions. Reinforced concrete intake and outlet structures incorporate the isolation gates and efficient transitions required to minimize head losses.

An overview of the Niagara Tunnel Project is provided in Report R-NAW130-29200--0001 Niagara Tunnel Project - Overview of Asset Turnover.

Project execution began in 2004 using the design build (DB) approach. It was preceded by concept and definition work, between 1982 and 1994, undertaken by Ontario Hydro (OPG's predecessor) with support from various consultants. Environmental Assessment, Niagara River Hydroelectric Development (EA) was submitted in 1991 and received approval in 1998 (the EA Approval included two tunnels, an underground powerhouse and transmission improvements, and permitted staged construction).

In 2004, OPG engaged Hatch Mott MacDonald in assocation with Hatch as Owner's Representative (OR) to assist with procurement and administration of the Design Build Agreement (DBA), to review design documentation and to monitor construction.

Through an international proposal competition in 2004-2005, OPG contracted STRABAG, an Austrian company, to design and construct the Niagara Tunnel. STRABAG acquired the purpose-built tunnel boring machine (TBM) and other tunnel construction equipment, and engaged engineering consultants, subcontractors and construction workers as needed to execute the work.

Construction work began in September 2005 with outlet site preparation. Tunnel excavation was executed between September 2006 and March 2011. Tunnel lining operations started in December 2008 and were completed in February 2013 when grouting operations were finished. Removal of the cofferdam at the intake and the rock plug at the outlet were completed in March 2013.

The Niagara Tunnel entered commercial service on March 9, 2013 and now delivers enough additional water to increase average annual energy output from OPG's Sir Adam Beck stations by about 1.5 TWh.

OPG Board approval for the project was completed in three stages. A partial release ($10M) in July 2004 facilitated addressing Conditions of the EA Approval (eg – groundwater monitoring, Welland River issues, etc), engagement of the OR and the RFP process for engagement of the DB contractor. In August 2005, a full release ($985M) facilitated project execution including engagement of the DB contractor (STRABAG) for the Niagara Tunnel Facility Project, extension of the OR contract, payments under the Community Impact Agreement, purchase of insurance and engagement of the contractors for work required on the Ontario Power and Toronto Power facilities. A superseding release in May 2009 increased approved project funding to $1.6B and extension of the approved schedule to December 2013.

The Project Charter was initially signed in January 2005. The final version of the Project Charter (Revision 1) was issued in December 2005.
A Memorandum of Understanding (MOU) between the Niagara Plant Group and the Niagara Tunnel Project was initially signed in March 2006. It identifies areas where shared interfaces exist and documents the agreed accountabilities and processes to manage the interfaces. An addendum was signed in January 2010 to document additional lands occupied for Niagara Tunnel construction. The MOU was augmented by communications protocols for emergency and non emergency situations.

A Community Impact Agreement [copy filed in OPG Law Corporate Vault], signed in December 1993 and amended in August 2005 and June 2013, outlined the agreement with the host municipalities to address project impacts on local residents and businesses, municipal roads and utilities, municipal permits and tourism.

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The Project Execution Plan (PEP), documented in Report R-NAW130-00121--0001, was initially issued in April 2005. The PEP was periodically updated with Revision 1 issued in March 2006 and Revision 2 issued in September 2010. The final version of the PEP, Revision 3, was issued in January 2013. The PEP incorporates copies of the Project Charter and Memorandum of Understanding.

During the execution of the project, the OR maintained OPG Official Records at site. The Official Records were transferred to OPG / Niagara Plant Group at project completion, including correspondence, reports, drawings and manuals. Agreed exceptions to this plan are as follows:

- Contracts and other legal documents were filed by OPG Law at 700 University Avenue, Toronto
- Procurement documents were transferred to OPG Supply Chain at 800 Kipling Avenue, Toronto.

Hard copy and electronic files for all project records (correspondence, reports, drawings, manuals, photographs, worksheets, etc) will be securely stored by the OR at off-site facilities for 7 years (until December 2020). Hard copy or electronic files of certain project records including employment records, health & safety records, purchase orders, vendor invoices, submittals and transmittals will be securely stored by STRABAG as required by Ontario Laws and by the Design Build Agreement with OPG. Durward Jones Barkwell & Company LLP (DJB) will store and retain electronic records related to the Niagara Tunnel Project for 7 years.

This Completion Report documents the retained Niagara Tunnel Project records and identifies the storage medium and location of the various records.

The appendices contain a listing of the project documents transferred to the Niagara Plant Group (NPG) with reference numbering and location.

The general arrangement of the completed works is shown on the following drawings included in Appendix 1:

NAW130-D0V-15000-0004	Intake Area Site Restoration Grading Plan - River (North) Side
NAW130-D0V-15000-0006	Outlet Area Site Restoration Grading Plan - Outlet East
NAW130-D0V-15000-0007	Outlet Area Site Restoration Grading Plan - Outlet West
NAW130-D0V-15000-0010	Site Restoration Plan - Island Area
NAW130-D0V-20102-0016	Approach Wall & Accelerating Wall, Layout Plan
NAW130-D0V-20102-0017	Approach Wall, General Arrangement

NAW130-D0V-20102-0018	Accelerating Wall, General Arrangement
NAW130-D0V-20102-0020	Diversion Tunnel Realignment Option 2 Layout Plan and Longitudinal Section
NAW130-D0V-29230-0017	Diversion Tunnel, Typical Cross Sections and Detail
NAW130-D0V-29230-0108	Diversion Tunnel Piezometer at CH3+300 and CH8+002, Section and Details
NAW130-D0V-29230-0134	Dewatering System - General Arrangement Sketch
NAW130-D0V-29270-0007	Dewatering System, In Line Arrangement, Plan & Section C-C
NAW130-D0V-29270-0011	Dewatering System, Dewatering Outfall & Pipe Plan, Sections & Details
NAW130-D0V-29270-0014	Dewatering System, Dewatering Outfall & Pipe, Plan & Section Dewatering System, Schematic Arrangement of Submersible Pumps
NAW130-D0V-29270-0030	Intake Structure, General Assembly
NAW130-D0V-29270-0033	Outlet Structure, Tunnel Section General Assembly
NAW130-D0V-29270-0103	Summary of Gate Positions and Timing
NAW130-D0V-29300-0051	Intake Structure, Final Lining - Part 1 Sections
NAW130-D0V-29700-0007	Outlet Structure, Final Lining, Plan and Sections

2 Physical Assets

2.1 Tunnel

The tunnel is 10,150 m long, has a nominal internal diameter of 12.7 m and has a nominal rated capacity of 500 m^3/s. The tunnel parallels the SAB2 tunnels. The tunnel operates as an inverted siphon transferring water from the Niagara River at the International Niagara Control Works (INCW) to the Sir Adam Beck canal near the Pump Generating Station (PGS). The vertical alignment centre line descends in two stages from El. 139 m. at the intake to a maximum depth of El. 45.4 m. and rises to the El.152.6 m. at the outlet structure. The sloped sections have a 7.25% grade and the slope of the flat sections averages 0.01% from the intake to the outlet. The vertical and horizontal alignments are shown on Drawing NAW130-D0V-20102-0020-06.

The tunnel was excavated to a diameter of 14.44 m by a tunnel boring machine (TBM). Initial rock support was provided by swellex rock bolts, steel mesh and steel channels in the crown and a full circle layer of shotcrete. Areas of overbreak that occurred during the tunnel boring were filled with shotcrete and self-levelling concrete supported by sacrificial forms of steel channels and mesh. All voids between the shotcrete and rock immediately surrounding the excavation were filled by consolidation grouting.

The inner liner is 600 mm thick un-reinforced concrete placed using steel formwork to achieve an internal Manning's friction factor of n = 0.013. Between the shotcrete and the concrete is an impermeable polyolefine membrane and interface grout injected under high pressure which provides a permanent compression of the concrete liner to prevent cracking.

2.2 Intake Structure and Intake Service Gate

The intake is submerged in the Niagara River bed immediately upstream from Gate 1 of the INCW. The intake configuration was developed utilizing physical hydraulic models and has a minimum submergence of 1.5 tunnel diameters.

The intake is designed to minimize head losses, avoid air and ice entrainment and facilitate ice passage with minimal water spill. The intake structure is reinforced concrete founded on rock with a watertight connection to the upstream end of the tunnel liner.

The tunnel can be isolated from the upper Niagara River for dewatering by installing the sectional steel intake gate in steel guides embedded in the intake structure.

The service gate consists of 10 fabricated steel gate sections with neoprene seals that seal against stainless steel sealing faces on the embedded parts. The top of the guides are located 4.5 m. below normal water level and removable steel guide towers are provided to enable the gate sections to be installed by mobile crane located on a crane pad built into the parking area adjacent to the approach wall. Drawing NAW130-D0V-20102-0017 shows the location and limits of the crane pad.

The gate sections and the guide towers are permanently stored near the outlet structure and can be transported over public roads to the intake site.

2.3 Outlet Structure and Outlet Gate

The outlet structure is located in a rock cut canal linking the tunnel outlet to the PGS canal. The outlet structure is reinforced concrete founded on rock with a watertight connection to the downstream end of the tunnel liner.

The water passage consists of a transition section from the 12.7 m internal diameter of the tunnel to the 12.78 m^2 square entrance to the surge shaft then a 7 m long gate section. The surge shaft is designed to contain any surge that occurs during outlet gate closure under flowing water conditions. The surge shaft will also provide tunnel access whenever the tunnel requires dewatering for future inspection/maintenance. The outlet gate allows for closure of the tunnel against full flow.

The vertical lift gate consists of five articulated structural steel sections running on steel wheels bearing on steel roller paths embedded in the concrete structure. The gate seals with neoprene seals on stainless steel sealing surfaces at the sill, lintel and both sides.

The gate is raised and lowered by two wire rope hoists powered by a single electric motor. In an emergency, the gate can be lowered without power, under its own weight controlled by a fan brake and manually applied friction brake. The outlet gate is fully open during normal operation. The outlet structure includes provision for installation of a service gate downstream from the outlet gate.

2.4 Intake and Outlet Channels

The tunnel intake is fed from the approach channel enclosed by the concrete accelerating wall in the river and the concrete approach wall at the river bank. Immediately upstream from the intake, the river bed has been excavated to form a short approach channel with vertical sides and a bottom slope of 1 to 4.

A vertical sided unlined outlet canal has been excavated in the rock to connect the tunnel outlet to the PGS canal and thence into the SAB forebay. The invert of the canal rises on a slope of 7.28% for 90 m from the outlet structure and then has a slope of 2.3% to meet the PGS canal invert at El. 156.95 m. The canal has a nominal width of 23 m.

2.5 Flowmeter

Flow in the tunnel is continuously measured by a dual 8-path ultrasonic transit time flowmeter installed in the tunnel adjacent to the outlet structure. The system has dual transducers for each of the 8 paths connected to the meter console by separate wiring to provide redundancy in the submerged equipment. The system determines the instantaneous flow rate by sending pulses between accurately positioned transducers located on the walls of the tunnel, capturing those signals and integrating the velocity measurements between transducer pairs relative to the accurately surveyed tunnel cross section.

Conduits containing the transducers and cabling are recessed into the concrete liner to minimize turbulence in the flow path and to improve protection of the immersed equipment. The control/communication computers are located in the outlet gate stair tower. Two fully operational meter consoles have been installed to provide redundancy to the data collection and logging system.

2.6 Dewatering Shafts and Tunnel Piezometers

Five 750 mm diameter shafts have been constructed above the lowest section of the tunnel (about 1,400 m upstream from the outlet structure) to facilitate tunnel dewatering in the future using multi-stage submersible pumps to be acquired when needed.

A buried concrete pipe will convey discharge into the SAB2 canal near the trapezoidal section. The 13.8 kV electrical service has a switched feeder line adjacent to the access road to the dewatering shafts to service a step-down transformer and the dewatering pumps when they are required in the future.

Standpipe piezometers (95 mm inside diameter), extending from the ground surface to the tunnel crown, have been installed at two locations in the tunnel. The piezometer at 3,369 m (from the outlet) is located on OPG property between Stanley Avenue and the SAB1 canal near Thorold Stone Road. The piezometer at 8,002 m is located on property acquired from the City of Niagara Falls through a permanent easement.

During future tunnel operation, these piezometers may be used by OPG to measure water levels at these locations. If required, these piezometers can be used for a flow verification test using the tracer transit time method.

2.7 Site Restoration, Services and Material Stock Piles

Areas of the site that were used during construction have been generally restored to their pre-construction condition; temporary works, fencing and signage have been removed.

The construction areas at the intake that were licensed from the Niagara Parks Commission (NPC) for the construction period have been cleaned, restored and landscaped, and security fencing installed to delineate the boundary between the NPC land and areas retained by OPG for the operation of the tunnel intakes and the INCW.

The following services remain in place and functioning:

- water supply piping from Stanley Avenue to PGS, SAB 1 and SAB 2
- 13.8 kV electrical supply from Niagara Peninsula Energy to step-down transformers near the outlet gate structure

Materials from the open excavations and the tunnel have been stock piled on the site for future use.

The site services, remaining and abandoned, the landscaping, concrete pads left in place and material stock piles are shown on the following drawings:

NAW130-D0V-88400-0007	Material Stockpiles& Fill Areas for Future OPG Use
NAW130-D0V-15000-0010	Site Restoration Plan – Island Area
NAW130-D0V-15000-0020	Site Restoration, Outlet Area – Utilities and Servicing Plan

3 Project Participants

ROLE	COMPANY
Constructor / Contractor	**STRABAG AG** Donau-City-Straße 9 1220 Vienna, Austria Phone: +43 1 22422-0 Fax: +43 1 22422-2226 Email: pr@strabag.com
Sub-Contractor Surface Works	**Dufferin Construction Company** 690 Dorval Drive, Suite 200, Oakville, ON, L6K 3W7 Phone: (905) 842.2741 Toll Free: 1-866-322-2003
Designer	**ILF Beratende Ingenieure ZT GmbH** Feldkreuzstraße 3 6063 Rum bei Innsbruck, Austria Phone: +43 (512) 24 12 - 0 Fax: +43 (512) 24 12 - 5900 EMail: info.ibk@ilf.com
Designer for Surface Works	**Morrison Hershfield Limited** Suite 175, 1005 Skyview Drive, Burlington, ON, L7P 5B1 Phone: (905) 319-6668 Fax: (905) 319-5548 Email: burlington@morrisonhershfield.com
Quality Control	**LVM Inc. (formerly Jegel)** 300-1200 Saint-Martin Blvd West, Laval, QC, H7S 2E4 Phone: (514) 281-5151 Fax: (450) 668-5532 Email: info@lvm.ca Website URL: http://www.lvm.ca
Gate Supply and Installation	**Canadian Overhead Handling Inc.** 801, Curé Boivin, Boisbriand, QC, J7G 2J2 Phone: (450) 430-6500 Fax: (450) 430-6611 Toll free: 1-800-363-6501
Flowmeter Supply and Installation	**Cameron International Corporation** Caldon Ultrasonics Technology Center 1000 McClaren Woods Drive, Coraopolis, PA, USA, 15108 Phone: (724) 273-9300 Fax: (724) 273-9301 Website URL: www.c-a-m.com/caldon
Flow Verification Test	**Alden Research Laboratory, Inc.** 30 Shrewsbury Street, Holden, MA, USA, 01520 Phone: (508) 829-6000 Fax: (508) 829-5939 Email: info@aldenlab.com
Ground Water Monitoring	**Genivar (formerly Jagger Hims)** 55 King Street, Suite 600, St. Catharines, ON, L2R 3H5 Phone: (905) 687-1771 Fax: (905) 687-1773

ROLE	COMPANY
Removal of Material from Queenston Shale Stock Pile	**Jazbrick Group of Companies** 18 Namco Road, Toronto, ON, M9W 1M5 Phone: (905) 547-1276 Fax: (905) 547-5321 **Mar-Co Clay Products Inc.** RR#3 Bright, ON N0J 1B0 Phone: (519) 684-7591 Fax: (519) 684-7457
Owner's Representative	**Hatch Mott MacDonald in Association with Hatch** 2800 Speakman Drive, Mississauga, ON, L5K 2R7 Phone: (905) 855-2010 Fax: (905) 855-2607
Chartered Accountants	**Durward Jones Barkwell & Company LLP (DJB)** 171 Division Street, P.O. Box 9 Welland, ON L3B 5N9 Phone: (905) 735-2140 Fax: (905) 735-4706 Email: welland@djb.com Website URL: www.djb.com

4 Project Documents

The project documents have been assigned to project archives at OPG, HMM and Strabag as required by OPG's contracts with Strabag and HMM. The following table lists the document by type, format, identification and location of which the document will be archived.

TYPE	DESCRIPTION	FORMAT	IDENTIFICATION	LOCATION
Design	Design Reports	PDF	Report Number	OPG
	Design Analyses	PDF	Report Number	OPG
	Calculations		Report Number	OPG
Construction	Specifications	PDF	Report Number	OPG
	As-built Drawings	PDF, DWG + Hard Copy	Drawing Number	OPG and HMM
	Construction Method Statements	PDF	Report Number	HMM
	Quality Control	PDF	Report Number	OPG
	Environmental	PDF	Report Number	OPG
	Monitoring records	PDF	Area of work, date	HMM
	Photographs	JPEG	Area of Work, year, date	OPG
	Progress Reports	PDF	Year, month, date	OPG
	Geological Mapping	PDF	Report Number	OPG
Reports	Technical Reports	PDF	Report Number	OPG
	Gates commissioning	PDF	Report Number	OPG
	Flow verification test	PDF	Report Number	OPG
	Articles and publications	PDF	Publication, title, date	OPG Library Services
	Technical Papers	PDF	Publication, title, date	OPG Library Services
Manuals	Operation & Maintenance	PDF, DOC + Hard Copy	Report Number	OPG
Transmittals	Incoming Correspondence to HMM from Strabag (DT)	XLS	SCI Number	OPG, HMM and Strabag
	Outgoing Correspondence from HMM to Strabag (CT)	XLS	SCI Number	OPG, HMM and Strabag
	Strabag Submittals (DS)	XLS	SCI Number	OPG, HMM and Strabag
	HMM Responses to Strabag Submittals (DSR)	XLS	Submittal Number, SCI Number	HMM and Strabag
	Outgoing Correspondence from HMM to OPG (DT)	XLS	SCI Number, Report Number	OPG and HMM
	Outgoing Correspondence from HMM to Third Parties (DT)	XLS	SCI Number, Report Number	OPG and HMM
Project Management Documents	Budget Transfers	PDF	File Number	OPG
	Project Charter	PDF	SCI Number	OPG
	Project Execution Plan	PDF	Report Number	OPG

TYPE	DESCRIPTION	FORMAT	IDENTIFICATION	LOCATION
	NPG Memorandum of Understanding	PDF	SCI Number	OPG
	NTP OPG Risk Management Plan	PDF	Report Number	OPG
	NTP – Overview of Asset Turnover Procedure	PDF	Report Number	OPG
	CCB Recommendations	PDF	Report Number	OPG and HMM
	Request for Expenditure	PDF + XLS	Report Number	OPG and HMM
	Request for Disposal Recommendations	PDF + XLS	Report Number	OPG and HMM
	OR Policies and Procedures	PDF	Manual Number	OPG and HMM
	NTP Budget Transfer Authorizations	PDF	SCI Number	OPG and HMM
	NTP Disposal of Surplus Goods	PDF	SCI Number	OPG
	Statutory Declarations	PDF	SCI Number	OPG, HMM and Strabag

The project documents described in this section include submittals and transmittals sent and received during the design, construction commissioning and turnover phases of the project; and construction monitoring records compiled by HMM .

The complete lists of documents are included in the appendices indicated in each section. The location of the document electronic files is indicated in the table above. The lists are sorted by category as indicated in the following sections.

4.1 Design Documents

This includes the design basis documents, design calculations and analyses, design reports produced by the design build team.

The list of Design Documents for the project is included in Appendix 2.

4.2 Specifications

The specifications included with the completion documents are the final revision of the technical specifications issued for construction and used during construction as the basis for monitoring quality control for supply of materials and equipment and for construction of the tunnel facilities.

The list of Specifications used on the project is included in Appendix 3.

4.3 As-Built Drawings

As-built drawings show the permanent works as-constructed with all design and field changes included.

The list of As-Built Drawings is included in Appendix 4.

In some cases an older revision of the same drawing number has been made available if the as-built drawing does not have a P.Eng Stamp on it. Both versions will show as 'Approved'.

4.4 Temporary Works

Issued for construction drawings for temporary works are included in the project documents:

This includes drawings showing:

- Site Works
- Cofferdam and Rock Plug
- Tunnel Initial Rock Support
- Tunnel Filling of Overbreak
- TBM – General Arrangement
- Excavation Drawings for Intake and Outlet Structures.

The list of Temporary Works drawings is included in Appendix 5.

4.5 Quality Control

The quality control documentation includes the final revision of the project Quality System Manual that sets out all of the quality control tasks undertaken during design, procurement and construction of the project.

The results of all the quality control operations, including materials testing and monitoring of construction tasks were documented and reported monthly during the project execution. These monthly records were reviewed by the Owner's Representative and submitted to OPG.

Any part(s) of the work that did not conform to the requirements of the approved for construction drawings, specifications and construction method statements were documented on Non-conformance Notices (NCN). The NCNs also document the accepted resolution to the non-conformance. All NCNs were resolved and copies of all the NCNs and their resolutions are included in the completion documentation. The register of NCNs is included in Appendix 6, showing all NCNs closed.

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The list of the Quality Control documentation for the project is included in Appendix 7.

4.6 Environmental

Compliance with applicable permits and approvals from environmental agencies during the construction is documented in the Compliance Monitoring Annual Reports included in the project documentation:

R-NAW130-07000--0059	Compliance Monitoring Annual Report 2005
R-NAW130-07000--0062	Compliance Monitoring Annual Report 2006
R-NAW130-07000--0064	Compliance Monitoring Annual Report 2007
R-NAW130-07000--0067	Compliance Monitoring Annual Report 2008
R-NAW130-07000--0102	Compliance Monitoring Annual Report 2009
R-NAW130-07000--0104	Compliance Monitoring Annual Report 2010
R-NAW130-07000--0111	Compliance Monitoring Annual Report 2011
R-NAW130-07000--0113	Compliance Monitoring Annual Report 2012
R-NAW130-07000--0114	Compliance Monitoring Annual Report 2013

4.7 Technical Reports, Papers and Articles

Technical reports covering various aspects of the design and construction of the project were produced by the design build contractor, the OR and OPG. Each report is assigned a report number in the OPG system. The list of the reports is included in Appendix 8.

During the course of planning, design and construction of the project 55 technical papers, articles and presentations have been published. A list of articles is included in Appendix 8 sorted by date of publication. OPG Library Services can assist in acquiring any required article(s) on an as needed basis.

4.8 Manuals

Operation and maintenance manuals have been prepared by the suppliers for the following equipment:

- Intake Service Gate, including the gate sections and guide towers

R-NAW130-29270--0022	Intake Gate O&M Manual Mechanical Technical Files and Drawings

- Outlet Gate, including the gate, hoist and controls

R-NAW130-29270--0018	Outlet Structure Gate Hoist O & M Manual

- Ultrasonic Flowmeter

R-NAW130-62900--0004	LEFM 880 Series Ultrasonic Flowmeter Transmitter User Manual & Installation Procedure and Work Plan

- Shape Array Accelerometers

R-NAW130-29230--0108	Shape Array Accelerometers – Installation, Operation & Maintenance Manual

4.9 Construction Monitoring Records

Daily construction monitoring reports detailing every aspect of the construction work were maintained by the Owner's Representative and will be archived by HMM for 7 years from the final completion of the project.

During the tunnel excavation, the Owner's Representative made detailed geological mapping of rock types, features, conditions and a complete record of installation of primary support rock bolts, steel channels and wire mesh. The mapping has been compiled into a report contained in:

R-NAW130-10120--0048	Geology Mapping Sheets
R-NAW130-10120--0049	Geology Mapping Sheets Grout Tunnel
R-NAW130-10120--0050	Intake Portal Transition

4.10 Photographs

Photographs documenting the progress of construction are included in the project records. The photographs are filed by subject, year and date. The subject categories are:

- Aerial views of the site
- Environmental
- Intake
- Outlet Surface Works
  - General
  - Ventilation Shaft
  - Outlet Structure
  - PGS Dewatering Structure
  - Rock Plug Removal
  - Carrier Disassembly
- Tunnel
  - Mining
  - Invert Concrete
  - Profile Restoration

  - Arch Final Liner
  - Contact Grouting
  - Prestress Grouting
  - Venting
  - Equipment Removal
  - Miscellaneous
- Geology
- Core Drilling and Well Drilling

Electronic copies of all the weekly construction reports issued by the Owner's Representative have been included with the photograph files to enable photographs of a particular area of the work to be identified by year and date and provide a description of the work shown.

Photographs and weekly construction reports have been transferred on an external hard drive which is to be stored in NPG records and filed as NAW130-00280-0001.

4.11 Transmittals and Correspondence

Transmittals and correspondence between OPG, HMM, Strabag and all other organizations are filed in archives retained for 7 years by HMM. The electronic files can be accessed through the project database. The database is maintained by HMM and documents can be searched by reference number, key words, date and SCI number.

OPG Niagara Plant Group has searchable excel file copies of the complete databases and they are filed as:

NAW130-00100-0001	OPG, Third Party Transmittals and Correspondence
NAW130-00100-0002	Contractor Submittals and Correspondence

4.12 Project Management Documents

Contracts and other legal documents are filed by OPG Law at 700 University Avenue, Toronto. Procurement documents were transferred to OPG Supply Chain at 800 Kipling Avenue, Toronto. Other project management documents that are filed with the Niagara Plant Group are listed in Appendix 13.

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5 Acceptance Criteria and Documents

5.1 Tunnel

The tunnel was accepted as ready for watering-up on March 02, 2013 following a series of inspections documented in the final checklist showing that all work in the tunnel was completed. The checklist is contained in:

R-NAW130-29230--0115	Tunnel Lining – Pre-Water Up Acceptance Criteria and Inspection

5.2 Intake Channel and Intake Structure

The intake channel and intake structure were inspected and accepted as ready for watering-up on November 13, 2012 following the installation of the intake service gate and prior to removal of the upstream cofferdam. The final checklist showing all work in the area completed is included in:

R-NAW130-26500--0009	Pre-Water Up of Intake Area Checklist 1

5.3 Outlet Canal and Outlet Structure

The outlet canal and outlet structure were inspected and accepted as ready for watering-up on February 9, 2013 following the commissioning and acceptance of the outlet gate and prior to removal of the rock plug between the outlet canal and the PGS canal. The final checklist showing all work in the area completed is included in:

R-NAW130-29700--0021	Pre-Water Up of Outlet Canal Area Checklist 2

5.4 Intake Service Gate

The intake service gate was tested and commissioned prior to water- up to verify the proper functioning of the intake gate guide towers, fit of the gate sections and fit of the seals, all in accordance with the procedure set out in:

R-NAW130-29270--0019	Intake Gate Dry Test Procedure

The dry test results for the intake service gate are documented in:

R-NAW130-29270--0021	Intake Gate Dry Test Results

After water-up, the gate was tested for leakage and structural deflection to verify conformance with the specified values.

5.5 Outlet Gate

The outlet gate was tested and commissioned prior to water-up to verify the proper functioning of the gate and hoist, fit of the gate and fit of the seals. The commissioning procedure and test results are set out in:

R-NAW130-29270--0020	Final Inspection and Acceptance Test Procedure (Commissioning Plan for Outlet Gate)

After water-up, the operation of the gate opening and closing under normal operating conditions was tested. The procedure and test results are included in:

R-NAW130-02700--0006	Hydraulic Testing of Outlet Gate

After water-up, the gate was tested for leakage and structural deflection to verify conformance with the specified values.

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6 Operation and Maintenance

6.1 Tunnel

The tunnel lining is designed to operate safely under all normal conditions, maximum credible earthquake and maximum credible flood conditions. The tunnel is designed to require no maintenance outages for 90 years.

Internal inspection of the tunnel may be undertaken if the flowmeter and water levels at the intake and outlet and two intermediate piezometer shafts indicate that flow is restricted or there is a loss of water from the tunnel. Internal inspection of the tunnel liner may be possible by video equipped submersible vehicle under static conditions with the outlet gate closed or by access through the surge shaft after dewatering.

6.2 Dewatering

The tunnel dewatering system is designed to allow the tunnel to be emptied within 3 weeks using five submersible pumps located at the low point of the tunnel. The general arrangement of the dewatering system is shown in Appendix 1. The details of the system and pump requirements are contained in the following document:

R-NAW130-29270--0036 Tunnel Dewatering Study

The procedure for dewatering the tunnel is to

1. close the outlet gate to stop the flow,
2. install the intake service gate,
3. dewater using multi-stage submersible pumps in the five dewatering shafts with the dewatering pipe discharging into the SAB2 canal,
4. access the interior of the tunnel from the surge shaft at the outlet structure,
5. install a dewatering pump and low head dam at the low point in the tunnel to discharge gate leakage.

6.3 Intake and Outlet Structures

The intake and outlet concrete structures are designed to be maintenance free for 90 years. The outlet gate hoist tower will require periodic inspection and maintenance of the exterior cladding, doors and windows. The roof cladding should be inspected every year for deterioration and leakage.

6.4 Channels

The intake channel and outlet canal require no maintenance. The stability of the rock cuts was monitored during construction and the rock faces are designed to remain stable throughout the design life of 90 years.

The rock faces should be inspected annually above the water level for signs of spalling, particularly in the wetted zone between low and high water levels.

6.5 Intake Service Gate

Operation and maintenance of the intake service gate is described in detail in:

R-NAW130-29270--0022	Intake Gate Operation and Maintenance Manual

6.6 Outlet Gate

Operation and maintenance of the outlet gate, hoist and controls is described in detail in:

R-NAW130-29270--0018	Outlet Gate Operation and Maintenance Manual

6.7 Flowmeter

Details of the installation, operation and maintenance of the ultrasonic flowmeter are described in detail in the following:

R-NAW130-62900--0004	LEFM 880 Series Ultrasonic Flowmeter Transmitter User Manual & Installation Procedure and Work Plan

6.8 Warranties

The following warranties are in place for the Works completed by the Design-Build Contractor:

ITEM	ISSUED BY	EFFECTIVE DATE	PERIOD
All works completed under the ADBA	Strabag	March 9, 2013	One year
Outlet gate, embedded parts, hoist, hoist shelter, towers	COH	February 11, 2013	One year
Outlet service gate embedded parts	COH	February 11, 2013	One year
Intake stop logs, embedded parts, foot bridge, slot covers	COH	February 11, 2013	One year
LEFM 880 flowmeters Serial Number 56138 Serial Number 60988	Cameron Measurement Systems	March 9, 2013	One year

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7 Environmental

The construction was completed in conformance with the requirements of the Provincial Environmental Assessment (EA) and with the provisions of all applicable permits and regulatory requirements and without any significant environmental incidents.

A list of the environmental permits issued for the project and the final status is included in Appendix 12. The record of environmental permits, activities and compliance is contained in the Compliance Monitoring Annual Reports listed in Section 4.5.

The following environmental commitments remain and will require ongoing action by OPG/NPG.

7.1 The Re-use of Queenston Shale

Agreements have been signed with two companies permitting them to remove Queenston shale from the Excavated Materials Disposal Site. The contact details are included in Section 3. It is recommended that particular attention be paid by the NPG to the Job Safety Requirements of excavating the Queenston Shale while maintaining a safe angle of repose for the exposed face.

7.2 Ground Water Monitoring

Condition 4.2 of the EA Approval required specific groundwater monitoring before, during and after construction. Baseline monitoring was undertaken in 2004 and 2005, construction monitoring commenced in 2006 and continued until substantial completion in March 2013. Post construction monitoring is required for 1 year following completion (to March 2014). A final report will then be provided by Genivar to OPG for submission to the Director, Ministry of the Environment West Central Region.

All groundwater monitoring wells and investigation boreholes will be decommissioned by OPG after completion of the groundwater monitoring commitment.

7.3 Permits and Approvals

All permits and approvals have been closed except for Certificate of Approval (Industrial Sewage) 4773-89XSHS.

All monitoring requirements for 2013 have been met. Ownership of the Certificate of Approval is to be transferred to OPG by amendment issued by the Ministry of Environment. The conditions for closeout of the Certificate of Approval are contained in the following:

R-NAW130-07000--0038-20	Application for Amendment Regarding CofA 4773-89XSHS Industrial Sewage Works

7.4 Ministry of Natural Resources Work Permits

Two Ministry of Resources (MNR) Work Permits expired December 31, 2013. MNR has advised that all requirements of the Work permits have been met. The Work Permits terminated on the their expiry date.

Appendix 1

General Arrangement Drawings

GENERAL ARRANGEMENT

Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-15000-0004	05	Intake Area Site Restoration Grading Plan - River (North) Side	16-Jan-14
NAW130-D0V-15000-0006	02	Outlet Area Site Restoration Grading Plan - Outlet East	16-Jan-14
NAW130-D0V-15000-0007	02	Outlet Area Site Restoration Grading Plan - Outlet West	16-Jan-14
NAW130-D0V-15000-0010	03	Excavated Materials Disposal Site Island Site Restoration Plan - Index Sheet	19-Nov-13
NAW130-D0V-20102-0016	06	Approach Wall & Accelerating Wall, Layout Plan	7-Jan-11
NAW130-D0V-20102-0017	08	Approach Wall, General Arrangement	26-Mar-13
NAW130-D0V-20102-0018	02	Accelerating Wall, General Arrangement	14-Jul-06
NAW130-D0V-20102-0020	06	Diversion Tunnel Realignment Option 2 Layout Plan and Longitudinal Section	25-Mar-13
NAW130-D0V-29230-0017	06	Diversion Tunnel, Typical Cross Sections and Detail	25-Mar-13
NAW130-D0V-29230-0108	01	Diversion Tunnel Piezometer at CH3+300 and CH8+002 Section and Details	25-Mar-13
NAW130-D0V-29230-0134	00	Dewatering System - General Arrangement Sketch	n/a
NAW130-D0V-29270-0007	09	Dewatering System In Line Arrangement Plan & Section C-C	25-Mar-13
NAW130-D0V-29270-0011	05	Dewatering System Dewatering Outfall & Pipe Plan, Sections & Details	25-Mar-13
NAW130-D0V-29270-0014	03	Dewatering System Dewatering Outfall & Pipe Plan & Section	25-Mar-13
NAW130-D0V-29270-0030	02	Intake Structure General Assembly	1-Feb-12
NAW130-D0V-29270-0033	02	Outlet Structure Tunnel Section General Assembly	1-Feb-12
NAW130-D0V-29270-0103	00	Summary of Gate Positions and Timing	1-Feb-12
NAW130-D0V-29300-0051	06	Intake Structure Final Lining - Part 1 Sections	12-Dec-12
NAW130-D0V-29700-0007	03	Outlet Structure, Final Lining, Plan and Sections	29-Jan-13

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Appendix 2

Design Documents

DESIGN DOCUMENTS

Report Number	Rev	Document Title	Date Issued
NAW130-D0V-10190-0011	00	Basic Design, Diversion Tunnel, St. David's Gorge Geotechnical Boreholes	10-Sep-05
NAW130-D0V-29300-0049	00	Intake Structure Transition Excavation Sequence and Support Details	10-Oct-07
R-NAW130-29230--0105	00	ILF Outline Design Basis and Method Statements	19-Oct-05
R-NAW130-01900--0039	00	Design Variance Form 006 - Intake Excavation Sequence	30-Jun-09
R-NAW130-02700--0001	02	Hydraulic Design Report for Steady Flow Conditions	30-Sep-10
R-NAW130-02700--0002	02	Hydraulic Design Report for Unsteady Flow Conditions	11-Sep-12
R-NAW130-02700--0004	00	Noise Assessment of Air Discharging from the Intake Vent During Filling	24-Aug-07
R-NAW130-02700--0005	01	Estimate of Hydraulic Losses Due to Curbs	20-Sep-12
R-NAW130-07000--0025	04	Construction Effects of Tunnel and Shafts	April 2011
R-NAW130-20102--0005	04	Alignment and Grade Report	23-Oct-09
R-NAW130-26500--0001	03	Cellular Cofferdam, Design Basis Report	10-May-06
R-NAW130-29230--0004	02	Diversion Tunnel, Design Report	25-May-07
R-NAW130-29230--0007	02	Diversion Tunnel Analysis of Chloride Diffusion	21-Feb-07
R-NAW130-29230-0008	02	Diversion Tunnel - Derivation of Rock Squeeze (includes OR Design Comment & ILF Response)	31-May-07
R-NAW130-29230--0010	03	Grout Tunnel - Design Report and Stability Analysis	26-Feb-08
R-NAW130-29230--0012	01	Diversion Tunnel Structural Design Analysis of Initial Lining and Excavation Support	16-Nov-06
R-NAW130-29230--0015	04	Diversion Tunnel - Structural Design Analysis of Final Lining Analysis Section 6, CH1+411.00	23-Apr-10
R-NAW130-29230--0016	01	Diversion Tunnel Final Lining Formwork Removal and Construction Loads	18-Aug-08
R-NAW130-29230--0017	01	Sealing Rochester Shale Seam in Tunnel	6-Oct-06
R-NAW130-29230--0018	01	Diversion Tunnel - Chloride Diffusion Test for Waterproofing Membranes	21-Feb-07
R-NAW130-29230--0019	03	Diversion Tunnel Interface Grouting Analysis	7-Feb-12
R-NAW130-29230--0020	02	Diversion Tunnel, Structural Design Analysis of Final Lining Analysis Section CH0+100.00	17-May-10
R-NAW130-29230--0021	00	Design Comments - Design Analysis of Excavation & Support	5-Oct-06
R-NAW130-29230--0022	00	Design Comments - Diversion Tunnel, Excavation & Support Drawings	23-Aug-06
R-NAW130-29230--0023	01	Design Comments - Diversion Tunnel Design Report	23-Aug-06
R-NAW130-29230--0025	00	Design Comments - Diversion Tunnel, Analysis of Swelling Loads	n/a
R-NAW130-29230--0035	02	Diversion Tunnel Structural Design Analysis of Final Lining, Analysis Section CH1+700.00	18-May-10
R-NAW130-29230--0038	03	Diversion Tunnel - Consequences of Design Analyses for Final Lining and Interface Grouting	7-Feb-12
R-NAW130-29230--0043	01	Diversion Tunnel Effects on Existing SAB Tunnels and Power Station Wheel Pits for Selection of Realignment	18-Dec-12
R-NAW130-29230--0044	04	Diversion Tunnel Dewatering Shafts Interface Structural Design Analysis	6-Dec-12
R-NAW130-29230--0057	01	Temporary Ventilation Shaft Design Report and Stability Analysis	29-Mar-10
R-NAW130-29230--0058	02	Fill of Overbreak Analysis - Diversion Tunnel, Cavity Grouting, Fill of Overbreaks and Structural Analysis of Shotcrete Arch	18-Jun-10
R-NAW130-29230--0063	00	Diversion Tunnel Influence of Varying Final Lining Thickness	10-Aug-10
R-NAW130-29230--0066	01	Diversion Tunnel Infilling of Overbreak Type IIb & IIc Structural Design	16-Nov-10
R-NAW130-29230--0069	00	Diversion Tunnel Influence of Varying Final Lining Thickness to 600 mm Thick Final Lining	20-Oct-10
R-NAW130-29230--0071	01	Diversion Tunnel Analysis of Structural Capacity of Concrete Bays 14, 51 and 482	5-Dec-12
R-NAW130-29230--0074	0	Diversion Tunnel Structural Design Analysis of Final Lining CH4+260m	29-Apr-11
R-NAW130-29230--0075	01	Diversion Tunnel Structural Design Analysis of Final Lining	22-Jul-11
R-NAW130-29230--0076	01	Diversion Tunnel Analysis of Structural Capacity of Concrete Bays 142 and 422	26-Aug-11
R-NAW130-29230--0080	01	Diversion Tunnel - Stability Analysis Fall of Ground CH6+033 to CH6+080	12-Nov-11
R-NAW130-29230--0086	01	Design Considerations for Analysis of Swelling Loads	15-Dec-11
R-NAW130-29230--0089	00	Diversion Tunnel - Overbreak Fill of Bay 486 Structural Analysis	22-Feb-12
R-NAW130-29270--0002	01	Dewatering System Design Report	5-Feb-08
R-NAW130-29270--0003	04	Dewatering System Structural Design Analyses	1-Feb-13
R-NAW130-29270--0008	5	Design, Supply & Installation of Intake and Outlet Gates	24-Feb-14
R-NAW130-29270--0009	01	Design, Supply & Installation of Intake and Outlet Gates, Calculations - Outlet Service Gate Embedded Parts	14-Nov-08

DESIGN DOCUMENTS

Report Number	Rev	Document Title	Date Issued
R-NAW130-29270--0010	01	Design, Supply & Installation of Intake and Outlet Gates - Outlet Gate Embedded Parts (Calculations)	12-Nov-08
R-NAW130-29270--0011	00	Design, Supply & Installation of Intake & Outlet Gates - Intake Stoplogs Embedded Parts (Calculations)	11-Mar-08
R-NAW130-29270--0012	00	Design, Supply & Installation of Intake & Outlet Gates - Intake Stoplogs (Calculations)	7-Apr-08
R-NAW130-29270--0013	01	Design, Supply & Installation of Outlet Gate - Calculations	12-Nov-08
R-NAW130-29270--0014	00	Design, Supply & Installation of Intake and Outlet Gates, Calculations - Outlet Gate Structure	30-Oct-08
R-NAW130-29270--0015	01	Intake Guide Structure Calculations	6-May-11
R-NAW130-29300--0001	01	Intake Approach and Accelerating Walls, Design Basis and Report	8-Mar-06
R-NAW130-29300--0002	03	Approach Walls, Design Submission, Stage 1	17-Mar-06
R-NAW130-29300-0003	03	Accelerating Walls, Design Submission, Stage 1	17-Mar-06
R-NAW130-29300--0004	01	Approach and Accelerating Walls Calculations	17-Oct-06
R-NAW130-29300--0008	02	INCW Pier Extensions Design Basis and Report	13-Mar-07
R-NAW130-29300--0012	00	Tremie Mix Design - Lafarge	23-Oct-06
R-NAW130-29300--0013	02	Intake Structure - Design Report	23-Oct-07
R-NAW130-29300--0014	01	Intake Structure Stability Analysis of Excavation	7-Sep-07
R-NAW130-29300--0015	00	Pier Extensions Calculations	Dec 2006
R-NAW130-29300--0022	01	Intake Structure - Structural Design Analysis	8-Jun-09
R-NAW130-29300--0025	01	Intake Structure - Structural Design Analysis of Vortex Breaker	3-Oct-12
R-NAW130-29700--0001	03	Outlet Canal Design Report	29-Jun-06
R-NAW130-29700--0002	03	Outlet Structure Design Report	27-Mar-07
R-NAW130-29700--0003	02	Outlet Canal, Slope Stability Analysis	30-Jun-06
R-NAW130-29700--0004	01	Outlet Structure, Slope Stability Ananlysis of Excavation Report	30-Jun-06
R-NAW130-29700--0006	1	Outlet Canal Permanent Concrete Slab/Launch Slab	4-May-06
R-NAW130-29700--0011	02	Outlet Structure Structural Design Analysis	11-Apr-08
R-NAW130-29700--0015	00	Outlet Structure - Structural Analysis Cantilever Beam for Hoist Shelter	3-Feb-12
R-NAW130-29700--0016	00	Outlet Canal; Stability Analyses of Rock Plug	25-Jul-12
R-NAW130-83000--0028	00	Concrete Mix Design for Pre-cast Elements	7-Jan-14
R-NAW130-83000--0010	00	Concrete Mix Design - 25MPa Tremie Mix	22-Mar-06

Appendix 3

Specifications

SPECIFICATIONS

Report Number	Rev	Document Title	Date Issued
R-NAW130-20102--0006	01	Technical Specification - Outside Works	15-Jan-07
R-NAW130-29270--0017	02	Technical Specification for Fabrication and Inspection	16-Jan-12
R-NAW130-83000--0001	02	Specification of Shotcrete	29-Jun-06
R-NAW130-83000--0002	04	Specification of Final Lining Concrete	24-Aug-09
R-NAW130-83000--0003	02	Specification of Concrete for Structures	16-Nov-07
R-NAW130-83000--0006	04	Specification of Steel Support for Excavation	20-Nov-07
R-NAW130-83000--0008	04	Diversion Tunnel Specification of Monitoring for Excavation & Tunnel Operations	27-Aug-12
R-NAW130-83000--0009	02	Specification of Waterproofing System	9-Aug-07
R-NAW130-83000--0015	04	Specifications of Contact Grouting and Interface Grouting	27-Jan-12
R-NAW130-83000--0022	01	Specification of Drill and Blast Tunnel Excavation	18-Aug-08
R-NAW130-83000--0023	02	Specification of Dewatering System Shafts	5-Dec-13
R-NAW130-83000--0025	01	Specification of Steel Fibre Reinforced Concrete for Final Lining	29-Apr-10
R-NAW130-83000--0026	01	Specification of Self-compacting Concete for Filling of Overbreaks	14-Sep-10
R-NAW130-83000--0027	03	Specification of Repair of Invert Cracks	14-Nov-11

Filed: 2016-10-26
EB-2016-0152
Exhibit L, Tab 4.3
Schedule 2 AMPCO-054
Attachment 1

Appendix 4

As-Built Drawings

AS BUILT DRAWINGS

Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-15000-0004	05	Site Restoration Intake Area - North Final Grading Plan	16-Jan-14
NAW130-D0V-15000-0005	01	Site Restoration Intake Area - South Final Grading Plan	16-Jan-14
NAW130-D0V-15000-0006	02	Site Restoration Outlet Area - Grading Plan, Outlet East	16-Jan-14
NAW130-D0V-15000-0007	02	Site Restoration Outlet Area - Grading Plan, Outlet West	16-Jan-14
NAW130-D0V-15000-0008	02	Site Restoration Outlet Area - Grading Plan, Dewatering Area, 1:500	16-Jan-14
NAW130-D0V-15000-0009	02	Site Restoration Outlet Area - Grading Plan, Main Office Area, 1:501	16-Jan-14
NAW130-D0V-15000-0010	02	Excavated Materials Disposal Site Island Site Restoration Plan Index Sheet	19-Nov-13
NAW130-D0V-15000-0011	02	Excavated Materials Disposal Site Island Site Restoration Plan Sheet A	19-Nov-13
NAW130-D0V-15000-0012	01	Excavated Materials Disposal Site Island Site Restoration Plan Sheet B	30-Sep-13
NAW130-D0V-15000-0013	01	Excavated Materials Disposal Site Island Site Restoration Plan Sheet C	30-Sep-13
NAW130-D0V-15000-0014	01	Excavated Materials Disposal Site Island Site Restoration Plan Sheet D	30-Sep-13
NAW130-D0V-15000-0015	01	Excavated Materials Disposal Site Island Site Restoration Plan Sheet E	30-Sep-13
NAW130-D0V-15000-0016	01	Excavated Materials Disposal Site Island Site Restoration Plan Sheet F	30-Sep-13
NAW130-D0V-15000-0020	00	Site Restoration, Outlet Area – Utilities and Servicing Plan	16-Jan-14
NAW130-D0V-15000-0022	00	Site Restoration - Satellite Sites	16-Jan-14
NAW130-D0V-20102-0014	04	Approach Wall & Accelerating Wall General Notes (1/2)	17-Dec-13
NAW130-D0V-20102-0015	04	Approach Wall & Accelerating Wall General Notes (2/2)	17-Dec-13
NAW130-D0V-20102-0016	07	Approach Wall & Accelerating Wall Layout Plan	17-Dec-13
NAW130-D0V-20102-0017	09	Approach Wall - General Arrangement	17-Dec-13
NAW130-D0V-20102-0018	03	Accelerating Wall - General Arrangement	17-Dec-13
NAW130-D0V-20102-0020	06	Diversion Tunnel Realignment Option 2 Layout Plan and Longitudinal Section	25-Mar-13
NAW130-D0V-20102-0021	02	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 1 of 12	25-Mar-13
NAW130-D0V-20102-0022	02	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 2 of 12	25-Mar-13
NAW130-D0V-20102-0023	02	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 3 of 12	25-Mar-13
NAW130-D0V-20102-0024	02	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 4 of 12	25-Mar-13
NAW130-D0V-20102-0025	03	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 5 of 12	25-Mar-13
NAW130-D0V-20102-0026	05	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 6 of 12	25-Mar-13
NAW130-D0V-20102-0027	05	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 7 of 12	25-Mar-13
NAW130-D0V-20102-0028	04	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 8 of 12	25-Mar-13
NAW130-D0V-20102-0029	04A	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 9 of 12	25-Mar-13
NAW130-D0V-20102-0030	04	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 10 of 12	25-Mar-13
NAW130-D0V-20102-0031	04	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 11 of 12	25-Mar-13
NAW130-D0V-20102-0032	04	Diversion Tunnel Realignment Option 2 Plan and Longitudinal Section, Part 12 of 12	25-Mar-13
NAW130-D0V-26500-0010	02	Grout Curtain - Plan, Section, Detail and Notes (GC 1)	18-Jul-07
NAW130-D0V-26500-0011	01	Grout Curtain - Plan, Inboard Perimeter Elevation (GC 2)	5-Dec-13
NAW130-D0V-26500-0012	01	Grout Curtain Sections	5-Dec-13
NAW130-D0V-26500-0013	00	Intake Grout Curtain - Grout Takes	5-Dec-13
NAW130-D0V-26500-0020	01	Intake Channel As Built Bathymetric Survey Colour Contoured Plan View (1 of 2)	March 2013
NAW130-D0V-26500-0021	01	Intake Channel As Built Bathymetric Survey Colour Contoured Plan View (2 of 2)	March 2013
NAW130-D0V-26500-0022	01	Intake Channel As Built Bathymetric Survey Contoured Bathymetric Plan View (1 of 2)	March 2013
NAW130-D0V-26500-0023	01	Intake Channel As Built Bathymetric Survey Contoured Bathymetric Plan View (2 of 2)	March 2013
NAW130-D0V-26500-0024	01	Intake Channel As Built Bathymetric Survey Colour Contoured Perspective Plan	March 2013

AS BUILT DRAWINGS

Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-26500-0025	00	Intake Channel As Built Bathymetric Survey Data Points and Contours	March 2013
NAW130-D0V-29230-0016	06	Diversion Tunnel, Geotechnical Longitudinal Section	25-Mar-13
NAW130-D0V-29230-0017	06	Diversion Tunnel, Typical Cross Sections Final Lining t=600mm	25-Mar-13
NAW130-D0V-29230-0022	03	Diversion Tunnel, Geotechnical Measurements Tunnel	25-Mar-13
NAW130-D0V-29230-0023	03	Diversion Tunnel, Geotechnical Measurements, Surface and Subsurface	25-Mar-13
NAW130-D0V-29230-0024	05	Diversion Tunnel, Final Lining and Interface Grouting Arrangement Plan and Sections	25-Mar-13
NAW130-D0V-29230-0025	04	Diversion Tunnel, Final Lining Single Layer, Waterproofing System, Details Part 1	25-Mar-13
NAW130-D0V-29230-0026	04	Diversion Tunnel, Final Lining Single Layer, Waterproofing System, Details Part 2	25-Mar-13
NAW130-D0V-29230-0027	04	Diversion Tunnel, Final Lining Dual Layer, Waterproofing System, Details Part 1	25-Mar-13
NAW130-D0V-29230-0028	04	Diversion Tunnel, Final Lining Dual Layer, Waterproofing System, Details Part 2	25-Mar-13
NAW130-D0V-29230-0030	05	Diversion Tunnel, Final Lining General Arrangement of Concrete Bays, Part 1	25-Mar-13
NAW130-D0V-29230-0031	03	Diversion Tunnel, Final Lining General Arrangement of Concrete Bays, Part 2	25-Mar-13
NAW130-D0V-29230-0032	05	Diversion Tunnel, Final Lining General Arrangement of Concrete Bays, Part 3	25-Mar-13
NAW130-D0V-29230-0036	08	Diversion Tunnel, Final Lining Contact Grouting Arrangement	25-Mar-13
NAW130-D0V-29230-0037	03	Diversion Tunnel, Final Lining Grouting Barrier	25-Mar-13
NAW130-D0V-29230-0038	06	Diversion Tunnel, Final Lining Concrete Bay 1	25-Mar-13
NAW130-D0V-29230-0046	06	Diversion Tunnel Final Lining, Interface Grouting Pressure Monitoring and Water Release Hole	25-Mar-13
NAW130-D0V-29230-0053	03	Diversion Tunnel Typical Cross Section Final Lining t=500 mm	25-Mar-13
NAW130-D0V-29230-0055	06	Diversion Tunnel Final Lining and Interface Grouting Part Outlet to Concrete Bay 120	25-Mar-13
NAW130-D0V-29230-0059	02	Diversion Tunnel Final Lining Concrete Bay at Connection to Intake	25-Mar-13
NAW130-D0V-29230-0060	05	Diversion Tunnel - Final Lining Dewatering Shafts Interface Reinforcement	25-Mar-13
NAW130-D0V-29230-0062	04	Diversion Tunnel Final Lining and Interface Grouting Concrete Bay No. 121-384	25-Mar-13
NAW130-D0V-29230-0063	05	Diversion Tunnel Final Lining and Interface Grouting, Concrete Bay No. 385-664	25-Mar-13
NAW130-D0V-29230-0064	07	Diversion Tunnel Final Lining and Interface Grouting Concrete Bay No. 665 to Intake	25-Mar-13
NAW130-D0V-29230-0083	03	Diversion Tunnel Temporary Pump Sumps	25-Mar-13
NAW130-D0V-29230-0084	02	Diversion Tunnel Temporary Ventilation Shaft Layout Plan and Sections	25-Mar-13
NAW130-D0V-29230-0085	03	Diversion Tunnel Temporary Ventilation Shaft Sections and Details	25-Mar-13
NAW130-D0V-29230-0086	03	Diversion Tunnel Temporary Ventilation Shaft Backfill Shaft and Adit	25-Mar-13
NAW130-D0V-29230-0087	02	Diversion Tunnel - Temporary Ventilation Shaft Construction Sequence Backfill Shaft and Adit	25-Mar-13
NAW130-D0V-29230-0088	02	Diversion Tunnel - Temporary Ventilation Shaft Final Lining Box Out	25-Mar-13
NAW130-D0V-29230-0108	01	Diversion Tunnel Piezometer at CH3+300 and CH8+002 Section and Details	25-Mar-13
NAW130-D0V-29230-0109	01	Diversion Tunnel Typical Cross Section Final Lining 550mm	25-Mar-13
NAW130-D0V-29230-0113	01	Diversion Tunnel - Tunnel Dewatering Sump CH.0+181 Connection to Final Lining	25-Mar-13
NAW130-D0V-29230-0114	01	Diversion Tunnel - Tunnel Dewatering Sump CH.0+181 Reinforced Concrete Ring	25-Mar-13
NAW130-D0V-29230-0120	04	Diversion Tunnel Temporary Tunnel Dewatering CH9+846 to CH10+150	25-Mar-13
NAW130-D0V-29230-0121	02	Diversion Tunnel Temporary Tunnel Dewatering Steel Sumps CH9+846 to CH10+150	25-Mar-13
NAW130-D0V-29230-0122	01	Diversion Tunnel Additional Strain Monitoring Cross Section	25-Mar-13
NAW130-D0V-29230-0125	01	Diversion Tunnel - Temporary Tunnel Dewatering Steel Sumps in Concrete Bays 640, 680, 720, 760 and 775	25-Mar-13
NAW130-D0V-29230-0126	01	Diversion Tunnel - Dimple Membrane Dewatering at Side Walls CH9+830 to CH10+150	25-Mar-13
NAW130-D0V-29230-0127	01	Diversion Tunnel - Hose Dewatering CH9+830 to CH10+150	25-Mar-13
NAW130-D0V-29230-0128	01	Diversion Tunnel - Dimple Membrane Dewatering at Tunnel Crown CH9+830 to CH10+150	25-Mar-13
NAW130-D0V-29230-0129	02	Diversion Tunnel - Additional Water Release Holes and Grouting Pipes CH9+830 to CH10+150	25-Mar-13
NAW130-D0V-29230-0133	01	Diversion Tunnel - Grouting Procedure for Concrete Bays 814, 813 and 812	25-Mar-13

AS BUILT DRAWINGS

Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29270-0006	09	Dewatering System In Line Arrangement Sections A-A, B-B	25-Mar-13
NAW130-D0V-29270-0007	09	Dewatering System In Line Arrangement Plan & Section C-C	25-Mar-13
NAW130-D0V-29270-0010	05	Dewatering System In Line Arrangement Details	25-Mar-13
NAW130-D0V-29270-0011	05	Dewatering System Dewatering Outfall & Pipe Details	25-Mar-13
NAW130-D0V-29270-0012	02	Dewatering System Flange Details	25-Mar-13
NAW130-D0V-29270-0014	03	Dewatering System Dewatering Outfall and Pipe Plan and Section	25-Mar-13
NAW130-D0V-29270-0015	02	Dewatering System Dewatering Outfall and Pipe Cross Sections	25-Mar-13
NAW130-D0V-29270-0016	02	Dewatering System Outfall Structure Typical Reinforcement	25-Mar-13
NAW130-D0V-29270-0017	02	Dewatering System Shaft Foundation and Water Collection Sump Cover Typical Reinforcement	25-Mar-13
NAW130-D0V-29270-0033	02	Outlet Structure Tunnel Section - General Assembly	1-Feb-12
NAW130-D0V-29270-0034	02	Outlet Gate - General Assembly	1-Feb-12
NAW130-D0V-29270-0035	05	Outlet Gate - Primary Anchors, Plan and Section	28-Nov-11
NAW130-D0V-29270-0036	05	Outlet Gate - Primary Anchors, Details and Section	28-Nov-11
NAW130-D0V-29270-0037	04	Outlet Gate - Primary Anchors, Details	29-Aug-12
NAW130-D0V-29270-0038	03	Outlet Gate - Primary Anchors, Corner Angles, Details	28-Nov-11
NAW130-D0V-29270-0039	02	Outlet Gate - Primary Anchors, Tie Rods, Assembly	26-Feb-08
NAW130-D0V-29270-0040	01	Outlet Gate - Primary Anchors, Tie Rods, Details	26-Feb-08
NAW130-D0V-29270-0041	04	Outlet Service Gate - Primary Anchors, Plan and Section	28-Nov-11
NAW130-D0V-29270-0042	04	Outlet Service Gate - Primary Anchors, Details and Sections	28-Nov-11
NAW130-D0V-29270-0043	04	Outlet Service Gate - Primary Anchors, Details	28-Nov-11
NAW130-D0V-29270-0044	01	Outlet Service Gate - Corner Angles, Details	26-Feb-08
NAW130-D0V-29270-0045	02	Outlet Service Gate - Tie Rods, Assembly	17-Mar-08
NAW130-D0V-29270-0046	01	Outlet Service Gate - Tie Rods, Details	26-Feb-08
NAW130-D0V-29270-0047	05	Outlet Gate Embedded Parts - Arrangement and Site Assembly	28-Nov-13
NAW130-D0V-29270-0048	05	Outlet Gate Embedded Parts - Section and Details	28-Nov-13
NAW130-D0V-29270-0049	05	Outlet Gate Embedded Parts - Site Tolerances and Details	28-Nov-13
NAW130-D0V-29270-0050	05	Outlet Gate Embedded Parts - Inferior Lateral Guide, Assembly and Welding	8-Jun-11
NAW130-D0V-29270-0051	06	Outlet Gate Embedded Parts - Inferior Lateral Guide, Machining, Drilling and Paint	8-Jun-11
NAW130-D0V-29270-0052	06	Outlet Gate Embedded Parts - Intermediate Lateral Guide, Assembly and Welding	10-Jun-11
NAW130-D0V-29270-0053	06	Outlet Gate Embedded Parts - Intermediate Lateral Guide, Machining, Drilling and Paint	11-Nov-11
NAW130-D0V-29270-0054	05	Outlet Gate Embedded Parts - Superior Lateral Guide, Assembly and Welding	9-Nov-11
NAW130-D0V-29270-0055	07	Outlet Gate Embedded Parts - Superior Lateral Guide, Machining, Drilling and Paint	9-Nov-11
NAW130-D0V-29270-0056	06	Outlet Gate Embedded Parts Sill Beam - Assembly, Welding and Machining	28-Nov-11
NAW130-D0V-29270-0057	05	Outlet Gate Embedded Parts Lintel - Assembly, Welding, Machining and Paint	22-Feb-11
NAW130-D0V-29270-0058	05	Outlet Gate Embedded Parts - Shielding Plate Details	28-Nov-11
NAW130-D0V-29270-0059	05	Outlet Gate - Primary Anchors, Tie Rods, Details	28-Nov-11
NAW130-D0V-29270-0060	05	Outlet Service Gate Embedded Parts - Arrangement and Site Assembly	31-Dec-12
NAW130-D0V-29270-0061	05	Outlet Service Gate Embedded Parts - Section and Details	1-Dec-12
NAW130-D0V-29270-0062	05	Outlet Service Gate Embedded Parts - Site Tolerances and Details	1-Dec-12
NAW130-D0V-29270-0063	05	Outlet Service Gate Embedded Parts - Infererior, Intermediate and Superior Lateral Guide "Upstream" (Assembly)	1-Dec-12
NAW130-D0V-29270-0064	05	Outlet Service Gate Embedded Parts - Infererior, Intermediate and Superior Lateral Guide "Upstream" (Machining)	1-Dec-12
NAW130-D0V-29270-0065	05	Outlet Service Gate Embedded Parts - Infererior, Intermediate and Superior Lateral Guide "Downstream" (Assembly)	1-Dec-12
NAW130-D0V-29270-0066	05	Outlet Service Gate Embedded Parts - Infererior, Intermediate and Superior Lateral Guide "Downstream" (Machining)	1-Dec-12
NAW130-D0V-29270-0067	06	Outlet Service Gate Embedded Parts Sill Beam - Assembly Welding, Machining and Paint	1-Dec-12
NAW130-D0V-29270-0068	06	Outlet Service Gate Embedded Parts - Tie Rod Details	1-Dec-12
NAW130-D0V-29270-0069	00	Outlet Service Gate Embedded Parts Sill Beam - Assembly, Welding and Machining	26-Feb-08
NAW130-D0V-29270-0070	00	Outlet Service Gate Embedded Parts - Shielding Plate Details	26-Feb-08

AS BUILT DRAWINGS

Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29270-0080	07	Intake Primary Anchors Plan and Section	20-Sep-12
NAW130-D0V-29270-0081	05	Intake Primary Anchors Details and Sections	20-Sep-12
NAW130-D0V-29270-0082	03	Intake Primary Anchors Details	20-Sep-12
NAW130-D0V-29270-0083	04	Intake Corner Angles Details	20-Sep-12
NAW130-D0V-29270-0090	07	Intake Embedded Parts Agencement and Site Assembly	12-May-10
NAW130-D0V-29270-0091	08	Intake Embedded Parts Section and Details	7-Aug-12
NAW130-D0V-29270-0092	07	Intake Embedded Parts Site Tolerances Details	7-Aug-12
NAW130-D0V-29270-0093	07	Intake Embedded Parts Inferior Lateral Guide Assembly and Welding	7-Aug-12
NAW130-D0V-29270-0094	08	Intake Embedded Parts Inferior Lateral Guide Machining, Drilling and Paint	7-Aug-12
NAW130-D0V-29270-0095	07	Intake Embedded Parts Intermediate Lateral Guide Assembly and Welding	7-Aug-12
NAW130-D0V-29270-0096	08	Intake Embedded Parts Intermediate Lateral Guide Machining, Drilling and Paint	7-Aug-12
NAW130-D0V-29270-0097	07	Intake Embedded Parts Superior Lateral Guide Assembly and Welding	7-Aug-12
NAW130-D0V-29270-0098	08	Intake Embedded Parts Superior Lateral Guide Machining, Drilling and Paint	7-Aug-12
NAW130-D0V-29270-0099	07	Intake Embedded Parts Sill Beam - Assembly Welding, Machining and Paint	7-Aug-12
NAW130-D0V-29270-0100	06	Intake Embedded Parts Shielding Plate Details	7-Aug-12
NAW130-D0V-29270-0101	06	Intake Embedded Parts Tie Rods Details	7-Aug-12
NAW130-D0V-29270-0102	06	Intake Embedded Parts Lintel - Assembly Welding, Machining and Paint	7-Aug-12
NAW130-D0V-29270-0103	01	Outlet Structure - Summary of Gate Positioning and Timing	12-Feb-13
NAW130-D0V-29270-0110	02	Outlet Gate - Gate General Assembly	1-Nov-12
NAW130-D0V-29270-0111	01	Outlet Gate - Gate General Assembly Section and Details	1-Nov-12
NAW130-D0V-29270-0112	02	Outlet Gate - Gate Assembly in Embedded Parts, Tolerance Details	1-Nov-12
NAW130-D0V-29270-0113	01	Outlet Gate - Inferior Gate #1 Assembly	1-Nov-12
NAW130-D0V-29270-0114	01	Outlet Gate - Inferior Gate #1 Frame, Assembly and Welding	1-Nov-12
NAW130-D0V-29270-0115	02	Outlet Gate - Inferior Gate #1 Machining. Drilling and Paint	1-Nov-12
NAW130-D0V-29270-0116	00	Outlet Gate - Intermediate Gate #2 Assembly	1-Nov-12
NAW130-D0V-29270-0117	00	Outlet Gate - Intermediate Gate 2 Frame, Assembly and Welding	1-Nov-12
NAW130-D0V-29270-0118	02	Outlet Gate - Intermediate Gate #2 Machining, Drilling and Paint	1-Nov-12
NAW130-D0V-29270-0119	00	Outlet Gate - Intermediate Gate #3 Assembly	1-Nov-12
NAW130-D0V-29270-0120	00	Outlet Gate - Intermediate Gate 3 Frame, Assembly and Welding	1-Nov-12
NAW130-D0V-29270-0121	00	Outlet Gate - Intermediate Gate #3 Machining, Drilling and Paint	1-Nov-12
NAW130-D0V-29270-0122	00	Outlet Gate - Intermediate Gate #4 Assembly	1-Nov-12
NAW130-D0V-29270-0123	00	Outlet Gate - Intermediate Gate #4 Frame, Assembly and Welding	1-Nov-12
NAW130-D0V-29270-0124	02	Outlet Gate - Intermediate Gate #4 Machining, Drilling and Paint	1-Nov-12
NAW130-D0V-29270-0125	00	Outlet Gate - TopGate #5 Assembly	1-Nov-12
NAW130-D0V-29270-0126	00	Outlet Gate - Top Gate #5 Frame, Assembly and Welding	1-Nov-12
NAW130-D0V-29270-0127	00	Outlet Gate - Top Gate #5 Machining, Drilling and Paint	17-Jan-11
NAW130-D0V-29270-0128	00	Outlet Gate - Gate Main Beam #1, #2, and #3 Assembly and Details	1-Nov-12
NAW130-D0V-29270-0129	00	Outlet Gate - Gate Main Beam #4, and 5 Assembly and Details	1-Nov-12
NAW130-D0V-29270-0130	00	Outlet Gate - Wheel Box Assembly and Details	1-Nov-12
NAW130-D0V-29270-0131	00	Outlet Gate - Wheel Box Assembly and Details #2	1-Nov-12
NAW130-D0V-29270-0132	00	Outlet Gate - Dogging Connection Assembly and Details	1-Nov-12
NAW130-D0V-29270-0133	00	Outlet Gate - Gate Wheel Type 2 Assembly	1-Nov-12
NAW130-D0V-29270-0134	00	Outlet Gate - Gate Wheel Type-2 Details	1-Nov-12
NAW130-D0V-29270-0135	00	Outlet Gate - Gate Wheel Type-1 Assembly	1-Nov-12
NAW130-D0V-29270-0136	02	Outlet Gate - Gate Wheel Type-1 Details	1-Nov-12
NAW130-D0V-29270-0137	00	Outlet Gate - Gate Lateral Wheel Assembly	1-Nov-12
NAW130-D0V-29270-0138	00	Outlet Gate - Gate Lateral Wheel Details	1-Nov-12
NAW130-D0V-29270-0139	00	Outlet Gate - Gate Grease Line Assembly	1-Nov-12
NAW130-D0V-29270-0140	00	Outlet Gate - Gate Grease Line Details	1-Nov-12
NAW130-D0V-29270-0141	00	Outlet Gate - Gate Grease Line Fixation Block and Support	1-Nov-12
NAW130-D0V-29270-0142	00	Outlet Gate - Gate Upstream and Lateral Guide Assembly and Details	1-Nov-12
NAW130-D0V-29270-0143	00	Outlet Gate - Gate Seals Assembly and Details	1-Nov-12
NAW130-D0V-29270-0144	00	Outlet Gate - Gate Retaining Bar	1-Nov-12
NAW130-D0V-29270-0145	00	Outlet Gate - Seals and Retaining Bars Assembly	1-Nov-12
NAW130-D0V-29270-0146	00	Outlet Gate - Gate Attached Plate Assembly and Details	1-Nov-12
NAW130-D0V-29270-0147	01	Outlet Gate - Handrails Assembly and Details	1-Nov-12
NAW130-D0V-29270-0200	01	Outlet Gate Hoist Structure General Arrangement Site Assembly	6-Sep-11
NAW130-D0V-29270-0201	02	Outlet Gate Hoist Structure General Arrangement Site Assembly - Details	15-Nov-11

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Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29270-0202	02	Outlet Gate Hoist Structure General Arrangement Site Assembly - Anchors	18-Oct-12
NAW130-D0V-29270-0203	02	Outlet Gate Hoist Structure Tower #1 - Site Assembly Cladding	6-Sep-11
NAW130-D0V-29270-0204	02	Outlet Gate Hoist Structure Tower #1 - Site Assembly General Arrangement	6-Sep-11
NAW130-D0V-29270-0205	02	Outlet Gate Hoist Structure Tower #1 - Site Assembly Details	6-Sep-11
NAW130-D0V-29270-0206	02	Outlet Gate Hoist Structure Tower #1 - Inferior Section Cladding Assembly	6-Sep-11
NAW130-D0V-29270-0207	02	Outlet Gate Hoist Structure Tower #1 - Inferior Section Shop Assembly	6-Sep-11
NAW130-D0V-29270-0208	02	Outlet Gate Hoist Structure Tower #1 - Inferior Section Detail, Frame Side A & C	6-Sep-11
NAW130-D0V-29270-0209	02	Outlet Gate Hoist Structure Tower #1 - Inferior Section Detail, Frame Side B & D	6-Sep-11
NAW130-D0V-29270-0210	02	Outlet Gate Hoist Structure Tower #1 - Superior Section Cladding Assembly	6-Sep-11
NAW130-D0V-29270-0211	02	Outlet Gate Hoist Structure Tower #1 - Superior Section Shop Assembly	6-Sep-11
NAW130-D0V-29270-0212	02	Outlet Gate Hoist Structure Tower #1 - Superior Section Detail, Frame Side A & C	6-Sep-11
NAW130-D0V-29270-0213	02	Outlet Gate Hoist Structure Tower #1 - Superior Section Detail, Frame Side B & D	6-Sep-11
NAW130-D0V-29270-0214	02	Outlet Gate Hoist Structure Tower #1 - Stair #1 Assembly Details	6-Sep-11
NAW130-D0V-29270-0215	02	Outlet Gate Hoist Structure Tower #1 - Stair #2 Assembly Details	6-Sep-11
NAW130-D0V-29270-0216	02	Outlet Gate Hoist Structure Tower #1 - Stair #3 Assembly Details	6-Sep-11
NAW130-D0V-29270-0217	02	Outlet Gate Hoist Structure Tower #1 - Stair #4 Assembly Details	6-Sep-11
NAW130-D0V-29270-0218	01	Outlet Gate Hoist Structure Tower #1 - Stair #5 Assembly Details	6-Sep-11
NAW130-D0V-29270-0219	02	Outlet Gate Hoist Structure Tower 1 & 2 - Lateral Guide Section & Detail	3-May-11
NAW130-D0V-29270-0220	02	Outlet Gate Hoist Structure Tower #2 - Site Assembly Cladding	6-Sep-11
NAW130-D0V-29270-0221	02	Outlet Gate Hoist Structure Tower #2 - Site Assembly General Arrangement	6-Sep-11
NAW130-D0V-29270-0222	02	Outlet Gate Hoist Structure Tower #2 - Site Assembly Details	6-Sep-11
NAW130-D0V-29270-0223	02	Outlet Gate Hoist Structure Tower #2 - Inferior Section Frame and Cladding Assembly	6-Sep-11
NAW130-D0V-29270-0224	02	Outlet Gate Hoist Structure Tower #2 - Inferior Section Frame Assembly	6-Sep-11
NAW130-D0V-29270-0225	02	Outlet Gate Hoist Structure Tower #2 - Inferior Section Detail - Frame Side A & C	6-Sep-11
NAW130-D0V-29270-0226	02	Outlet Gate Hoist Structure Tower #2 - Inferior Section Detail - Frame Side B & D	6-Sep-11
NAW130-D0V-29270-0227	02	Outlet Gate Hoist Structure Tower #2 - Superior Section Frame and Cladding Assembly	6-Sep-11
NAW130-D0V-29270-0228	02	Outlet Gate Hoist Structure Tower #2 - Superior Section Shop Assembly	6-Sep-11
NAW130-D0V-29270-0229	01	Outlet Gate Hoist Structure Tower #2 - Superior Section Detail - Frame Side A & C	6-Sep-11
NAW130-D0V-29270-0230	01	Outlet Gate Hoist Structure Tower #2 - Superior Section Detail - Frame Side B & D	6-Sep-11
NAW130-D0V-29270-0231	02	Outlet Gate Hoist Structure Hoist Shelter General Assembly	10-May-10
NAW130-D0V-29270-0232	01	Shelter Frame - Assembly and Details	6-Sep-11
NAW130-D0V-29270-0233	01	Hoist Bridge with Tower Pin and Sliding Connection Assembly & Details	6-Sep-11
NAW130-D0V-29270-0234	05	Outlet Gate Hoist Structure Hoist Bridge Shop Assembly and Details	22-Dec-10
NAW130-D0V-29270-0235	01	Outlet Gate Hoist Structure Dogging Hook Mechanism Assembly and Details	6-Sep-11
NAW130-D0V-29270-0236	01	Outlet Gate Hoist Structure Dogging Hook Mechanism Details	6-Sep-11
NAW130-D0V-29270-0237	01	Hoist Bridge with Tower Pin and Sliding Connection Details	6-Sep-11
NAW130-D0V-29270-0238	01	Shelter Frame - Details	6-Sep-11
NAW130-D0V-29270-0239	01	Shelter Frame - Details	6-Sep-11
NAW130-D0V-29270-0240	03	Outlet Gate Electrical Schematics Title Sheet & Table of Contents	5-Nov-13
NAW130-D0V-29270-0241	04	Outlet Gate Electrical Schematics Legend & Fabrication	11-Nov-13
NAW130-D0V-29270-0242	03	Outlet Gate Electrical Schematics Primary Power	5-Nov-13
NAW130-D0V-29270-0243	03	Outlet Gate Electrical Schematics Hoist Power	22-Oct-13
NAW130-D0V-29270-0244	03	Outlet Gate Electrical Schematics Main Control	5-Nov-13
NAW130-D0V-29270-0245	03	Outlet Gate Electrical Schematics Hoist Control	5-Nov-13
NAW130-D0V-29270-0246	03	Outlet Gate Electrical Schematics Pilot Lights	5-Nov-13
NAW130-D0V-29270-0247	03	Outlet Gate Electrical Schematics Distribution 600VAC	5-Nov-13
NAW130-D0V-29270-0248	04	Outlet Gate Electrical Schematics Distribution 240/120VAC	11-Nov-13
NAW130-D0V-29270-0249	03	Outlet Gate Electrical Schematics Part List	5-Nov-13
NAW130-D0V-29270-0250	04	Outlet Gate Electrical Schematics Part List	11-Nov-13
NAW130-D0V-29270-0251	04	Outlet Gate Electrical Schematics Panel Layout	11-Nov-13
NAW130-D0V-29270-0252	03	Outlet Gate Electrical Schematics A/C Layout and Hoist Level Control Box	5-Nov-13
NAW130-D0V-29270-0253	03	Outlet Gate Electrical Schematics Control Level Control Box	5-Nov-13

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Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29270-0254	03	Outlet Gate Electrical Schematics Interconnection	5-Nov-13
NAW130-D0V-29270-0255	03	Outlet Gate Electrical Schematics Wire List 1	5-Nov-13
NAW130-D0V-29270-0256	03	Outlet Gate Electrical Schematics Wire List 2	5-Nov-13
NAW130-D0V-29270-0300	05	Intake Gate - General Assembly	25-Sep-12
NAW130-D0V-29270-0301	06	Intake Gate - Assembly in Embedded Parts Tolerances Details	25-Sep-12
NAW130-D0V-29270-0302	06	Intake Gate - Bottom Sectional Gate Assembly	25-Sep-12
NAW130-D0V-29270-0303	06	Intake Gate - Bottom Sectional Gate Frame	25-Sep-12
NAW130-D0V-29270-0304	06	Intake Gate - Bottom Sectional Gate Welding	25-Sep-12
NAW130-D0V-29270-0305	06	Intake Gate - Bottom Sectional Gate Machining, Drilling and Paint	25-Sep-12
NAW130-D0V-29270-0306	06	Intake Gate - Intermediate Sectional Gates - Assembly	25-Sep-12
NAW130-D0V-29270-0307	07	Intake Gate - Intermediate Sectional Gates Frame	25-Sep-12
NAW130-D0V-29270-0308	06	Intake Gate - Intermediate Sectional Gates Welding	25-Sep-12
NAW130-D0V-29270-0309	06	Intake Gate - Intermediate Sectional Gate Machining, Drilling ad Paint	25-Sep-12
NAW130-D0V-29270-0310	06	Intake Gate - Top Sectional Gates Assembly	25-Sep-12
NAW130-D0V-29270-0311	06	Intake Gate - Top Sectional Gate Frame	25-Sep-12
NAW130-D0V-29270-0312	05	Intake Gate - Top Sectional Gate Welding	25-Sep-12
NAW130-D0V-29270-0313	06	Intake Gate - Top Sectional Gate Machining, Drilling and Paint	25-Sep-12
NAW130-D0V-29270-0314	04	Intake Gate - Main Beam and Lateral Beam Assembly and Details	28-Nov-11
NAW130-D0V-29270-0315	06	Intake Gate - Spring Blades and Guides Assembly and Details	25-Sep-12
NAW130-D0V-29270-0316	04	Intake Gate - Filling Valve Assembly	28-Nov-11
NAW130-D0V-29270-0317	04	Intake Gate - Filling Valve Details #1	28-Nov-13
NAW130-D0V-29270-0318	05	Intake Gate - Filling Valve Details #2	28-Nov-11
NAW130-D0V-29270-0319	04	Intake Gate - Filling Valve Details #3	28-Nov-11
NAW130-D0V-29270-0320	05	Intake Gate - Seal Assembly	23-Aug-12
NAW130-D0V-29270-0321	04	Intake Gate - Seals Details	28-Nov-11
NAW130-D0V-29270-0322	04	Intake Gate - Retaining Bar Details	28-Nov-11
NAW130-D0V-29270-0325	03	Intake Gate - Temporary Storage Rack	30-Nov-12
NAW130-D0V-29270-0326	02	Intake Gate Lifting Plan with Lifting Beam and Equalizing Device for Dry Test	18-Jun-13
NAW130-D0V-29270-0327	03	Intake Gate - Rigging Plan	18-Jun-13
NAW130-D0V-29270-0328	02	Intake Gate Storage Rack	25-Jun-13
NAW130-D0V-29270-0329	05	Intake Gate - Main Beam and Lateral Beam Assembly and Details	28-Nov-11
NAW130-D0V-29270-0331	00	Intake Gate - Bottom Sectional Gates Counterweight Details	30-Nov-12
NAW130-D0V-29270-0332	00	Intake Gate - Intermediate Sectional Gates Counterweight Details	30-Nov-12
NAW130-D0V-29270-0333	00	Intake Gate - Top Sectional Gates Counterweight Details	30-Nov-12
NAW130-D0V-29270-0335	00	Intake Gate - Intermediate Sectional Gate Numbering Detail	30-Nov-12
NAW130-D0V-29270-0336	03	Intake Structure Lifting Lugs - Assembly & Details Complete Tower	9-Jul-12
NAW130-D0V-29270-0400	02	Intake Structure Guiding System - General Assembly	9-Jun-11
NAW130-D0V-29270-0401	02	Intake Structure Guiding System - Site Assembly	9-Jun-11
NAW130-D0V-29270-0402	02	Intake Structure Guiding System Assembly & Details Lower & Intermediate Tower	9-Jun-11
NAW130-D0V-29270-0403	01	Intake Structure Guiding System Assembly & Details Lower & Intermediate Tower	9-Jun-11
NAW130-D0V-29270-0404	02	Intake Structure Guiding System Assembly & Details Upper Tower	9-Jun-11
NAW130-D0V-29270-0405	05	Intake Structure Guiding System Tower Lateral Guide Assembly & Detail	6-Nov-12
NAW130-D0V-29270-0406	02	Intake Structure Walkway Assembly & Detail	9-Jun-11
NAW130-D0V-29270-0407	01	Intake Structure Slot Cover, Assembly & Details	9-Jun-11
NAW130-D0V-29270-0408	03	Intake Gate Lifting Beam Assembly	29-Oct-13
NAW130-D0V-29270-0409	01	Intake Gate Lifting Beam Details	9-Jun-11
NAW130-D0V-29270-0410	01	Intake Gate Lifting Beam Details	9-Jun-11
NAW130-D0V-29270-0411	01	Intake Structure Guiding System Assembly & Detail Upper & Intermediate Tower	9-Jun-11
NAW130-D0V-29270-0412	01	Intake Structure Guiding System Intermediate & Lower Guide Assembly & Details	9-Jun-11
NAW130-D0V-29270-0501	02	Hoist System General Assembly	5-Mar-13
NAW130-D0V-29270-0502	02	Drum 36" PD Complete with Bull Gear Assembly	5-Mar-13
NAW130-D0V-29270-0503	02	Hoist Drum 36" PD Bull Gear and Pinion Details	5-Mar-13
NAW130-D0V-29270-0504	02	Drum 36" PD Complete with Bull Gear Assembly	5-Mar-13
NAW130-D0V-29270-0505	02	Lower Block Assembly	5-Mar-13

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Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29270-0506	02	Upper Block and Rope Dead End Assembly	5-Mar-13
NAW130-D0V-29270-0507	01	Hoist System Details	5-Jun-13
NAW130-D0V-29270-0508	02	Lower Block Details	5-Jun-13
NAW130-D0V-29270-0509	02	Upper Block and Rope Dead End Details	5-Jun-13
NAW130-D0V-29270-0510	01	Gate Hoist Structure - Floor Plate Detail, Hand Rail -- Stair and Ladder Gear and Pinion Insp. Cover	6-Sep-11
NAW130-D0V-29270-0511	00	Gate Hoist Structure - Access Ladder Assembly & Detail	25-Jan-11
NAW130-D0V-29270-0512	00	Gate Hoist Structure - Ladder & Platform Detail, Assembly & Details	25-Jan-11
NAW130-D0V-29270-0513	00	Gate Hoist Structure - Gear and Pinion Protector, Assembly & Details	25-Jan-11
NAW130-D0V-29300-0005	04	Approach Wall Elevation (1 of 3)	16-Jan-14
NAW130-D0V-29300-0006	03	Approach Wall Elevation (2 of 3)	16-Jan-14
NAW130-D0V-29300-0007	06	Approach Wall Elevation (3 of 3)	16-Jan-14
NAW130-D0V-29300-0008	06	Approach Wall Cross Sections (1 of 4)	16-Jan-14
NAW130-D0V-29300-0009	04	Approach Wall Cross Sections (2 of 4)	16-Jan-14
NAW130-D0V-29300-0010	04	Approach Wall Cross Sections (3 of 4)	16-Jan-14
NAW130-D0V-29300-0011	07	Approach Wall Cross Sections (4 of 4)	16-Jan-14
NAW130-D0V-29300-0012	05	Approach Wall Cross Sections for Module 'APP1', 'APP2' and Dock	16-Jan-14
NAW130-D0V-29300-0013	04	Approach Wall Cross Sections for Module 'APP3', 'APP4' and 'APP5'	16-Jan-14
NAW130-D0V-29300-0014	05	Approach Wall Details	16-Jan-14
NAW130-D0V-29300-0018	02	Intake Channel - Plan and Sections	16-Jan-14
NAW130-D0V-29300-0019	02	Pier 1 - Extension Removal Details	16-Jan-14
NAW130-D0V-29300-0020	07	Pier 1 - Extension New Construction (1 of 2)	16-Jan-14
NAW130-D0V-29300-0021	05	Pier 1 - Extension New Construction (2 of 2)	16-Jan-14
NAW130-D0V-29300-0022	03	Pier 1 - Extension New Construction	16-Jan-14
NAW130-D0V-29300-0023	02	Pier 2 - Extension Removal Details	16-Jan-14
NAW130-D0V-29300-0024	03	Pier 2 - Extension New Construction (1 of 2)	16-Jan-14
NAW130-D0V-29300-0025	03	Pier 2 - Extension New Construction (2 of 2)	16-Jan-14
NAW130-D0V-29300-0031	03	Accelerating Wall, Elevation (1 of 4)	16-Jan-14
NAW130-D0V-29300-0032	03	Accelerating Wall, Elevation (2 of 4)	16-Jan-14
NAW130-D0V-29300-0033	03	Accelerating Wall, Elevation (3 of 4)	16-Jan-14
NAW130-D0V-29300-0034	03	Accelerating Wall, Elevation (4 of 4)	16-Jan-14
NAW130-D0V-29300-0035	02	Accelerating Wall, River Bed Cross Sections	16-Jan-14
NAW130-D0V-29300-0036	04	Accelerating Wall, Cross Sections (1 of 2)	16-Jan-14
NAW130-D0V-29300-0037	03	Accelerating Wall, Cross Sections (2 of 2)	16-Jan-14
NAW130-D0V-29300-0038	05	Accelerating Wall, Concrete Deck Slab	16-Jan-14
NAW130-D0V-29300-0039	03	Accelerating Wall, Details (1 of 2)	16-Jan-14
NAW130-D0V-29300-0040	08	Accelerating Wall, Details (2 of 2)	16-Jan-14
NAW130-D0V-29300-0041	01	Accelerating Wall - Travel Restraint System and Details	26-Jun-07
NAW130-D0V-29300-0042	05	Pier 5 Aluminum Ladder Details	16-Jan-14
NAW130-D0V-29300-0043	05	Accelerating Wall - Electrical Embedded Work for Strobe Lights	16-Jan-14
NAW130-D0V-29300-0051	06	Intake Structure Final Lining - Part 1 Sections	12-Dec-12
NAW130-D0V-29300-0052	04	Intake Structure Final Lining - Part 2 Cross Sections	12-Dec-12
NAW130-D0V-29300-0053	02	Intake Structure Final Lining - Part 3 Cross Sections	12-Dec-12
NAW130-D0V-29300-0054	02	Intake Structure Final Lining - Part 4 Cross Sections	12-Dec-12
NAW130-D0V-29300-0055	03	Intake Structure Final Lining - Part 5 3-Dimensional Sections	12-Dec-12
NAW130-D0V-29300-0056	04	Intake Structure Bottom Slab - 1/2 Reinforcement	12-Dec-12
NAW130-D0V-29300-0057	02	Intake Structure Bottom Slab - 2/2 Reinforcement	12-Dec-12
NAW130-D0V-29300-0058	03	Intake Structure Side, Front and Gate wall Reinforcement, 1/2	12-Dec-12
NAW130-D0V-29300-0059	02	Intake Structure Side, Front and Gate wall Reinforcement, 2/2	12-Dec-12
NAW130-D0V-29300-0060	02	Intake Structure Transition Reinforcement	12-Dec-12
NAW130-D0V-29300-0063	02	Intake Structure Final Lining, Layout of Waterstops	12-Dec-12
NAW130-D0V-29300-0064	02	Intake Structure - Vortex Breaker (6 bolts)	12-Dec-12
NAW130-D0V-29300-0066	01	Tie Down Plate for Steel Covers at Intake Structure	16-Jan-14
NAW130-D0V-29300-0068	01	Approach Wall Connection Dowels for Top Slab (Blocks 75-80)	16-Jan-14
NAW130-D0V-29300-0069	02	Approach Wall - Travel Restraint System Layout & Details	7-Feb-14
NAW130-D0V-29300-0071	02	Pier 1 and Pier 2 Hand railing	14-Jan-14
NAW130-D0V-29300-0100	00	Intake Structure As Built Drawings	12-Dec-12
NAW130-D0V-29300-0101	00	Intake Structure, Intake Base Slab, Pour 1A Bot Bars	12-Dec-12

AS BUILT DRAWINGS

Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29300-0102	00	Intake Structure, Intake Base Slab; Pour 1A Dwls	12-Dec-12
NAW130-D0V-29300-0103	00	Intake Structure, Intake Base Slab; Pour 1A Shear/Tie Bars	12-Dec-12
NAW130-D0V-29300-0104	00	Intake Structure, Bullnose Down Turn	12-Dec-12
NAW130-D0V-29300-0105	00	Intake Structure, Intake Base Slab; Pour 2 Trench/Dwl Bars Sht. 1 of 2	12-Dec-12
NAW130-D0V-29300-0106	00	Intake Structure, Intake Base Slab; Pour 2 Top Bars Sht. 2 of 2	12-Dec-12
NAW130-D0V-29300-0107	00	Intake Structure, Intake Base Slab; Pour 2 & 3 (Sht. 1 of 3)	12-Dec-12
NAW130-D0V-29300-0108	00	Intake Structure, Intake Base Slab; Pour 2 & 3 (Sht. 2 of 3)	12-Dec-12
NAW130-D0V-29300-0109	00	Intake Structure, Intake Base Slab; Pour 2 & 3 (Sht. 3 of 3)	12-Dec-12
NAW130-D0V-29300-0110	00	Intake Structure, Intake Base Slab; Top Layers; Pour 2 Support Bars	12-Dec-12
NAW130-D0V-29300-0111	00	Intake Structure, Roof Support Dwls; Sheet 1 of 3	12-Dec-12
NAW130-D0V-29300-0112	00	Intake Structure, Roof Support Dwls; Sheet 2 of 2	12-Dec-12
NAW130-D0V-29300-0113	00	Intake Structure, Pour 4, 5 & 6 (Sht 1 of 7)	12-Dec-12
NAW130-D0V-29300-0114	00	Intake Structure, Pour 4, 5 & 6 (Sht 2 of 7)	12-Dec-12
NAW130-D0V-29300-0115	00	Intake Structure, Pour 4, 5 & 6 (Sht 3 of 7)	12-Dec-12
NAW130-D0V-29300-0116	00	Intake Structure, Pour 4, 5 & 6 (Sht 4 of 7)	12-Dec-12
NAW130-D0V-29300-0117	00	Intake Structure, Pour 4, 5 & 6 (Sht 5 of 7)	12-Dec-12
NAW130-D0V-29300-0118	00	Intake Structure, Pour 4, 5 & 6 (Sht 6 of 7)	12-Dec-12
NAW130-D0V-29300-0119	00	Intake Structure, Pour 4, 5 & 6 (Sht 7 of 7)	12-Dec-12
NAW130-D0V-29300-0120	00	Intake Structure, Pour 7, 8, 9, 10, 11 & 12 (Sht 1 of 5)	12-Dec-12
NAW130-D0V-29300-0121	00	Intake Structure, Pour 7, 8, 9, 10, 11 & 12 (Sht 2 of 5)	12-Dec-12
NAW130-D0V-29300-0122	00	Intake Structure, Pour 7, 8, 9, 10, 11 & 12 (Sht 3 of 5)	12-Dec-12
NAW130-D0V-29300-0123	00	Intake Structure, Pour 7, 8, 9, 10, 11 & 12 (Sht 4 of 5)	12-Dec-12
NAW130-D0V-29300-0124	00	Intake Structure, Pour 7, 8, 9, 10, 11 & 12 (Sht 5 of 5)	12-Dec-12
NAW130-D0V-29300-0125	00	Intake Structure, Pour 5 & 6 (Sht 1 of 6)	12-Dec-12
NAW130-D0V-29300-0126	00	Intake Structure, Pour 5 & 6 (Sht 2 of 6)	12-Dec-12
NAW130-D0V-29300-0127	00	Intake Structure, Pour 5 & 6 (Sht 3 of 6)	12-Dec-12
NAW130-D0V-29300-0128	00	Intake Structure, Pour 5 & 6 (Sht 4 of 6)	12-Dec-12
NAW130-D0V-29300-0129	00	Intake Structure, Pour 5 & 6 (Sht 5 of 6)	12-Dec-12
NAW130-D0V-29300-0130	00	Intake Structure, Pour 5 & 6 (Sht 6 of 6)	12-Dec-12
NAW130-D0V-29300-0131	00	Intake Structure, TBM Trench; Sheet 1 of 2	12-Dec-12
NAW130-D0V-29300-0132	00	Intake Structure, TBM Trench; Sheet 2 of 2	12-Dec-12
NAW130-D0V-29700-0005	06	Outlet Structure/Canal Plan and Longitudinal Section	29-Jan-13
NAW130-D0V-29700-0006	04	Outlet Structure/Canal Cross Sections	29-Jan-13
NAW130-D0V-29700-0007	03	Outlet Structure - Final Lining Plan and Sections	29-Jan-13
NAW130-D0V-29700-0008	03	Outlet Structure - Final Lining Cross Sections	29-Jan-13
NAW130-D0V-29700-0018	05	Outlet Structure - Final Lining - Part 1 Sections	29-Jan-13
NAW130-D0V-29700-0019	05	Outlet Structure - Final Lining - Part 2 Cross Sections	29-Jan-13
NAW130-D0V-29700-0020	04	Outlet Structure - Final Lining - Part 3 Cross Sections	8-Apr-13
NAW130-D0V-29700-0021	03	Outlet Structure - Final Lining - Part 4 Cross Sections	29-Jan-13
NAW130-D0V-29700-0022	03	Outlet Structure - Final Lining - Part 5 Cross Sections	29-Jan-13
NAW130-D0V-29700-0023	05	Outlet Structure Bottom Slab - Part 1 Reinforcement	29-Jan-13
NAW130-D0V-29700-0024	04	Outlet Structure Bottom Slab - Part 2 Reinforcement	29-Jan-13
NAW130-D0V-29700-0025	04	Outlet Structure Bottom Slab - Part 3 Reinforcement	29-Jan-13
NAW130-D0V-29700-0026	06	Outlet Structure, Bottom Slab - Part 4 Reinforcement	8-Apr-13
NAW130-D0V-29700-0027	02	Outlet Structure Bottom Slab - Part 5 Reinforcement	8-Apr-13
NAW130-D0V-29700-0028	04	Outlet Structure Sidewall Reinforcement	8-Apr-13
NAW130-D0V-29700-0029	03	Outlet Structure Frontwall and Gate wall Reinforcement	8-Apr-13
NAW130-D0V-29700-0030	03	Outlet Structure Frontwall, Gate wall and Sidewall Reinforcement, Sections Y, Z	29-Jan-13
NAW130-D0V-29700-0031	03	Outlet Structure Frontwall, Gate wall and Sidewall Reinforcement, Sections W, X	29-Jan-13
NAW130-D0V-29700-0032	02	Outlet Structure Transition Reinforcement	8-Apr-13
NAW130-D0V-29700-0033	02	Outlet Structure Bottom Slab Shear Reinforcement	29-Jan-13
NAW130-D0V-29700-0034	04	Outlet Structure Walls and Transition Shear Reinforcement	29-Jan-13
NAW130-D0V-29700-0035	03	Outlet Structure Final Lining, Layout of Waterstops - Part 1/2	29-Jan-13
NAW130-D0V-29700-0036	03	Outlet Structure Final Lining, Layout of Waterstops - Part 2/2	29-Jan-13
NAW130-D0V-29700-0037	01	Outlet Structure - Cantilever Beam for Hoist Shelter, Reinforcement	29-Jan-13
NAW130-D0V-29700-0038	01	Outlet Structure - Canal Reinforced Shotcrete Infill	29-Jan-13

AS BUILT DRAWINGS

Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29700-0044	02	Outlet Channel and PGS Canal As Built Bathymetric Survey Colour Contour Plan View	March 2013
NAW130-D0V-29700-0045	02	Outlet Channel and PGS Canal As Built Bathymetric Survey Colour Contoured Bathymetric Plan View	March 2013
NAW130-D0V-29700-0046	02	Outlet Channel and PGS Canal As Built Bathymetric Survey Contoured Bathymetric Plan View	March 2013
NAW130-D0V-29700-0047	02	Outlet Channel and PGS Canal As Built Bathymetric Survey Colour Contoured Perspective Views	March 2013
NAW130-D0V-29700-0048	01	Outlet Structure - Outlet Hand Railings Details & Shop Drawing	13-Jan-14
NAW130-D0V-29700-0049	01	Outlet Structure - Gate Tower #1, Gate Tower #2 Proposed Railings & Grading	14-Jan-14
NAW130-D0V-29700-0050	00	Outlet Channel and PGS Canal As Built Bathymetric Survey Data Points and Contours	March 2013
NAW130-D0V-29700-0100	00	Outlet Structure As Built Drawings Package List	29-Jan-13
NAW130-D0V-29700-0101	00	Outlet Structure - Outlet Base Slab Pour 1A Bottom & Dwls (Sht 1/6)	29-Jan-13
NAW130-D0V-29700-0102	00	Outlet Structure - Outlet Base Slab Pour 1A Bottom & Dwls (Sht 2/6)	29-Jan-13
NAW130-D0V-29700-0103	00	Outlet Structure - Outlet Base Slab Pour 1A Bottom & Dwls (Sht 3/6)	29-Jan-13
NAW130-D0V-29700-0104	00	Outlet Structure - Outlet Base Slab Pour 1A Bottom & Dwls (Sht 4/6)	29-Jan-13
NAW130-D0V-29700-0105	00	Outlet Structure - Outlet Base Slab Pour 1A Bottom & Dwls (Sht 5/6)	29-Jan-13
NAW130-D0V-29700-0106	00	Outlet Structure - Outlet Base Slab Pour 1A Bottom & Dwls (Sht 6/6)	29-Jan-13
NAW130-D0V-29700-0107	00	Outlet Structure - Outlet Base Slab Pour 1A Shipment Runs	29-Jan-13
NAW130-D0V-29700-0108	00	Outlet Structure - Outlet Base Slab Pour 1 Bottom & Dwls (Sht 1/6)	29-Jan-13
NAW130-D0V-29700-0109	00	Outlet Structure - Outlet Base Slab Pour 1 Bottom & Dwls (Sht 2/6)	29-Jan-13
NAW130-D0V-29700-0110	00	Outlet Structure - Outlet Base Slab Pour 1 Bottom & Dwls (Sht 3/6)	29-Jan-13
NAW130-D0V-29700-0111	00	Outlet Structure - Outlet Base Slab Pour 1 Bottom & Dwls (Sht 4/6)	29-Jan-13
NAW130-D0V-29700-0112	00	Outlet Structure - Outlet Base Slab Pour 1 Bottom & Dwls (Sht 5/6)	29-Jan-13
NAW130-D0V-29700-0113	00	Outlet Structure - Outlet Base Slab Pour 1 Bottom & Dwls (Sht 6/6)	29-Jan-13
NAW130-D0V-29700-0114	00	Outlet Structure - Outlet Base Slab Pour 2A Top Bars (Sht 1/3)	29-Jan-13
NAW130-D0V-29700-0115	00	Outlet Structure - Outlet Base Slab Pour 2A Top Bars (Sht 2/3)	29-Jan-13
NAW130-D0V-29700-0116	00	Outlet Structure - Outlet Base Slab Pour 2A Top Bars (Sht 3/3)	29-Jan-13
NAW130-D0V-29700-0117	00	Outlet Structure - Outlet Base Slab Pour 2C Top Bars (Sht 1/4)	29-Jan-13
NAW130-D0V-29700-0118	00	Outlet Structure - Outlet Base Slab Pour 2C Top Bars (Sht 2/4)	29-Jan-13
NAW130-D0V-29700-0119	00	Outlet Structure - Outlet Base Slab Pour 2C Top Bars (Sht 3/4)	29-Jan-13
NAW130-D0V-29700-0120	00	Outlet Structure - Outlet Base Slab Pour 2C Top Bars (Sht 4/4)	29-Jan-13
NAW130-D0V-29700-0121	00	Outlet Structure - Outside Vertical Bars Pours 3, 4, 5 & 6 (Sht 1/4)	29-Jan-13
NAW130-D0V-29700-0122	00	Outlet Structure - Outside Vertical Bars Pours 3, 4, 5 & 6 (Sht 2/4)	29-Jan-13
NAW130-D0V-29700-0123	00	Outlet Structure - Outside Vertical Bars Pours 3, 4, 5 & 6 (Sht 3/4)	29-Jan-13
NAW130-D0V-29700-0124	00	Outlet Structure - Outside Vertical Bars Pours 3, 4, 5 & 6 (Sht 4/4)	29-Jan-13
NAW130-D0V-29700-0125	00	Outlet Structure - Inside Face Horizontal Bars Pours 3, 4, 5 & 6 (Sht 1/5)	29-Jan-13
NAW130-D0V-29700-0126	00	Outlet Structure - Inside Face Horizontal Bars Pours 3, 4, 5 & 6 (Sht 2/5)	29-Jan-13
NAW130-D0V-29700-0127	00	Outlet Structure - Inside Face Plan View Pours 3, 4, 5, 6 (Sht 3/5)	29-Jan-13
NAW130-D0V-29700-0128	00	Outlet Structure - Shear/Crack & Brace Bars Pours 3, 4, 5 & 6 (Sht 4/5)	29-Jan-13
NAW130-D0V-29700-0129	00	Outlet Structure - Inside Face Bar List (Sht 5/5)	29-Jan-13
NAW130-D0V-29700-0130	00	Outlet Structure - Outside Face Vertical Bars Pours 7, 8, 9, 10 & 11 (Sht 1/4)	29-Jan-13
NAW130-D0V-29700-0131	00	Outlet Structure - Outside Face Horizontal Bars Pours 7, 8, 9 10 & 11 (Sht 2/4)	29-Jan-13
NAW130-D0V-29700-0132	00	Outlet Structure - Outside Face Plan View Pours 7, 8, 9, 10 & 11 (Sht 3/4)	29-Jan-13
NAW130-D0V-29700-0133	00	Outlet Structure - Outside Face Sections Pours 7, 8, 9, 10 & 11 (Sht 4/4)	29-Jan-13
NAW130-D0V-29700-0134	00	Outlet Structure - Inside Face Horizontal Bars Pours 7, 8, 9, 10 & 11A (Sht 1/6)	29-Jan-13
NAW130-D0V-29700-0135	00	Outlet Structure - Inside Face Vertical Bars Pours 7, 8, 9, 10 & 11A (Sht 2/6)	29-Jan-13
NAW130-D0V-29700-0136	00	Outlet Structure - Inside Face Plan View Pour 7, 8, 9, 10 & 11A (Sht 3/6)	29-Jan-13
NAW130-D0V-29700-0137	00	Outlet Structure - Inside Face Upper Plan View Pours 7, 8, 9, 10 & 11A (Sht 4/6)	29-Jan-13
NAW130-D0V-29700-0138	00	Outlet Structure - shear & Placing Bars Pours 7, 8, 9, 10 & 11A (Sht 5/6)	29-Jan-13
NAW130-D0V-29700-0139	00	Outlet Structure - Bar List Pours 7, 8, 9, 10 & 11A (Sht 6/6)	29-Jan-13
NAW130-D0V-29700-0140	00	Outlet Structure - Outside Face Bars Pour 11B	29-Jan-13
NAW130-D0V-29700-0141	00	Outlet Structure - West Outside & Inside Face Pour 12 (Sht 1/4)	29-Jan-13
NAW130-D0V-29700-0142	00	Outlet Structure - North & South Faces Pour 12 (Sht 2/4)	29-Jan-13
NAW130-D0V-29700-0143	00	Outlet Structure - Plan View Pour 12 (Sht 3/4)	29-Jan-13
NAW130-D0V-29700-0144	00	Outlet Structure - Gate wall/Shear Bar Pour 12 (Sht 4/4)	29-Jan-13

AS BUILT DRAWINGS

Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29700-0145	00	Outlet Structure - West Outside & Inside Face Pour 13 (Sht 1/5)	29-Jan-13
NAW130-D0V-29700-0146	00	Outlet Structure - North & South Faces Pour 13 (Sht 2/5)	29-Jan-13
NAW130-D0V-29700-0147	00	Outlet Structure - Plan View Pour 13 (Sht 3/5)	29-Jan-13
NAW130-D0V-29700-0148	00	Outlet Structure - Gate wall Pour 13 (Sht 4/5)	29-Jan-13
NAW130-D0V-29700-0149	00	Outlet Structure - Shear Bar Pour 13 (Sht 5/5)	29-Jan-13
NAW130-D0V-29700-0150	00	Outlet Structure - West Outside & Inside Face Pour 14 (Sht 1/5)	29-Jan-13
NAW130-D0V-29700-0151	00	Outlet Structure - North & South Faces Pour 14 (Sht 2/5)	29-Jan-13
NAW130-D0V-29700-0152	00	Outlet Structure - Plan View Pour 14 (Sht 3/5)	29-Jan-13
NAW130-D0V-29700-0153	00	Outlet Structure - Gate wall Pour 14 (Sht 4/5)	29-Jan-13
NAW130-D0V-29700-0154	00	Outlet Structure - Shear Bar Pour 14 (Sht 5/5)	29-Jan-13
NAW130-D0V-29700-0155	00	Outlet Structure - West Outside & Inside Faces Pours 15 & 16 (Sht 1/6)	29-Jan-13
NAW130-D0V-29700-0156	00	Outlet Structure - North & South Faces Pours 15 & 16 (Sht 2/6)	29-Jan-13
NAW130-D0V-29700-0157	00	Outlet Structure - Plan View Pours 15 & 16 (Sht 3/6)	29-Jan-13
NAW130-D0V-29700-0158	00	Outlet Structure - Plan View Pour 16 (Sht 4/6)	29-Jan-13
NAW130-D0V-29700-0159	00	Outlet Structure - Gate wall Pours 15 & 16 (Sht 5/6)	29-Jan-13
NAW130-D0V-29700-0160	00	Outlet Structure - Shear Bar Pours 15 & 16 (Sht 6/6)	29-Jan-13
NAW130-D0V-29700-0161	00	Outlet Structure - West Outside & Inside Faces Pour 17	29-Jan-13
NAW130-D0V-86000-0015	00	Outlet Site - Electrical Services, Line Schematic Whirlpool Road to Outlet Structure	5-Nov-13
NAW130-D0V-86000-0018	00	Outlet Site - Water Services, Line Schematic Stanley Avenue to PGS	5-Nov-13
NAW130-D0V-86000-0020	01	Quonset Hut Inspection, Foundation Plan, Building A (Dwg 13-281 S1)	23-Jul-13
NAW130-D0V-86000-0021	01	Quonset Hut Inspection, Foundation Plan, Building B (Dwg 13-281 S2)	23-Jul-13
NAW130-D0V-86000-0022	01	Quonset Hut Inspection, Building A & B, Sections (Dwg 13-281 S3)	23-Jul-13
NAW130-D0V-86000-0023	01	Quonset Hut Inspection, Building A & B, Details (Dwg 13-281 S4)	23-Jul-13
NAW130-D0V-88200-0018	00	Discharge Conveyor Corrugated Steel Pipe Sections	15-Feb-13
NAW130-D0V-88400-0007	02	Material Stockpiles & Fill Areas for Future OPG Use	17-Dec-13

Appendix 5

Temporary Works Drawings

TEMPORARY WORKS DRAWINGS

Report/Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-88200-0019	00	Final TBM Drawings (27 Dwgs)	14-May-08
NAW130-D0V-88200-0001	00	TBM General Arrangements (4 dwgs)	29-Nov-05
NAW130-D0V-20102-0019	00	Construction Facilities Outlet Area, General Arrangement Equipment Layout Plan	11-May-06
NAW130-D0V-26500-0001	03	Cellular Cofferdam & Caisson Cutoff Wall, Plan & Detail, Notes & Schedule	18-Jan-07
NAW130-D0V-26500-0002	02	Cellular Cofferdam & Caisson Cutoff Wall, Sections	18-Jan-07
NAW130-D0V-26500-0003	01	Cellular cofferdam & Caisson Cutoff Wall - Typical Cell Module, Plan & Section	08-May-06
NAW130-D0V-26500-0004	02	Cellular cofferdam & Caisson Cutoff Wall - Plan & Section & Detail	18-Jan-07
NAW130-D0V-26500-0005	02	Cellular Cofferdam & Caisson Cutoff Wall, Elevations	18-Jan-07
NAW130-D0V-26500-0006	01	Cellular Cofferdam & Caisson Cutoff Wall	08-May-06
NAW130-D0V-26500-0007	05	Cofferdam at Pier 2, Plan, Section, Elevations, Details & Notes	10-Sep-07
NAW130-D0V-26500-0008	01	Intake Area - Ice Groyne Plan	03-Oct-06
NAW130-D0V-26500-0009	01	Intake Area - Ice Groyne Sections	03-Oct-06
NAW130-D0V-26500-0010	02	Grout Curtain - Plan, Section Detail and Notes	18-Jul-07
NAW130-D0V-26500-0011	01	Grout Curtain Elevation	05-Dec-13
NAW130-D0V-26500-0012	01	Grout Curtain Sections	05-Dec-13
NAW130-D0V-26500-0013	00	Intake Area - Intake Grout Curtain	05-Dec-13
NAW130-D0V-29230-0018	03	Diversion Tunnel, Rock Support, Types 1 and 2	28-Feb-07
NAW130-D0V-29230-0019	06	Diversion Tunnel, Rock Support, Types 3 and 4	21-May-07
NAW130-D0V-29230-0020	02	Diversion Tunnel, Rock Support, Types 5 and 6	24-Aug-06
NAW130-D0V-29230-0021	01	Diversion Tunnel, Rock Support Measures, Details	24-Aug-06
NAW130-D0V-29230-0034	03	Diversion Tunnel, Steel Rib Segments, Rock Support Types 2, 3 and 4	01-Feb-07
NAW130-D0V-29230-0035	01	Diversion Tunnel, Steel Rib Segments, Rock Support Types 4Q, 5 and 6	24-Aug-06
NAW130-D0V-29230-0039	02	Grout Tunnel Longitudinal Section and Cross Sections	21-Nov-07
NAW130-D0V-29230-0040	03	Grout Tunnel Rock Support Type 3G	20-Feb-08
NAW130-D0V-29230-0041	02	Grout Tunnel Rock Support Type 4G	20-Feb-08
NAW130-D0V-29230-0043	04	Diversion Tunnel Interface Grouting Sequence and Monitoring	11-Sep-12
NAW130-D0V-29230-0044	00	Diversion Tunnel, Tunnel Overbreak Appr. Ch. 0+840, Excavation and Pre-Support Sequence Part 1	30-May-06
NAW130-D0V-29230-0045	00	Diversion Tunnel, Tunnel Overbreak Appr. Ch. 0+840, Excavation and Pre-Support Sequence Part 2	30-May-06
NAW130-D0V-29230-0047	01	Diversion Tunnel Rock Support, Type 4S	07-Sep-07
NAW130-D0V-29230-0048	01	Diversion Tunnel Rock Support Type 4R	22-Oct-07
NAW130-D0V-29230-0049	00	Diversion Tunnel Final Lining Concrete Fill of Overbreak Crown Accessible	10-Dec-08
NAW130-D0V-29230-0050	00	Diversion Tunnel Final Lining Concrete Fill of Overbreak Crown Not Accessible	10-Dec-08
NAW130-D0V-29230-0051	00	Diversion Tunnel Grout Fill of Voids Behind Initial Lining	15-Jan-09
NAW130-D0V-29230-0052	00	Diversion Tunnel Grout Fill of Voids Behind Spile Arch	15-Jan-09
NAW130-D0V-29230-0054	00	Diversion Tunnel Final Lining Shotcrete Fill of Overbreak	11-Dec-08
NAW130-D0V-29230-0067	03	Diversion Tunnel Rock Support Type 4T	07-Jul-11
NAW130-D0V-29230-0069	03	Diversion Tunnel Rock Support Type 4T Details	07-Jul-11
NAW130-D0V-29230-0071	00	Diversion Tunnel Fill of Overbreak Longitudinal Section CH 0+000 - 0+450	10-Feb-10
NAW130-D0V-29230-0072	00	Diversion Tunnel Fill of Overbreak Longitudinal Section CH 0+450 - 1+300	10-Feb-10
NAW130-D0V-29230-0073	01	Diversion Tunnel Fill of Overbreak Longitudinal Section CH 1+300 - 2+250	30-Mar-10
NAW130-D0V-29230-0074	01	Diversion Tunnel Fill of Overbreak Longitudinal Section CH 2+250 - 3+200	30-Mar-10
NAW130-D0V-29230-0075	01	Diversion Tunnel Fill of Overbreak Longitudinal Section CH 3+200 - 4+150	30-Mar-10
NAW130-D0V-29230-0076	01	Diversion Tunnel Fill of Overbreak Longitudinal Section CH 4+150 - 5+100	30-Mar-10
NAW130-D0V-29230-0077	01	Diversion Tunnel Fill of Overbreak Longitudinal Section CH 5+100 - 6+050	30-Mar-10
NAW130-D0V-29230-0090	02	Diversion Tunnel Cavity Grouting Behind Initial Lining	12-May-10
NAW130-D0V-29230-0091	02	Diversion Tunnel Initial Lining Fill of Overbreak Type 1	15-Mar-10
NAW130-D0V-29230-0092	02	Diversion Tunnel Initial Lining Fill of Overbreak Type II Details of Steel Elements	12-May-10
NAW130-D0V-29230-0093	02	Diversion Tunnel Initial Lining Fill of Overbreak Type II Shotcrete Arch	12-May-10
NAW130-D0V-29230-0094	02	Diversion Tunnel Fill of Overbreak Type II, Construction Sequence, Part 1	12-May-10
NAW130-D0V-29230-0095	02	Diversion Tunnel, Fill of Overbreak Type II, Construction Sequence, Part 2	12-May-10
NAW130-D0V-29230-0097	00	Diversion Tunnel-Grouting Collar CH 0+561	15-Mar-10
NAW130-D0V-29230-0096	00	Final Lining, Bay 3 To Bay 13 Drain Pipes Through Lining	26-Apr-10
NAW130-D0V-29230-0098	01	Diversion Tunnel - Fill of Overbreak Type IIA Construction Sequence	Sept 2010

TEMPORARY WORKS DRAWINGS

Report/Drawing Number	Rev	Document Title	Date Issued
NAW130-D0V-29230-0100	02	Diversion Tunnel, Fill of Overbreak Types IIb Construction Sequence	09-Sep-11
NAW130-D0V-29230-0101	01	Diversion Tunnel, Fill of Overbreak Types IIb, Construction Sequence, Part 1 - Section with Shallow Inclination	09-Sep-11
NAW130-D0V-29230-0102	01	Diversion Tunnel, Fill of Overbreak Types IIb, Construction Sequence, Part 2 - Section with Shallow Inclination	09-Sep-11
NAW130-D0V-29230-0103	01	Diversion Tunnel, Fill of Overbreak Types IIc, Profiles and Abutment - Part 1	09-Sep-11
NAW130-D0V-29230-0104	01	Diversion Tunnel, Fill of Overbreak Types IIc, Profiles and Abutment - Part 2	15-Nov-10
NAW130-D0V-29230-0107	00	Diversion Tunnel Additional Rock Support Tunnel Section CH5+700 to CH6+150	22-Dec-10
NAW130-D0V-29230-0115	03	Diversion Tunnel Additional Rock Support Tunnel Section CH5+900 to CH6+170 Part 4	10-Jan-12
NAW130-D0V-29230-0116	03	Diversion Tunnel Additional Rock Support Tunnel Section CH5+900 to CH6+170 Part 4 Details	10-Jan-12
NAW130-D0V-29230-0118	02	Diversion Tunnel - Additional Rock Support Tunnel Section CH5+170 to CH5+770, CH6+170 to CH6+214	11-Nov-11
NAW130-D0V-29230-0119	01	Diversion Tunnel - Additional Rock Support at Additional Overbreak CH5+900 to CH6+170	11-Nov-11
NAW130-D0V-29230-0123	02	Diversion Tunnel - Fill of Overbreak, Bay 486 and 487 Sections	05-Jul-12
NAW130-D0V-29230-0124	01	Diversion Tunnel - Fill of Overbreak, Bay 486 and 487, Details 1-5	14-Mar-12
NAW130-D0V-29230-0130	04	Diversion Tunnel - Watering Up Procedure Step 1 and 2	15-Feb-13
NAW130-D0V-29230-0131	04	Diversion Tunnel - Watering Up Procedure Step 3 and 4	15-Feb-12
NAW130-D0V-29230-0132	00	Diversion Tunnel - Interface Grouting Sequence and Monitoring, 6 Scanners Bays 151 to 814	11-Sep-12
NAW130-D0V-29300-0046	03	Intake Structure Rock Dowels Support, Plan, Sections and Details	1-Oct-07
NAW130-D0V-29300-0049	01	Intake Structure Transition Excavation Sequence and Support Details	10-Feb-14
NAW130-D0V-29300-0061	02	Intake Structure TBM Disassembly Staging of Bottom Slab	22-Sep-09
NAW130-D0V-29300-0062	01	Intake Structure - TBM Disassembly Staging of Bottom Slab Part 2 of 2	23-Sep-09
NAW130-D0V-29700-0003	03	Outlet Structure/Canal - Excavation, Plan & Longitudunal Section	07-Apr-06
NAW130-D0V-29700-0004	03	Outlet Structure/Canal - Excavation, Cross Sections	07-Apr-06
NAW130-D0V-29700-0009	02	Outlet Structure/Canal, Tunnel Portal Area - Excavation, Plan and Sections	07-Apr-06

Filed: 2016-10-26
EB-2016-0152
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Appendix 6

NCN Register

NCN REGISTER

Report Number	Rev	Document Title	Date Issued
R-NAW130-01900--0080	00	NCN Reigster	n/a
R-NAW130-01900--0070	00	NCN 015 Intake Channel - Dry Blasting near INCW Strabag Response	29-May-13
R-NAW130-01900--0071	00	NCN 041 Tunnel Initial Lining - Thickness Variance Observed 04-Feb-10	24-Jun-10
R-NAW130-01900--0072	00	NCN 061 Contact Grouting of Final Lining	6-Mar-13
R-NAW130-01900--0073	00	NCN 063 Final Lining Waterproofing Membrane	24-Apr-12
R-NAW130-01900--0074	00	NCN 064 Interface Grouting of Final Lining	6-Mar-13
R-NAW130-01900--0075	00	NCN 065 Outlet Gate Guide Embedment Self-Leveling Concrete	6-Nov-12
R-NAW130-01900--0076	00	NCN 066 Final Lining - Reinforced Concrete Arch Bay 814	16-Nov-12
R-NAW130-01900--0077	00	NCN 067 Outlet Gate Embedded Parts Arrangement and Site Assembly	27-Nov-12
R-NAW130-01900--0078	00	NCN 068 Bay 808 Invert Repairs	6-Mar-13
R-NAW130-01900--0005	01	NCR 001 - Outlet Structure Alignment	1-Feb-06
R-NAW130-01900--0006	03	NCR002 - Blocks in Location 115 to 120	12-Oct-06
R-NAW130-01900--0007	03	NCR 003 - Concrete Blocks with Work Orders WK046879 and WK046381	12-May-06
R-NAW130-01900--0008	04	NCR 004 - Accelerating Wall Top Blocks in Location 64 to 128	23-Aug-06
R-NAW130-01900--0009	04	NCR 005 - Rockfill Materials for Accelerating and Approach Wall Blocks	31-Aug-06
R-NAW130-01900--0010	01	NCR 006 - Maximum Tolerance for Centreline Alignment	21-Sep-06
R-NAW130-01900--0011	02	NCR 007 - Accelerating Wall Blocks 23B, 46B, 63B, 64B	4-Oct-06
R-NAW130-01900--0012	03	NCR 008 - Bottom Approach Wall Blocks in Location 13, 14, 15 and 16	18-Oct-06
R-NAW130-01900--0013	02	NCR 009 - Diversion Tunnel - Steel Support for Excavation	23-Feb-09
R-NAW130-01900--0014	03	NCN 011 - Approach Wall Locations 23B, 24B, 47B and 48B	19-Jan-07
R-NAW130-01900--0015	00	NCR 010 - Accelerating Wall Locations 1, 2 & Nose Cone	18-Dec-06
R-NAW130-01900--0016	01	NCN 013 - Rockfill Materials Used in the Approach Wall Blocks	20-Apr-07
R-NAW130-01900--0017	01	NCN 012 - Elevation of Approach Wall Block 27B	21-Dec-06
R-NAW130-01900--0018	01	NCN 014 - No Pull Out Testing was Performed on Swellex Rock Dowels	26-Nov-07
R-NAW130-01900--0020	01	NCN 016 - Location of Dewatering Shaft No. 1	28-Mar-08
R-NAW130-01900--0021	03	NCN 017 - Tunnel Dewatering Pipe Station 0+235 to Station 0+200	19-Aug-13
R-NAW130-01900--0022	03	NCN 018 - Tunnel Dewatering System - Dewatering Pipe from Station 0+200 to Station 0+165	19-Aug-13
R-NAW130-01900--0023	01	NCN 020 - Location of Dewatering Shaft No. 5	30-Apr-08
R-NAW130-01900--0024	01	NCN 019 - Bottom Steel of Outlet Slab Placed at 0+000.666	16-Apr-08
R-NAW130-01900--0025	01	NCN 021 - Tunnel Shotcrete	11-Jun-08
R-NAW130-01900--0026	00	NCN 022 - Location of Tunnel Dewatering Shafts 2, 3 and 4	6-Jul-08
R-NAW130-01900--0027	01	NCN 023 - Outlet Structure Bottom Slab	28-Jul-08
R-NAW130-01900--0028	03	NCN 024 - Tunnel Dewatering System - Shafts 4 and 5	9-Oct-08
R-NAW130-01900--0029	01	NCN 025 - Tunnel Dewatering System - Site Welding Procedure	10-Oct-08
R-NAW130-01900--0030	03	NCN 026 - Tunnel Dewatering System - Dewatering Pipes	17-Oct-08
R-NAW130-01900--0031	02	NCN 027 - Diversion Tunnel Shotcrete - Testing Not Performed	28-Oct-08
R-NAW130-01900--0032	00	NCN028 - First Load of Shotcrete Sampled at Batch Plant Instead of at Inlet	22-Jan-09
R-NAW130-01900--0033	02	NCN 029 - High Slumps in 5 Concrete Loads During Placement of the Bay 2	3-Mar-09
R-NAW130-01900--0034	01	NCN 030 - Improper Consolidated of Concrete & Non Conforming Concrete in Bay 2	6-Mar-09
R-NAW130-01900--0035	01	NCN 031 Notice - Average 28 Days Compressive Strength for Set 2 for Bay 2 is 29.4 Mpa	6-Apr-09
R-NAW130-01900--0036	01	NCN 032 - Non Conforming Concrete for Tunnel Invert Final Lining Concrete Bays 2, 4, 6, 11, 16, 20, 30 & 34	8-May-09
R-NAW130-01900--0037	01	NCN 033 - Tunnel Dewatering System, Outfall Structure, Low Concrete Cover Over Reinforcing Steel	13-May-09
R-NAW130-01900--0038	01	NCN 034 - Damage to Installed Waterproofing Membrane	17-Feb-12
R-NAW130-01900--0040	01	NCN 035 - Dewatering Shafts Foundation & Slab (Concrete Reinforcement)	20-Aug-09
R-NAW130-01900--0045	01	NCN 038 - Concrete Temperature	30-Jan-13
R-NAW130-01900--0046	02	NCN 039 - Crack in Intake Structure Slab Pour 1	10-Dec-09
R-NAW130-01900--0047	01	NCN 037 - Dome Washer	30-Jan-13
R-NAW130-01900--0048	01	NCN 040 - Improper Consolidation of Concrete in Invert Bay No. 295	30-Jan-13
R-NAW130-01900--0049	01	NCN 043 - Intake Structure Pour 2A by Dufferin Construction	11-Jun-10
R-NAW130-01900--0050	01	NCN 036 - Final Lining Invert Concrete Bay 162	14-Sep-09
R-NAW130-01900--0051	00	NCN 042 - Tunnel Lining Bay 109	24-Jun-10
R-NAW130-01900--0052	01	NCN 044 - Arch Lining Concrete	7-Dec-10

NCN REGISTER

Report Number	Rev	Document Title	Date Issued
R-NAW130-01900--0053	01	NCN 045 - Premature Deterioration of Precast Blocks at Intake Approach Wall & Pier 1 Extension	16-Mar-11
R-NAW130-01900--0054	02	NCN 046 - Final Lining Arch Concrete Bays 6, 14 and 32	24-Mar-11
R-NAW130-01900--0055	02	NCN 047 - Final Lining Arch Concrete Bays 41, 46, 51 and 55	24-Mar-11
R-NAW130-01900--0056	02	NCN 048 - Final Lining Invert Concrete Bays	24-Mar-11
R-NAW130-01900--0057	01	NCN 049 - Final Lining Invert Bays 494 and 502; Final Lining Arch Concrete Bays 68 and 70	24-Jun-11
R-NAW130-01900--0058	02	NCN 050 - Final Lining Invert Bay 447 Placed on 20-Sep-10	30-Jan-13
R-NAW130-01900--0059	01	NCN-051 - Invert Lining Concrete - Bay 422	24-Feb-11
R-NAW130-01900--0060	01	NCN 052 - Final Lining Arch Concrete Bay 142	15-Mar-11
R-NAW130-01900--0061	01	NCN053 Interface Grouting Connections in Nine Final Lining Concrete Bays	1-Jun-11
R-NAW130-01900--0062	01	NCN054 Final Lining Concrete Bays	1-Jun-11
R-NAW130-01900--0063	01	NCN055 - Final Lining Concrete Bays	8-Jun-11
R-NAW130-01900--0064	01	NCN056 - Longitudinal Cracks in Concrete at Invert Bays	9-Jun-11
R-NAW130-01900--0065	00	NCN 058 - Outlet Structure Pour 3	22-Jun-11
R-NAW130-01900--0066	01	NCN057 - Final Lining Concrete Bays	9-Jun-11
R-NAW130-01900--0067	01	NCN059 - Outlet Structure Pour 6	23-Jun-11
R-NAW130-01900--0068	00	NCN060 Additional Tunnel Support	7-Nov-11
R-NAW130-01900--0069	01	NCN062 Final Lining Concrete Bays	1-Mar-12

Filed: 2016-10-26
EB-2016-0152
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Appendix 7

Quality Control Documents

QUALITY CONTROL DOCUMENTS

Report Number	Rev	Document Title	Date Issued
R-NAW130-29230--0013	00	Rock Bolts - Preconstruction Trial Report	26-Jul-06
R-NAW130-29230--0028	04	Convergence Monitoring	3-Oct-10
R-NAW130-29230--0040	00	Diversion Tunnel Interface Grouting Trial	15-Apr-08
R-NAW130-29230--0047	00	Tunnel Surveying Co-ordinates	n/a
R-NAW130-29230--0048	00	Axis Report Realignment	n/a
R-NAW130-29230--0081	01	Diversion Tunnel - Evaluation of Monitoring Results	19-Oct-12
R-NAW130-29230--0085	04	Evaluation of Monitoring Results Interface Grouting	31-Oct-12
R-NAW130-29230--0093	01	Diversion Tunnel - Evaluation of Monitoring Results; Interface Grouting Bays 099 to 200	5-Sep-12
R-NAW130-29230--0095	01	Diversion Tunnel - Evaluation of Monitoring Results; Interface Grouting Bays 201 to 300	10-Sep-12
R-NAW130-29230--0096	00	Diversion Tunnel - Evaluation of Monitoring Results; Interface Grouting Bays 301 to 400	11-Sep-12
R-NAW130-29230--0098	01	Diversion Tunnel - Evaluation of Monitoring Results Interface Grouting Bays 401 to 500	31-Oct-12
R-NAW130-29230--0099	00	Diversion Tunnel - Evaluation of Monitoring Results; Interface Grouting Bays 501 to 600	2-Nov-12
R-NAW130-29230--0101	00	Diversion Tunnel - Evaluation of Monitoring Results; Interface Grouting Bays 601 to 700 (CH7+512 to CH8+750)	13-Dec-12
R-NAW130-29230--0102	01	Testing Waterproofing Membrane	2-Feb-13
R-NAW130-29230--0104	00	Diversion Tunnel - Evaluation of Monitoring Results; Interface Grouting Bays 701 to 814 (CH8+737 to CH10+156)	26-Feb-13
R-NAW130-29700--0013	01	Intake Structure - Compressible Material Testing Report & Recommendations	5-Dec-13
R-NAW130-29230--0109 (previously submitted as R-NAW130-29800--0000-00)	00	Grout Pipes Test Report - Technical Requirements on Grout Pipes and Verification of the Materials	n/a
R-NAW130-29230--0106-01 (previously submitted as R-NAW130-61000--0001-00)	01	Extensometer Measurements	2-Oct-08
R-NAW130-01900--0081	00	ILF Site Review Reports - Observation of Works	2007 - 2009
R-NAW130-01900--0004	00	Non-Conformance Report - Steel Rebar Reinforcing Slipped While Pouring Concast Approach Wall Top Units	22-Aug-06
R-NAW130-01900--0001	12	Quality System Manual	20-Dec-10
R-NAW130-01900--0079	00	Shotcrete: Pre-Construction Trials	6-Jul-06
R-NAW130-00240--0000	00	Monthly Progress / Quality Review Report July 2006	2-Aug-06
R-NAW130-00240--0001	00	Monthly Progress / Quality Review Report August 2006	12-Sep-06
R-NAW130-00240--0002	00	Monthly Progress / Quality Review Report September 2006	4-Oct-06
R-NAW130-00240--0003	00	Monthly Progress / Quality Review Report October 2006	8-Nov-06
R-NAW130-00240--0004	00	Monthly Progress / Quality Review Report November 2006	6-Dec-06
R-NAW130-00240--0005	00	Monthly Progress / Quality Review Report December 2006	12-Jan-07
R-NAW130-00240--0004	01	Monthly Progress / Quality Review Summary of Revisions and Response to OR Comments November 2006 Report	7-Feb-07
R-NAW130-00240--0007	00	Monthly Progress / Quality Review Report January 2007	15-Feb-07
R-NAW130-00240--0001	08	Monthly Progress / Quality Review Summary of Revisions and Response to OR Comments December 2006 Report	6-Mar-07
R-NAW130-00240--0009	00	Monthly Progress / Quality Review Report February 2007	7-Mar-07
R-NAW130-00240--0010	00	Monthly Progress / Quality Review Report March 2007	4-Apr-07
R-NAW130-00240--0011	00	Monthly Progress / Quality Review Report April 2007	2-May-07
R-NAW130-00240--0012	00	Monthly Progress / Quality Review Report May 2007	1-Jun-07
R-NAW130-00240--0013	00	Monthly Progress / Quality Review Report June 2007	4-Jul-07
R-NAW130-00240--0014	00	Monthly Progress / Quality Review Report July 2007	8-Aug-07
R-NAW130-00240--0015	00	Monthly Progress / Quality Review Report August 2007	5-Sep-07
R-NAW130-00240--0016	00	Monthly Progress / Quality Review Report September 2007	5-Oct-07
R-NAW130-00240--0001	17	Monthly Progress / Quality Review Report October 2007	9-Nov-07
R-NAW130-00240--0001	18	Monthly Progress / Quality Review Report November 2007	10-Dec-07
R-NAW130-00240--0001	19	Monthly Progress / Quality Review Report December 2007	10-Jan-08
R-NAW130-00240--0001	20	Monthly Progress / Quality Review Report January 2008	12-Feb-08
R-NAW130-00240--0001	21	Monthly Progress / Quality Review Report February 2008	7-Mar-08

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R-NAW130-00240--0001	22	Monthly Progress / Quality Review Report March 2008	10-Apr-08
R-NAW130-00240--0001	23	Monthly Progress / Quality Review Report April 2008	8-May-08
R-NAW130-00240--0001	24	Monthly Progress / Quality Review Report May 2008	10-Jun-08
R-NAW130-00240--0001	25	Monthly Progress / Quality Review Report June 2008	7-Jul-08
R-NAW130-00240--0001	26	Monthly Progress / Quality Review Report July 2008	11-Aug-08
R-NAW130-00240--0001	27	Monthly Progress / Quality Review Report August 2008	5-Sep-08
R-NAW130-00240--0001	28	Monthly Progress / Quality Review Report September 2008	20-Oct-08
R-NAW130-00240--0001	29	Monthly Progress / Quality Review Report October 2008	7-Nov-08
R-NAW130-00240--0001	30	Monthly Progress / Quality Review Report November 2008	10-Dec-08
R-NAW130-00240--0001	31	Monthly Progress / Quality Review Report December 2008	12-Jan-09
R-NAW130-00240--0001	32	Monthly Progress / Quality Review Report January 2009	10-Feb-09
R-NAW130-00240--0001	33	Monthly Progress / Quality Review Report February 2009	11-Mar-09
R-NAW130-00240--0001	34	Monthly Progress / Quality Review Report March 2009	6-Apr-09
R-NAW130-00240--0001	35	Monthly Progress / Quality Review Report April 2009	14-May-09
R-NAW130-00240--0001	36	Monthly Progress / Quality Review Report May 2009	15-Jun-09
R-NAW130-00240--0001	37	Monthly Progress / Quality Review Report June 2009	10-Jul-09
R-NAW130-00240--0001	38	Monthly Progress / Quality Review Report July 2009	15-Aug-09
R-NAW130-00240--0001	39	Monthly Progress / Quality Review Report August 2009	15-Sep-09
R-NAW130-00240--0001	40	Monthly Progress / Quality Review Report September 2009	14-Oct-09
R-NAW130-00240--0001	41	Monthly Progress / Quality Review Report October 2009	16-Nov-09
R-NAW130-00240--0001	42	Monthly Progress / Quality Review Report November 2009	16-Jan-10
R-NAW130-00240--0001	43	Monthly Progress / Quality Review Report December 2009	1-Feb-10
R-NAW130-00240--0001	44	Monthly Progress / Quality Review Report January 2010	10-Feb-10
R-NAW130-00240--0001	45	Monthly Progress / Quality Review Report February 2010	15-Mar-10
R-NAW130-00240--0001	46	Monthly Progress / Quality Review Report March 2010 (incorrect SCI No. on report R-NAW130-00240--0016 was used for September 2007 Report)	29-Apr-10
R-NAW130-00240--0001	47	Monthly Progress / Quality Review Report April 2010	3-Jun-10
R-NAW130-00240--0001	48	Monthly Progress / Quality Review Report May 2010	8-Oct-10
R-NAW130-00240--0001	49	Monthly Progress / Quality Review Report June 2010	June 2010
R-NAW130-00240--0001	50	Monthly Progress / Quality Review Report July 2010	July 2010
R-NAW130-00240--0001	51	Monthly Progress / Quality Review Report August 2010	August 2010
R-NAW130-00240--0001	52	Monthly Progress / Quality Review Report September 2010	September 2010
R-NAW130-00240--0001	53	Monthly Progress / Quality Review Report October 2010	October 2010
R-NAW130-00240--0001	54	Monthly Progress / Quality Review Report November 2010	November 2010
R-NAW130-00240--0001	55	Monthly Progress / Quality Review Report December 2010	December 2010
R-NAW130-00240--0001	56	Monthly Progress / Quality Review Report January 2011	January 2011
R-NAW130-00240--0001	57	Monthly Progress / Quality Review Report February 2011	February 2011
R-NAW130-00240--0001	58	Monthly Progress / Quality Review Report March 2011	March 2011
R-NAW130-00240--0001	59	Monthly Progress / Quality Review Report April 2011	Apil 2011
R-NAW130-00240--0001	60	Monthly Progress / Quality Review Report May 2011	May 2011
R-NAW130-00240--0001	61	Monthly Progress / Quality Review Report June 2011	June 2011
R-NAW130-00240--0001	62	Monthly Progress / Quality Review Report July 2011	July 2011
R-NAW130-00240--0001	63	Monthly Progress / Quality Review Report August 2011	August 2011
R-NAW130-00240--0001	64	Monthly Progress / Quality Review Report September 2011	September 2011
R-NAW130-00240--0001	65	Monthly Progress / Quality Review Report October 2011	October 2011
R-NAW130-00240--0001	66	Monthly Progress / Quality Review Report November 2011	November 2011
R-NAW130-00240--0001	67	Monthly Progress / Quality Review Report December 2011	December 2011
R-NAW130-00240--0001	68	Monthly Progress / Quality Review Report January 2012	January 2012
R-NAW130-00240--0001	69	Monthly Progress / Quality Review Report February 2012	February 2012

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R-NAW130-00240--0001	70	Monthly Progress / Quality Review Report March 2012	March 2012
R-NAW130-00240--0001	71	Monthly Progress / Quality Review Report April 2012	Apil 2012
R-NAW130-00240--0001	72	Monthly Progress / Quality Review Report May 2012	May 2012
R-NAW130-00240--0001	73	Monthly Progress / Quality Review Report June 2012	June 2012
R-NAW130-00240--0001	74	Monthly Progress / Quality Review Report July 2012	July 2012
R-NAW130-00240--0001	75	Monthly Progress / Quality Review Report August 2012	August 2012
R-NAW130-00240--0001	76	Monthly Progress / Quality Review Report September 2012	September 2012
R-NAW130-00240--0001	77	Monthly Progress / Quality Review Report October 2012	October 2012
R-NAW130-00240--0001	78	Monthly Progress / Quality Review Report November 2012	November 2012
R-NAW130-00240--0001	79	Monthly Progress / Quality Review Report December 2012	December 2012
R-NAW130-00240--0001	80	Monthly Progress / Quality Review Report January 2013	January 2013
R-NAW130-00240--0001	81	Monthly Progress / Quality Review Report February 2013	February 2013
R-NAW130-00240--0001	82	Monthly Progress / Quality Review Report March 2013	March 2013
R-NAW130-00240--0001	83	Monthly Progress / Quality Review Report April 2013	Apil 2013
R-NAW130-00240--0001	84	Monthly Progress / Quality Review Report May 2013	May 2013
R-NAW130-00240--0001	85	Monthly Progress / Quality Review Report June 2013	June 2013
R-NAW130-00240--0001	86	Monthly Progress Final Quality Review Report	28-Oct-13
R-NAW130-29270--0029	00	COH History Docket for Intake/Outlet Gates (DT1906 04-Jul-12)	n/a

Filed: 2016-10-26
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Appendix 8

Reports, Papers and Articles

REPORTS PAPERS AND ARTICLES

Report Number	Technical Reports	Date Issued
R-NAW130-29230--0088-02	Diversion Tunnel - Analysis of Swelling Loads Below Invert	18-Dec-12
R-NAW130-29230--0090-02	Diversion Tunnel - Analysis of Swelling Loads Due to Pinhole	5-Feb-13
R-NAW130-29230--0092-01	Site Visit to CNP Wheel Pit Report	18-Dec-12
R-NAW130-29700--0023-00	Outlet Canal - Blast of Rock Plug	8-Apr-13
R-NAW130-10120--0045-00	Geotechnical Monitoring Reports	2009 - 2011
R-NAW130-10120--0046-00	Geotechnical Monitoring Interpretation of Readings	
R-NAW130-10120--0047-00	Geotechnical Monitoring Report General Statements	
R-NAW130-10120--0048-00	Geology Mapping Sheets	
R-NAW130-10120--0049-00	Geology Mapping Sheets Grout Tunnel	
R-NAW130-10120--0050-00	Intake Portal Transition	
R-NAW130-07000--0086-03	Building Permit Application for Permanent 2 Quonset Huts	7-Aug-13
R-NAW130-88400--0002-04	Plan for the Disposal of Surplus Goods	18-Jun-13
R-NAW130-15000--0001-04	Island Restoration - Checklist 4	8-Nov-13
R-NAW130-07000--0059-00	Compliance Monitoring Annual Report 2005	February 2006
R-NAW130-07000--0062-00	Compliance Monitoring Annual Report 2006	February 2007
R-NAW130-07000--0064-00	Compliance Monitoring Annual Report 2007	January 2008
R-NAW130-07000--0067-00	Compliance Monitoring Annual Report 2008	April 2009
R-NAW130-07000--0102-00	Compliance Monitoring Annual Report 2009	April 2010
R-NAW130-07000--0104-00	Compliance Monitoring Annual Report 2010	April 2011
R-NAW130-07000--0111-00	Compliance Monitoring Annual Report 2011	n/a
R-NAW130-07000--0113-00	Compliance Monitoring Annual Report 2012	n/a
R-NAW130-07000--0114-00	Compliance Monitoring Annual Report 2013	December 2013
R-NAW130-07000--0038-20	Application for Amendment Regarding CofA 4773-89XSHS Industrial Sewage Works	August 2013
R-NAW130-29230--0025-00	Application of the Swelling Law in the FE-calculations	
R-NAW130-29230--0012-01	Diversion Tunnel Structural Design Analysis of Initial Lining and Excavation Support	
R-NAW130-07000--0008-00	Environmental Assessments and Approvals and Third Party Information	March 2005
R-NAW130-07000--0089-00	Community Impact Agreement (CIA) and Amendments	

Publication	Magazine Articles	Date
Tunnels & Tunnelling	Exploratory Adit for Niagara River Hydroelectric Development	May 1995
International Water Power and Dam Construction	Ontario Hydro to Build New Niagara Tunnel	July 1998
International Water Power and Dam Construction	Adam Beck Expansion to Proceed	December 2002
International Water Power and Dam Construction	Niagara Tunnelling Plan Cleared	July 2004
International Water Power and Dam Construction	New Tunnel For Niagara Falls	August 2005
Planning Niagara	Province and Ontario Power Generation Launch Major New Energy Project	Autumn 2005
International Water Power and Dam Construction	Niagara's New Addition	September 2005
Tunnels and Tunnelling International	Work Starts for Niagara Tunnel	October 2005
Tunnels and Tunnelling International	Niagara Job Falls for Robbins TBM	November 2005
Canadian Tunnelling Magazine	Sir Adam Beck Generating Complex Expansion	2006
Hydropower & Dams	Progress at the New Niagara Tunnel Facility Project	Issue 6 2006
Popular Science	The Tunnel Monster	April 2006
ENR	Giant TBM Will Cut Through Hard Rock to Niagara Falls	July 2006
ENR	Tunneling to the Falls	July 2006
International Water Power and Dam Construction	TBM Assembled at Niagara Tunnel	August 2006
Tunnels & Tunnelling International	Niagara TBM on Time	August 2006

REPORTS PAPERS AND ARTICLES

Publication	Magazine Articles	Date
Tunnels & Tunnelling International	Large Scale Success	September 2006
Tunnelling & Trenchless Construction	Canada Launches World's Largest Hard-Rock TBM; ROWA Back-Up for Giant Hard-Rock TBM	September 2006
Tunnels & Tunnelling North America	Mega TBM Ready to Roll	December 2006
Tunnels & Tunnelling North America	Niagara Plan of Attack	December 2006
The Ontario Technologist	New Precast Concrete Box Technique Holds Promise for Other Applications	November/ December 2006
International Water Power and Dam Construction	Synchronized Tunnelling at Niagara	May 2007
Tunnel Business	Full Speed Ahead – World's Largest Rock TBM Advances Niagara Tunnel	June 2007
Tunnelling and Underground Construction	New Tunneling Innovations Revolve Around More Efficient Disc Cutters	September 2007
International Water Power and Dam Construction	Ontario Power Hydro Output up 6% in Q3	November 2007
Tunnel Business	Manufacturing Change – A Perspective on the Latest Development in TBM Design	April 2008
Tunnel Business	Niagara Tunnel Project May Be Delayed	April 2008
Tunnelling and Underground Construction	World's Largest TBM Keeps Niagara Project on Track	June 2008
Tunnelling and Underground Construction (T&UC)	Progress at Niagara Tunnel Project	June 2008
Tunnel Business	Take a Good Long Look – Geotechnical Investigation and its Place in Tunneling	August 2008
Tunnel Business	TBM Roundtable Design-Build	August 2008
Tunnels & Tunnelling International	Beating the Clock – On-Site First Time Assembly	September 2008
Ontario Professional Surveyor	Overview of the Niagara Tunnel Facility Project and Surveying Activities	Winter 2008
Geomechanics and Tunnelling	TBM Modification for Challenging Rock Conditions – A Progress Report of the Niagara Tunnel Project	2009
Tunnelling and Underground Construction	Current State of Disc Cutter Design and Development Directions	March 2009
International Water Power and Dam Construction	New Tunnel to Optimize Hydro Potential at Niagara	May 2009
Inform, Strabag Magazine	Gigantic in a New Dimension, Niagara Tunnel Facility Project	May 2010 Issue 19
Canadian Tunnelling Magazine	Overcoming Water Inflow Issues at Sir Adam Beck 1 Generating Station	2011
Canadian Consulting Engineer	Massive Niagara Project Sees End of Tunnel	January 2011
International Water Power and Dam Construction	Nearing Breakthrough at Niagara	February 2011
International Water Power and Dam Construction	Big Becky Breaks Through at Niagara Tunnel Project	May 2011
Niagara Magazine	The Biggest Drill on Earth	May/June 2011
TBM: Tunnel Business	Serious Tunneling Power	August 2011
International Water Power and Dam Construction	TBMs Take Center Stage	September 2011
Niagara This Week	The Wide Hole World	January 2012
International Water Power and Dam Construction	Construction Milestone for Niagara Tunnel Project	January 2012
Canadian Consulting Engineer	Niagara Tunnel Project	January/ February 2012
Tunnelling and Underground Construction	2012 Fox Conference Turns its Focus to International Projects	March 2012
Canadian Geographic	Niagara Power – An Epic Tunnel Project to Tap the Flow from the Falls	April 2012
Canadian Consulting Engineer	Pumped Power – Future Hope	May 2012

REPORTS PAPERS AND ARTICLES

Publication	Magazine Articles	Date
On-Site Magazine	Lining Ontario Homes with Power – Cast-in-Place Concrete Liner Vital Piece of Puzzle for Niagara Tunnel Project	June 2012
Canadian Manufacturing	Niagara Tunnel Project Nears Completion	November 2012
Civil Engineering	New Tunnel Will Boost Canada's Hydroelectric Capacity	June 2013
International Water Power and Dam Construction	North America: Project of the Year – Niagara Tunnel Project	June 2013
World Tunnelling	Continuing the Niagara Legacy	October 2013

Appendix 9

Warranties

WARRANTIES

Report Number	Rev	Document Title	Date Issued
R-NAW130-29270--0028	00	COH Warranty - WO3000 Outlet: Gate, Embedded Parts, Hoist, Hoist Shelter, Towers Outlet Service: Embedded Parts Intake: Stoplogs, Embedded Parts, Follower Beam, Guide Structures, Guide Structure Embedded Guides, Footbridge, Hole Covers	11-Feb-13
R-NAW130-62900--0005	00	LEFM 880 Series Ultrasonic Flowmeter	15-Oct-13
		Strabag Warranty (as per ADBA section 9)	

Filed: 2016-10-26
EB-2016-0152
Exhibit L, Tab 4.3
Schedule 2 AMPCO-054
Attachment 1

Appendix 10

Transfer of Control Documents

TRANSFER OF CONTROL DOCUMENTS

Document Number	Document Title	Date Issued
NAW130-00181-0001	Transfer of Operating Control - Package 1 Water Conveyance	9-Mar-13
	Transfer of Operating Control - Package 2 Outlet Gate and Hoist	9-Mar-13
	Transfer of Operating Control - Package 3 Intake Site	25-Sep-13
	Transfer of Operating Control - Package 4 Outlet Site	24-Nov-13
	Transfer of Operating Control - Package 5 Strabag Outlet Site Office Area and Access Road and Gate	19-Dec-13
	Transfer of Operating Control and Turnover of Equipment - Remove PGS Dewatering Structure Down to Canal Bottom	12-Aug-11
	Transfer of Operating Control - Construction of Tunnel Intake Upstream of ICD Gate 1	22-Oct-07
	Transfer of Operating Control - Construction of New Ice Accelerating Wall at INCW	21-Sep-07
	Transfer of Control/Turnover of Equipment - Niagara Plant Group Main Domestic Watermain	20-Nov-05

Appendix 11

Testing and Commissioning and Operating & Maintenance Manuals

TESTING AND COMMISSIONING
OPERATING AND MAINTENANCE MANUALS

Report Number	Rev	Document Title	Date Issued
R-NAW130-29270--0019	00	Intake Gate Dry Test Procedure	5-Nov-12
R-NAW130-29270--0021	00	Intake Gate Dry Test Results	25-Jan-13
R-NAW130-29270--0020	01	Final Inspection and Acceptance Test Procedure (Commissioning Plan for Outlet Gate)	27-Jan-13
R-NAW130-02700--0006	02	Hydraulic Testing of Outlet Gate	21-Mar-13
R-NAW130-29270--0036	00	Tunnel Dewatering Study (ID038)	May 2007
R-NAW130-29230--0115	00	Tunnel Lining - Pre Water-up Acceptance Criteria and Inspection	Sept 2013
R-NAW130-26500--0009	05	Pre-Waterup of Intake Area Checklist 1	17-Nov-12
R-NAW130-29700--0021	01	Pre-Waterup of Outlet Canal Area Checklist 2	6-Feb-13
R-NAW130-29230--0103	01	Pre-Waterup of Tunnel Checklist 3	3-Mar-13
R-NAW130-29270--0026	00	Intake Stop Logs Allowable Leakage Test	5-Feb-13
R-NAW130-29270--0027	00	Outlet Gate Allowable Leakage Test	5-Feb-13
R-NAW130-62900--0002	02	Method Statement - Flow Verification Test	23-Jul-13
R-NAW130-62900--0003	02	Flow Verification Tests Final Results	20-Sep-13
R-NAW130-86000--0004	00	ESA Inspection Certification of Outlet Hoist Tower	12-Nov-13
R-NAW130-29270--0022		Intake Gate- O&M Manual Mechanical Technical Files and Drawings	March 2014
R-NAW130-29270--0018		Outlet Structure Gate Hoist O & M Manual	March 2014
R-NAW130-62900--0004	01	LEFM 880 Series Ultrasonic Flowmeter Transmitter User Manual & Installation Procedure and Work Plan	3-Feb-14
R-NAW130-29230--0108	00	Shape Array Accelerometers - Installation, O&M Manual	15-Jan-14

Appendix 12

Environmental Permits

ENVIRONMENTAL PERMITS

Appendix 10

AGENCY	PERMIT/APPROVAL	DATE ISSUED	EXPIRY DATE	STATUS	COMMENTS
FEDERAL					
DFO	Fisheries Act Authorization (Amendment 5)(5250-43) (Consolidation of Authorizations under Sec 32 and Sec 35 of the Act)	25-Nov-11	31-Dec-15	Closed 07-Oct-13	DFO confirmed 07-Oct-13 all Conditions of the Fisheries Authorization had been met and the File was closed
Tranport Canada, CCG	Navigable Waters Protection Act – Approval under Sec 10(2) to alter a Diversion	28-Dec-05		Closed	Plans approved 31-Aug-99 under Sec 5(2) by DFO, subsequent approval by Transport Canada under Sec 10(2) of the Act; OPG issued letter to close CCG file # 8200-90-7303 09-Apr-13
PROVINCIAL					
MOE	Permit to Take Water – Outlet Channel (0153-8HVLCD)	16-Aug-11	31-Dec-13	Cancelled	Permit revoked 13-Nov-13
MOE	Permit to Take Water – Tunnel Sump (7027-8HVKRK)	16-Aug-11	13-Dec-13	Open	Request to revoke submitted 16-Oct-13
MOE	Permit to Take Water – Cofferdam (7730-75HKQC)	27-Jul-07	13-Dec-13	Cancelled	Permit revoked 13-Apr-13
MOE	Amended Environmental Compliance Approval 2215-8X5LMC (Sec 20.2 of Part II.1 of EPA) for Batch Plant and Diesel Generators	15-Aug-12		Revoked	ECA revoked 16-Oct-13
MOE	Certificate of Approval (Industrial Sewage Works) (4773-89XSHS) and Notices 1 and 2	08-Nov-10 Notice 1, 27-Jul-11 Notice 2, 10-Nov-11		Open	Semi-Annual report for period Jul to 31-Dec-13 submitted to MOE Niagara District Office 21-Oct-13 (all effluent monitoring requirements and reporting for 2013 completed). Submission to Amend this C of A and Notices 1 and 2 submitted to MOE 23-Aug-13, included request to change ownership to OPG
MNR	LRIA Work Permit Construction of Approach Wall Stage 1 and Demolition and construction of Accelerating Wall and Dock Stage 2	15-Mar-06	31-Dec-15	Expires 31-Dec-15	Submission 25-Jun-13 of signed affidavits by Design Professionals that Work constructed in accordance with their designs. MNR Confirmed 02-Oct-13 all Conditions on Work met and Permit will be allowed to expire
MNR	LRIA Work Permit Construction of Intake Channel (In-Water Blasting and Excavation) Stage 3	11-Apr-06	11-Apr-08	Expired	Submission 25-Jun-13 of signed affidavits by Design Professionals that Work constructed in accordance with their designs. MNR Confirmed 02-Oct-13 all Conditions on Work met and Permit will be allowed to expire
MNR	LRIA Work Permit Installation and Removal of Cofferdam Stage 4a	2-Jun-06	31-Dec-15	Expires 31-Dec-15	Cofferdam filled with water 15-Nov-12, and cofferdam removal commenced 20-Nov-12. Permit will be allowed to expire
MNR	LRIA Work Permit Installation and Removal of Ice Groyne Stage 4b	20-Nov-06	31-Dec-15	Expires 31-Dec-15	Ice groyne removal completed 03-Mar-13. Permit will be allowed to expire
MNR	LRIA Work Permit Pier 2 Extension Stage 5a (GU N 69	26-Apr-07	1-May-09	Expired	Submission 25-June-13 of signed affidavits by Design Professionals that Work constructed in accordance with their designs. MNR Confirmed 02- Oct-13 all Conditions of Work met and Permit will be allowed to expire
MNR	LRIA Work Permit Intake Channel – Dry Blasting and Excavation Stage 5b (STF 0039)	11-Jul-07	1-Oct-09	Expired	Submission 25-June-13 of signed affidavits by Design Professionals that Work constructed in accordance with their designs. MNR Confirmed 02-Oct-13 all Conditions of Work met
MNR	LRIA Work Permit – Construction Intake Structure – Stage 5c	10-Sep-09	30-Sep-12	Expired	Submission 25-Jun-13 of signed affidavits by Design Professionals that Work constructed in accordance with their designs. MNR Confirmed 02-Oct-13 all Conditions of Work met
MNR	LRIA Work Permit – Construction Pier 1 Extension – Stage 5d (GU-N-82)	23-Aug-10	26-Aug-12	Expired	Submission 25-Jun-13 of signed affidavits by Design Professionals that Work constructed in accordance with their designs. MNR Confirmed 02-Oct-13 all Conditions of Work met
MUNICIPAL					
RMON	Entrance Permits to CH3+369 and CH5+318 (concrete drop shaft location)	01-Mar-10 20-Sep-10 14-Mar-12		Closed	Inspected entrances 11-Sep-13 and no issues identified
NF	Occupancy Permit for CH8+002 (concrete drop shaft location)	24-Aug-11		Revoked	Revoked by City 02-Jul-13. Restoration and conditions addressed to satisfaction of the City

Appendix 13

Project Management Documents

PROJECT MANAGEMENT DOCUMENTS

Report Number	Rev	Document Title	Date
R-NAW130-00700--0001	00	CCB Recommendations	2006 - 2013
NAW130-08621.31-0001		NPG Memorandum of Understanding	
NAW130-08701.01-0001		NTP Budget Transfer Authorizations	
R-NAW130-29200--0001		Niagara Tunnel Project - Overview of Asset Turnover	13-Feb-13
NAW130-08132--0001		Niagara Tunnel Project - Disposal of Surplus Goods Strategy	June 2013
M-NAW130-08132--0001		Policies and Procedures	May 2012
R-NAW130-00121--0001	00	The Niagara Tunnel Project Execution Plan (PEP)	8-Apr-05
R-NAW130-00121--0001	01	The Niagara Tunnel Project Execution Plan (PEP)	27-Mar-06
R-NAW130-00121--0001	02	The Niagara Tunnel Project Execution Plan (PEP)	September 2010
R-NAW130-00121--0001	03	The Niagara Tunnel Project Execution Plan (PEP)	January 2013
NAW130-00120-0001		Project Charter (Project ID - EXEC0007-R01)	23-Dec-05
R-NAW130-01900--0041	00	Niagara Tunnel Project OPG Risk Management Plan	20-Mar-06
R-NAW130-01900--0041	01	Niagara Tunnel Project OPG Risk Management Plan	10-May-07
R-NAW130-01900--0041	02	Niagara Tunnel Project OPG Risk Management Plan	15-May-08
R-NAW130-01900--0041	03	Niagara Tunnel Project OPG Risk Management Plan	12-Aug-08
R-NAW130-01900--0041	04	Niagara Tunnel Project OPG Risk Management Plan	April 2012
R-NAW130-00400--0012	00	Request for Disposals (RFD001 to RFD008)	2011 - 2013
R-NAW130-00400--0013	00	Request for Expenditures (RFE001 to RFE094)	2009 - 2013

AMPCO Interrogatory #55

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-2 Page 5

Preamble: The evidence states that "….all major contracts required to execute the DRP scope were awarded."

a) Please confirm all major contract agreements have been signed and approved by all parties.

b) Please explain if there have been any further amendments to these contracts to date.

Response

a) All major contract agreements set out in Ex. D2-2-3, Chart 2, have been signed and approved by all parties.

b) OPG's prefiled evidence included contract summaries that set out the amendments as of May 6, 2016 to the major contracts (see: Ex. D2-2-3, Attachments 1 to 5). As of October 25, 2016, the following additional amendments have executed:

- Amendment 6 with for the Retube and Feeder Replacement Engineering, Procurement and Construction (EPC) Contract with the SNC/AECON Joint Venture
- Amendment 2 for the Turbine Generators Engineering Services and Equipment Supply Contract with Alstom
- Amendment 2 for the Turbine Generators EPC Contract with the SNC/AECON Joint Venture
- Amendment 3 for the Extended Services Master Services Agreement with E.S. Fox Limited
- Amendment 3 for the Extended Services Master Services Agreement with Black & Macdonald Limited

AMPCO Interrogatory #56

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-4 Page 2 Figure 1

a) Please provide the costs for F&IP and Refurb Support Facilities Projects separately.

Response

a) The costs for F&IP and the Refurb Support Facilities Projects are $484M and $17M respectively, as shown in Ex. D2-2-8, Attachment 1, p. 29, Table C1.

AMPCO Interrogatory #57

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-4 Page 6

Preamble: The evidence states "OPG has a high degree of confidence in its schedule for the RFR work bundle."

a) Please provide the confidence level on the reliability of the tooling.

b) Please provide the percentage of customized tools. (i.e. tool not used in any other refurbishment.

c) Please provide the percentage of tools that are First of A Kind (FOAK).

d) Please list the tools that are FOAK and if they will be used in the actual refurbishment project or will be used in other building or processes, i.e. waste processing.

Response

a) OPG cannot provide a specific percentage for the confidence level in the reliability of the tooling. OPG's high degree of confidence in the reliability of the Retube and Feeder Replacement (RFR) tooling is based on the fact that, with very few exceptions, all tooling is an iteration of reference designs used in prior refurbishment campaigns and the tooling has been tested on OPG's reactor mock-up.

b) The percentage of customized tools is >95%. Almost all tooling is customized for form, fit and function to accommodate the unique dimensions of a Darlington reactor. For example, while some of the tooling may be identical in function to a previous toolset used in other refurbishments, it required lengthening or widening for the Darlington units.

   A factor that led to customization was the incorporation of lessons learned and operating experience of the previous generation toolsets to eliminate any weaknesses and flaws for improved performance and reliability.

c) There is a small percentage of first-of-a-kind tools (<5%).

d) First-of-a-kind Tooling includes elements of the Waste Tooling System subsystems located in the Retube Waste Processing Building, such as the End Fitting Processing Cell, Fuel Channel Processing Cell, Hardware and Lidding Cell, and Trolley and Rails Cell. The tooling leveraged existing tooling components and controls components utilized in the Fuel Channel Removal tooling to the extent practicable.

In the reactor vault, there will be Automated Guided Vehicles which are used to transport flasks and equipment. These are first of a kind for a refurbishment application but widely used throughout the world.

AMPCO Interrogatory #58

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-5 Page 1

Preamble: The evidence indicates that the operating experience from each of the Pickering 'A' Return to Service project, the Pt. Lepreau refurbishment and various Bruce Power restart projects, where cost and schedule overruns were significantly driven by scope growth.

a) For each project, please provide the specific details of the cost and schedule overruns driven by scope growth/creep and explain how OPG has accounted for potential scope growth in the DRP.

Response

a) OPG conducted many benchmarking and lessons learned trips and other interactions with both Pt. Lepreau and Bruce Power, including having staff seconded to both stations. OPG documented all of these lessons learned in its RMO tool (see Ex. L-4.3-2 AMPCO-052 Attachment 3). The RMO tool is a live tool where staff can record lessons learned.

   OPG's lessons learned database is not set up in a manner that allows extraction of the specific details of the cost and schedule overruns driven by scope growth/creep as contemplated by the question. Rather, all lessons learned from a particular interaction, field trip, conference attendance, etc, are documented in the database in one entry. Below is an example of one such entry in the RMO database for Bruce Power (see Ex. L-04.3-2 AMPCO-053 Attachment 3, entry no. 00001997, p. 62).

   > "Many lessons and recommendations came out of this presentation: Control the transition between layup and startup. The time period for this transition should be minimalised. Ensure technical drawings always represent reality. Check this using field assessments/inspections, and ensure they are done early. Keep your regulator updated and get them involved early. Make sure important decisions are well documented and there is a basis for decision making. The ISR (Integrated Safety Review) should be done early. Integrate documents into a governance whole, and make sure they reference and link to one another: processes have to be aligned. Specify baseline performance of components: use tests to do this. Think about what information you will want 10

years from now when the system breaks. Don't forget about commissioning plans. Engage station staff and those with specialist skills when needed."

OPG's staff and management have taken all of this information from Bruce Power, Pt. Lepreau and other stations and megaprojects and distilled it into key lessons learned, as documented in Ex. D2-2-4, p. 4 Chart 1.

The Pickering 'A' Return to Service (PARTS) project is dissimilar to the Darlington Refurbishment Program in that PARTS was not a refurbishment of a unit, but a restart (see Ex. L-4.3-1 Staff-052). For the PARTS project, which was completed in 2005, it would require a significant amount of effort to analyze and compare the initial scope for the PARTS project against the actual scope executed. This type of detailed comparison would be of limited value given the differences in scope between the two projects. There were two key lessons learned pertaining to scope from the PARTS project: (i) complete the regulatory process well in advance to establish regulatory scope (at PA RTS, the Environmental Assessment was not completed until after project start), and (ii) complete the detailed design engineering in advance of project start. For the DRP, the Environmental Assessment, the Integrated Safety Review and the Integrated Implementation Plan, which are all regulatory submissions which helped to clarify the regulatory scope, were completed well in advance of the planned start of execution, and complete the engineering in advance of the start of execution for Unit 2.

OPG has applied the lessons learned regarding scope growth and scope creep from all of the projects it has reviewed by implementing an extensive Definition Phase planning effort over a period of six years, involving all aspects of the project and applying lessons learned, not only in the area of scope, but on many fronts, as described in Ex. D2-2-4, pp. 3 to 6.

In Ex. D2-2-5, OPG describes its process for identifying and defining the scope of the work, including: (i) the steps taken by OPG during the Definition Phase to identify and define the scope of the DRP, in particular, the work to be performed on Unit 2; (ii) the completion of the engineering, and (iii) the resulting scope of work identified for each of the major work bundles.

Specifically with respect to the avoidance of scope creep, Ex. D2-2-5, p. 2, Figure 1 depicts the screening processes which the initially identified scope was subjected to before the final scope of the DRP was determined (i.e. Initial Scope Screening, Regulatory Review, Cost/Benefit Analysis, Initial Component Condition Review followed by the Blue Ribbon Review, further Regulatory Review and further Component Condition Review). In addition, OPG describes its rigorous and multi-level Change Management Process in Ex. D2-2-9, p. 6, D2-2-9, Attachment 1. OPG's Change Management process is described in Nuclear Refurbishment - Program Change Management N-MAN-00120-10001-PC-12, provided in Ex. L-4.3-1 Staff-48, Attachment 27 and in Ex. L-4.3-15 SEC-038.

AMPCO Interrogatory #59

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-5 Page 1

Preamble: The evidence states "…having a detailed definition of scope enables OPG and its contractors to take the necessary steps to ensure completion of all corresponding engineering in advance of unit execution, and to secure necessary parts, tools, labour and craft resources to support the schedule."

a) Please confirm that within the Definition Phase all of the Unit 2 contractors have confirmed they have all the necessary labour, equipment, materials, tools, parts and craft resources to complete and support the schedules.

Response

a) Confirmed. During the Definition Phase, all of the Unit 2 equipment, materials, tools and parts were identified, ordered and in many cases have been delivered. The balance of the equipment, materials and parts will be available before they are required in the field. The labour and craft resources required to successfully execute the field work in accordance with the schedule have been specified. Resources will be available when required to complete the field work to successfully execute in accordance with the schedule. Resource quantity and type will vary depending on what work is being executed at any given point during the refurbishment. OPG and the vendors have worked with the EPSCA trade unions to confirm that adequate trades of all types will be available.

AMPCO Interrogatory #60

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-5 Page 4

a) Please confirm the current scope of the DRP has not changed since June 1, 2015.

Response

a) Exhibit D2-2-5, p. 4, Figure 1 notes that there were 340 Darlington Scope Requests (DSRs) in June 2015 and included in the RQE.

There have been no material changes in the DRP scope since approval of the RQE.

The count of approved DSRs within the Darlington Refurbishment Program has increased by 4, totaling 344 DSRs as of August 1, 2016 when the number of DSRs was reassessed. This increase is largely a result of scope refinement as opposed to growth. Only 1 DSR, for the Refurbishment Project Office Trailer Complex, is considered new scope. This scope addition does not have a material impact on the overall cost and schedule estimate for the Darlington Refurbishment Program.

AMPCO Interrogatory #61

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-5 Pages 4-5

a) Of the 340 Scope Requests within the DRP Scope, 40% include engineering modifications. Please categorize the remaining Scope Requests.

b) Please provide the % of Scope Requests assigned to each of the five major work bundles.

c) Please provide the % of the 560 specific projects (when applied to the four units) that need to be completed directly for Unit 2.

Response

a) As of August 1, 2016, the count of approved Darlington Scope Requests (DSRs) within the DRP has increased by four since June 1, 2015, and totals 344 DSRs. Please see L-4.3-2 AMPCO-060 for details on the variance. Of these 344 DSRs, 40% require engineering modifications. The remaining 60% of DSRs do not require engineering modifications. Examples include replacement of an existing valve with a new valve of the same make/model, or refurbishment of an existing component.

b) The % of scope requests assigned to the five major bundles are:

- Retube & Feeder Replacement (5%)
- Turbine Generator (19%)
- Balance of Plant (50%)
- Fuel Handling & Defueling (5%)
- Steam Generator (2%)

The remaining 19% of scope requests are assigned to functional groups, the Safety Improvement Opportunities and the Facilities & Infrastructure Projects, or non-refurbishment funded groups who have been approved to perform work during the Unit 2 refurbishment.

c) As of August 1, 2016, there were 561 specific projects of which 23% are for Unit 2. This includes work for the five major work bundles, as well as the Safety Improvement

Opportunities, Facilities & Infrastructure Projects, and non-refurbishment funded projects that have been approved to perform work during the Unit 2 refurbishment. The current number of projects funded by the Darlington Refurbishment Program is 501, as described in L-4.3-2 AMPCO-033, of which 24% need to be completed directly for Unit 2.

AMPCO Interrogatory #62

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-2 Page 5

a) Please explain the process OPG uses to determines which SIO and F&IP projects are part of the DRP.

Response

a) Please refer to Ex. L-4.3-1 Staff-8 and Ex. L-4.5-2 AMPCO-105.

AMPCO Interrogatory #63

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-5 Pages 7-9

a) Please confirm the delivery of all tool sets by mid-2016.

b) If any tools have not been delivered, please provide a list of tools required and the scheduled delivery dates.

c) Please discuss the delivery schedule against plan of long lead materials including pressure tubes, calandria tubes, fuel channel end fitting assemblies, feeders and retube waste containers ordered for Unit 2.

d) Please confirm the date the Retube Waste Processing Building will be available and completed.

Response

a) All planned toolsets as per original scope were delivered by mid-2016 to the Darlington Energy Complex with few exceptions.

b) The exceptions to part a) are:

- **Waste Tooling System**: As of October 11, 2016, the system is at a company in Cambridge, Ontario. The testing of the tooling was successfully completed in Q2 2016; however, OPG directed the contractor to perform a series of rehearsal trials on the tooling system to reduce risks associated with the tooling. This was successfully completed in September 2016. The toolset will now be dismantled and shipped to the Darlington site for assembly in Q4 2016 to Q1 2017 as per the schedule to coincide with Retube Waste Processing Building construction.
- **Annulus Spacer Retrieval Tooling**: The Retube and Feeder Replacement contractor was contracted in 2014 to retrieve 24 Annulus Spacers to support OPG Nuclear Engineering Major Components Aging Management. This tooling is scheduled to be delivered in December 2016.
- **In-Station Flask Transfer Route**: The Retube and Feeder Replacement contractor was contracted in 2015 to procure tooling to allow for flask and material transfer inside

the station from any reactor unit to the Retube Waste Processing building. This is scheduled for delivery in Q4 2016.

- **Accessibility Platform Trolley**: As part of the Bulkhead Installation scope, a trolley is being built and delivered in Q4 2016.
- **Pressure Test Cart**: In 2015, the Retube and Feeder Replacement project identified the need for a Pressure Test Cart to be fabricated to meet the requirement not to utilize equipment from the operating station to pressurize the heat transport system. A specification has been prepared to allow for fabrication and testing in 2017 to allow for delivery in Q4 2017 to Q1 2018.

c) With respect to long lead materials delivery, the contract calls for all reactor material for the first unit (Unit 2) to be on site September 15, 2017. None of the delivery dates below are impacting installation need dates at this time:

- **Pressure Tubes**: On Track.
- **Calandria Tubes**: On Track.
- **End Fittings**: On Track.
- **Channel Closures**: Q2 2018. Purchase order was issued later than others because of design changes.
- **Annulus Spacers**: Q3 2017. Trending one month late on September 15, 2017 milestone.
- **Feeders**: Q3 2018. Delays due to first of a kind nature of the new material composition of the flow element material requiring new process qualification for welding and machining.
- **Retube Waste Containers**: Q1 2018. First of a kind container resulted in many design dispositions prior to completion of manufacturing of the first prototype container. Production rates are good now that design issues have been addressed.

d) The target dates for the Retube Waste Processing Building (RWPB) are as follows:

- RWPB Available For Use – Substantial Completion: June 15, 2017
- RWPB Work Complete: July 31, 2017

AMPCO Interrogatory #64

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-6 Page 5

Preamble: The evidence states "OPG also evaluated risks and uncertainties for each segment of the schedule, and determined the amount of contingency required to deliver the Unit 2 refurbishment in consideration of the risks and uncertainties evaluated. This resulted in the production of a schedule that includes contingency for certain schedule risks that may be encountered during the execution of the refurbishment outages. Through probabilistic analysis, OPG expects to execute the Unit 2 refurbishment within this schedule. This high confidence schedule is the basis for Release Quality Estimate ("RQE"), which is the program level control budget. This schedule is also the schedule from which project success will be assessed."

a) Please provide the risks and uncertainties for each segment of the schedule.

b) Please provide the amount of contingency for each schedule risk.

c) Please provide the Release Quality Estimate (RQE) document that OPG and its consultants relied upon in preparing the evidence.

Response

a) The list of top risks and duration uncertainty ranges used for the RQE contingency estimate and their application to the segments in the Unit 2 schedule is shown in the chart below:

Chart 1

	LEAD IN SEGMENT	REMOVALS SEGMENT	INSTALL SEGMENT	LEAD OUT SEGMENT
Duration Uncertainty range Compared to Planned Duration	-23 days, +22 days	-46 days, +134 days	-99 days, +113 days	-33 days, +63 days
Top Schedule Risks Associated with Segment	Primary Heat Transport Pump Breakdown Stops Flow Defueling	End Fitting Waste Processing – first-of-a-kind risks	Interference with RFR activities due to unexpected OPG RFR related activities	Risk of increased scope for fuel defect management
	Insufficient Qualified Radiation Protection Coordinators (BTU) to support Execution	Failure to eliminate current constraints on vault loading	Ineffective Practices in Maintaining the Tools	Failure to eliminate current constraints on vault loading
		Removal of shielding and bulkheads prior to staircase install	Improper brushing and excessive as found deposits (CTSB)	Availability of DN Authorized Staff for Station and Refurbishment Support
		Interference with Retube and Feeder Replacement (RFR) activities due to unexpected OPG Plant Operations activities (for in Vault Activities)	Excusable Delays Encountered During Execution of Work	
		All physical Interferences in Unit not identified	Present emergency response plan does not accommodate for an Islanded Unit while meeting adequate response time to emergent events	
Total Days Contingency By Segment Due to Uncertainty and Risk	12 days	58 days	52 days	36 days

b) Please refer to the total contingency days by segment provided in part a). OPG is unable to provide the cost contingency associated with each schedule risk.

c) Please refer to the attachments to L-4.5-5 CCC-22 and Ex. D2-2-8 Attachment 1 for documentation related to the RQE.

AMPCO Interrogatory #65

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-6 Attachment 1

Preamble: OPG provides the Refurbishment Outage Schedule for Unit 2.

a) Please provide the Refurbishment Outage Schedules for Units 1, 3 and 4.

b) Please explain OPG's resource strategy to meet the Schedule for Unit 2.

Response

a) The Start and End dates for Units 1, 3 and 4 at the time of Release Quality Estimate (RQE) are provided in Ex. D2-2-8, Attachment 1, p. 7, Table 1. The equivalent detailed Level 1 Refurbishment Outage schedule for Units 1, 3, and 4, shown in Ex. D2-2-6 Attachment 1 for Unit 2, are not yet available.

   Since the RQE was completed in November 2015, OPG has completed an updated estimate referred to as the Unit 2 Execution Estimate. This update resulted in minor changes to the dates for Units 3 and 1. Please refer to L-4.3-8 GEC-10 and L-4.3-1 Staff-55 for these dates.

b) Please refer to L-4.3-1 Staff-48, Attachment 69 and 4.3-2 AMPCO-59, L-4.3-2 AMPCO-87.

AMPCO Interrogatory #66

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-6 Attachment 1

a) Please complete the following table:

Unit #	Critical Path Start Date	Critical Path End Date	Duration Days	Duration Months
2				
3				
1				
4				
4 Units				

Response

a) Ex. D2-2-6, Attachment 1 provides the planned outage duration (target duration) to which OPG will manage day-to-day performance for Unit 2. Overall project performance will be measured against the high confidence schedule. The critical path durations in the target duration do not include the schedule contingency.

Chart 1 below provides the projected target durations for each of the four units at the time of RQE in November 2015, with the start date for each unit consistent with Ex. D2-2-8, Attachment 1, p.7.

Chart 1

Unit #	Critical Path Start Date*	Critical Path End Date*	Duration Months	Duration Days
2	15-Oct-16	15-Sep-19	35	1,065
3	15-Dec-19	15-Oct-22	34	1,035
1	15-Apr-21	15-Jan-24	33	1,003
4	15-Jan-23	15-Sep-25	32	973
4 Units	**15-Oct-16**	**15-Sep-25**	**107**	**3,257**

(*dates are shown to the nearest 15th of the month)

Chart 2 provides the target durations for each of the four units at the time of the Unit 2 Execution Estimate in August 2016. The Unit 2 Execution Estimate is provided in Ex. L-4.3-1 Staff 55 Attachment 1.

Chart 2

Unit #	Critical Path Start Date	Critical Path End Date	Duration Months	Duration Days
2	15-Oct-16	15-Sep-19	35	1,071
3	15-Feb-20	15-Dec-22	34	1,035
1	15-Jul-21	15-Apr-24	33	1,005
4	15-Jan-23	15-Sep-25	32	974
4 Units	**15-Oct-16**	**15-Sep-25**	**107**	**3,257**

(*dates are shown to the nearest 15th of the month)

Please note that, while OPG has provided the start and end dates for the target duration of Units 3, 1 and 4, the detailed schedules for these units are not developed to the same degree as for the Unit 2 detailed schedule; therefore, these schedules are subject to change based on final refinement of plans for each unit and the results of the preceding unit.

Please see Ex. D2-2-8 Attachment 1, Table 1, p. 7 for the high confidence start and end dates for each of the units at the time of RQE and Ex. L-4.3-8 GEC-10 for the high confidence start and end dates from the recently completed Unit 2 Execution Estimate.

AMPCO Interrogatory #67

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-7

a) Please summarize OPG's operating experience from other refurbishments.

Response

Please see to Ex. L-4.3-1 Staff-53 for information OPG reviewed from megaprojects, including refurbishments.

AMPCO Interrogatory #68

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-7 Page 3

a) Please provide the contingency amount allocated to each of the three key contributors to contingency: cost estimating uncertainty, schedule estimating uncertainty and discrete risks.

b) Please provide the confidence levels for each key contributor.

Response

a) Cost Estimating Uncertainty: $282M
Schedule Estimating Uncertainty and Risk: $550M
Discrete Project and Program Risks: $874M

b) OPG did not prepare separate Monte Carlo analyses to identify confidence levels for each of the key contributors to contingency. A single integrated Monte Carlo analysis was performed incorporating all contributors.

AMPCO Interrogatory #69

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-7 Page 4

Preamble: The evidence indicates a comprehensive risk register including AACE estimate classifications for each project and detailed schedule logic was used to develop the contingency estimate.

a) Please provide the comprehensive risk register.

b) Please provide OPG's Risk Management Plan.

c) Please provide the top 10 contributors to cost risk.

d) Please provide the top 10 contributors to OPG-accountable delay risk.

e) Please provide the top 10 contributors to Contractor-accountable delay risk.

Response

a) Please see L-4.3-15 SEC-26, part f.

b) Please see L-4.3-1 Staff-48, Attachment 24.

c) The top ten contributors to cost risks are shown in the following chart:

Chart 1 – Top Ten Contributors to Cost Risk

Item	Risk Description	Risk Owner
1	Contingent scope due to unexpected Turbine Generator equipment conditions (could not inspect)	Turbine Generator Project
2	Vendor Performance issues resulting in increased costs	Project Execution (Program)
3	Insufficient Materials budget for emergent broke-fix maintenance during Shutdown, Layup and Run-up.	Project Execution (Program)
4	Concealed Conditions encountered during Execution	Retube and Feeder Replacement Project
5	Vendor Default results in need to secure New Vendor to execute refurbishment work	Project Execution (Program)
6	The Cyclic Maintenance budget may not have enough funds to cover Shutdown Maintenance Backlog	Project Execution (Program)
7	F&IP and SIO Projects exceed forecasted life cycle costs	Project Execution (Program)
8	Heavy Water Facility costs exceeds current estimate to complete	Project Execution (Program)
9	Discovery work scope caused by inspections with impact on long lead items or major repairs	Turbine Generator Project
10	Impact of Foreign Exchange on project costs	Project Execution (Program)

d) OPG as the project manager is accountable to manage all risks associated with the Darlington Refurbishment Program ("DRP"). The top twenty risks impacting schedule as generated by the contingency analysis are listed below in order from most impactful to the least. The current owners of these risks on behalf of OPG are listed in the following chart:

Chart 2 – Top Twenty Risks Impacting Schedule

Item	Risk Description	Risk Owner
1	Risk of increased scope for fuel defect management	OPG
2	End Fitting Waste Processing - First of a kind risks	OPG
3	Interference with RFR activities due to unexpected OPG RFR related activities	Joint Venture
4	Ineffective Practices in Maintaining the Tools	OPG
5	Improper brushing and excessive as found deposits (CTSB)	Joint Venture
6	Failure to eliminate current constraints on vault loading	OPG
7	Removal of shielding and bulkheads prior to staircase install	Joint Venture
8	Interference with RFR activities due to unexpected OPG Plant Operations activities (for in Vault Activities)	Joint Venture
9	All physical Interferences in Unit not identified	OPG
10	Excusable Delays	OPG
11	Rebar being hit causing additional PMOD or Safety Analysis	OPG
12	Interference with RFR activities due to unexpected OPG Plant Operations activities (for flask transfer activities)	Joint Venture
13	Ozone excursion into the vault	Joint Venture
14	APT breakdown -Bulkhead Install	Joint Venture
15	Safety events caused by OPG or other contractors (occurrences <3 days)	Joint Venture
16	Lack of Power for tools and supporting equipment (i.e. lighting, munters)	Joint Venture
17	Unexpected Vault Equipment Airlock Malfunction	Joint Venture
18	CTI falls out of tubesheet into lattice tube	Joint Venture
19	Loss of highly radioactive debris/particles - EF Removal	Joint Venture
20	Insufficient Qualified Radiation Protection Coordinators (BTU) to support Execution	OPG

e) Please refer to the response to part d).

AMPCO Interrogatory #70

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-7 Page 5-6

Preamble: OPG indicates that its Monte Carlo simulation provides decision makers with a range of possible outcomes and the probabilities that those outcomes will occur to certain confidence levels.

a) Please provide the confidence levels tested and the contingency amounts at these confidence levels.

b) Were P10, P50 and P70 confidence levels tested? If not, please provide the total cost of the four units and the average cost per unit at low confidence (10%), medium confidence (50%), medium high confidence (70%) and high confidence (90%).

Response

a) The Monte Carlo Simulation generated a cumulative distribution from P0 to P99.9. Select high probability risks were added to contingency during final reviews by Management. Please refer to Ex. L-04.3-15 SEC-027 for calculated contingency amounts in 5% increments ranging from 70% to 95% and also the contingency amount at 99%.

b) Please refer to the chart below. Contingency amounts are in $2015 and exclude interest and escalation. Total costs for the Darlington Refurbishment Program include interest and escalation. Simplifying assumptions were made in order to generate the total DRP costs.

Chart 1

Reference Confidence Level (%)	Total DRP Contingency Estimate At Reference Confidence Level (2015$B)	Total Project Cost [(1)] $B
P10	1.2	12.1
P50	1.4	12.4
P70	1.5	12.6

P90	1.7	12.8

(1) A factor has been applied to approximate the impact of reduced escalation and interest resulting from reduced contingency expenditures

AMPCO Interrogatory #71

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-7 Page 6

a) Please explain further what is meant by "Program contingency is derived from overarching Program risks managed at the executive level that could influence the overall Program's objectives, may require Program-wide response and may have a global impact on the Program".

b) Please provide a listing of the key Program risks managed at the executive level and the corresponding probability.

c) Please provide more details on the types of unforeseen changes to financial and other economic factors beyond those assumed in the Program.

Response

a) Program risks are risks to the refurbishment that are not specific to one project bundle (sub-project) or another, but could have a global impact on multiple project bundles. For example, the unavailability of skilled trade workers would impact multiple project bundles and requires an integrated program level strategy to mitigate it. Managing this risk locally within each project bundle would be inefficient and cause confusion due to potential conflicting strategies.

b) The following table lists the title of the program risks that were included in the contingency analysis and their residual risk probability. For each risk title identified in the table, a detailed risk description is included in the refurbishment risk register which clearly outlines the adverse event, the cause of the event, and the impact on refurbishment objectives in the event that the risk occurs. For brevity, only risks with a residual risk probability of 40% or greater are shown.

Program Function	Risk Title	Residual Risk Probability at RQE
Contract Management	Potential Contract Management Function Resources Required for future Master Services Contract(s) or Replacement Contracts	50%
Program Support	P&M Executed F&IP and SIO Projects Exceed Forecasted Life Cycle Costs	50%
Program Support	Heavy Water Storage Building Costs Exceed Planned Budget	50%
Program Support	Foreign Exchange Impacts	40%
Operations and Maintenance	O&M Procedure Update Program may not have sufficient Funding	50%
Operations and Maintenance	Civil Functions to support Radiation Protection	70%
Operations and Maintenance	Chemistry Laboratory Support	50%
Operations and Maintenance	Acute Tritium Release above Station IIL during NR Primary Side Drain and Dry Operation	50%
Operations and Maintenance	Chemistry Control Procedural Review Risk	50%
Operations and Maintenance	The Cyclic Maintenance budget may not have enough funds to cover Shutdown Maintenance Backlog	50%
Operations and Maintenance	Materials budget for emergent broke-fix maintenance during Shutdown, Layup and Run-up	50%
Operations and Maintenance	Availability of DN Authorized Staff for Station and Refurb Support	50%
Refurbishment Execution	Key skilled craft resources not available when required for Units 1, 3, 4 Execution	45%
Refurbishment Execution	Estimated Cost of RPPE Laundry may be underestimated	40%
Refurbishment Execution	Risk of Vendor Purchased or Owner Supplied Materials not arriving in time to support the NR Execution Schedule	50%
Refurbishment Execution	Estimated Cost of General Services contract underestimated	60%
Refurbishment Execution	Refurbishment does not retain key trades and supporting staff	60%
Refurbishment Execution	Vendor Default	50%

c) There is a residual risk that financial factors such as interest rates, escalation rates, and labour market demands could change dramatically over the DRP's execution period of 2016-2026.

For example, nominal escalation rates built into the DRP are approximately 2% per annum. There is a low-probability, high consequence risk that Ontario's economy could enter a period of runaway inflation during the DRP execution phase, which would invalidate the assumptions regarding escalation in the RQE, and result in the RQE potentially being exceeded.

Another example would be a return to a period of high interest rates, such as those which existed in the 1980s, which would result in accumulation of much higher than planned interest charges.

These types of risks are unpredictable and outside of the control of DRP management and, therefore, not included in the development of the contingency.

AMPCO Interrogatory #72

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-7 Page 7 Chart 1

a) Please explain how OPG determined the contingency $ split between Project Contingency and Program Contingency.

b) Please explain how Program contingency amounts were determined for each project in Chart 1.

c) Please explain why Program contingencies are greater than Project contingencies for the following projects: RFR, Fuel Handling and Defueling and Project Execution and Operations and Maintenance.

d) For each of the projects in Chart 1 please provide the allocation between the three key contributors to contingency (cost estimating uncertainty, schedule estimating uncertainty and discrete risks) for both Project contingency and Program contingency.

e) Have other nuclear refurbishment projects reviewed by OPG included an unallocated program contingency amount under Program contingency? If yes, please provide project details and compare to OPG's proposal.

f) Please provide the total contingency amount held by the contractors, i.e. total amounts included in contracts, that are in addition to the $1.7 billion help by OPG.

Response

a) Project contingency was derived from project specific discrete risks and estimating uncertainties. Program contingency was derived from program risks, the critical path schedule analysis, and functional support organization estimating uncertainties. Please see section 4 of Ex. D2-2-7 for more information.

b) Exhibit D2-2-7, p. 7, Chart 1, shows that the majority of the program contingency amounts are allocated to the Retube and Feeder Replacement (RFR), Defueling/Fuel Handling Project, and Project Execution and Operations and Maintenance, which forms a substantial portion of the overall critical path for the refurbishment. The program contingency figures shown represent the portion of program schedule contingency

attributable to RFR and Defueling/Fuel Handling activities. The remainder of the schedule contingency was allocated to the Project Execution and Operations and Maintenance organization as they are accountable for integration and execution of activities on the critical path including reactor start-up after refurbishment of the unit.

c) As schedule contingency is held at the program level, the projects on the critical path will carry a higher share of the schedule contingency and thus, a higher program contingency.

d) Please refer to the chart below:

Chart 1

	Project Contingency			Program Contingency		
	% Cost Un-certainty	% Discrete Risks	% Schedule Un-certainty	% Cost Un-certainty	% Discrete Risks	% Schedule Un-certainty
RFR	18	82	0	0	31	69
Turbine Generator	14	86	0	0	80	20
Steam Generators	24	76	0	N/A		
Fuel Handling/ Defueling	17	83	0	0	6	94
Balance of Plant	30	70	0	N/A		
F&IP and SIO	0	100	0	0	100	0
Project Execution and Operations and Maintenance	100	0	0	0	80	20
Unallocated Program Contingency (1)	N/A			0	48	52

(1) Refers to contingency that is not directly allocable to specific projects, and is held at the program level only.

e) OPG cannot answer this question as it does not have access to that level of detail in the cost estimates reviewed for other refurbishment projects.

f) For target price contracts (RFR Engineering, Procurement and Construction Contract (EPC) and the Turbine Generator EPC), the contingency embedded within their Execution Phase Target Cost is $371M and $28.4M, respectively.

The value of the fixed price contracts, namely Steam Generators EPC and the Turbine Generator Engineering Support and Equipment Supply Contract, were negotiated to be inclusive of contractor contingency. The magnitude of such contingency is not disclosed to OPG.

AMPCO Interrogatory #73

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-7 Page 1

Preamble: The evidence indicates that contingency is not an extra amount that will not be spent if the project goes as planned, nor is it a tool to compensate for an underdeveloped project plan.

a) Please explain the rationale for the $202 million in Unallocated Program Contingency.

b) How was the amount of $202 million determined?

c) What types of risks are covered under the Unallocated Program Contingency?

d) How will use of the $202 million in Unallocated Program Contingency be authorized and controlled?

Response

a) The Unallocated Program Contingency figure represents risks that are not specific to an individual project bundle but are risks to the entire Darlington Refurbishment Program as a whole.

b) This contingency was determined in the same manner that all contingencies were determined; however, these contingencies were not allocated to a project, but held at the program level.

c) The risks covered by the unallocated program contingency are strategic risks to ensure continuity of trained and experienced workforce throughout the refurbishment program as well as schedule contingency for multiple risks that are not allocable to specific project bundles.

d) The unallocated program contingency will be authorized and controlled in the same manner as all other contingency funds. A change control form will be submitted outlining the risk realized and magnitude of the impact for approval by the relevant authority.

Please refer to L-4.3-1 SEC-38 for more information on the change management process.

AMPCO Interrogatory #74

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-7 Page 8 Chart 2

Preamble: Of the total $1.7B of DRP contingency, $694.1M (40%) is attributed specifically to Unit 2.

a) Please provide the DRP contingency allocated to Units 1, 3 and 4 on the same basis as Chart 2.

b) Does the Monte Carlo analysis differentiate between Units?

c) If the contingency for Unit 2 is not used, please discuss how the funds will be treated and if any remaining contingency funds will be reallocated to other units.

d) Please provide the amount of Unallocated Program Contingency allocated to Unit 2.

Response

a) An allocation of contingency to Units 1, 3 and 4 on a similar basis as shown in Ex. D2-2-7, p. 8, Chart 2 is not available. Please refer to L-4.3-1 Staff-057 for the allocation of contingency to each of the four units across the Major Work Bundles, Facilities and Infrastructure Projects and Safety Improvement Opportunities, Project Execution and Operations and Maintenance functions and Unallocated Program Contingency.

b) The Monte Carlo analysis performed was a four-unit, integrated analysis. While the inputs were created on a unit by unit basis, only integrated results were produced. OPG did not run an independent unit by unit model (e.g., a Unit 2 model, a Unit 3 model, etc.) as this would not be an accurate representation of the four-unit DRP.

c) If Unit 2 is completed with less than the estimated contingency spent, the contingency would be retained for possible use on other units, based on the risk profile of those units, subject to approval by OPG's Board of Directors, or retained at the Program level until the end of the four-unit refurbishment when the program is complete. This approach is consistent with that outlined by Pegasus Global Holdings for management of unused contingency within a megaprogram (see Ex. D2-2-11, Attachment 3, p. 29).

In the event of any unallocated Unit 2 contingency when Unit 2 goes in-service, the revenue requirement impact of the reduced in-service amounts would be recorded in the Capacity Refurbishment Variance Account and returned to ratepayers in a future term (refer to L-9.2-2 CCC-040).

d) Please refer to L-4.3-1 Staff-057 for the amount of Unallocated Program Contingency allocated to Unit 2.

AMPCO Interrogatory #75

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-7 Page 8

Preamble: The evidence states "In allocating contingency to Unit 2, OPG assumed, based on industry experience, that the first unit will realize more risks then subsequent units…."

a) Please provide the specific industry experience OPG is relying on to support this statement and the 40% contingency allocation to Unit 2.

Response

a) The Pickering A Return to Service project encountered substantial lessons learned on the first unit. This led to a number of improvements that were integrated into the execution of the second unit, resulting in demonstrably better cost and schedule performance. Improved performance through the integration of lessons learned from first unit execution was also observed on the Bruce Power Restart project for Units 1 and 2. Please refer to section 4 of Ex. D2-2-7 for more information on the basis for allocating 40% of contingency to Unit 2.

AMPCO Interrogatory #76

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-7 Attachment 1 Page 2

Preamble: The evidence indicates KPMG reviewed the following OPG documents, in combination with the October 6th, 2015 interview of key OPG staff:

- RQE Contingency Development Plan, Dated 2015-06-04, NK38-Plan-09701-10006
- RQE Contingency Development Report, Dated 2015-08-20, N-REP-09701-0556625
- Nuclear Project Risk Management, Dated 2015-03-30, N-MAN-00120-1000
- Nuclear Refurbishment Risk Management & Contingency Development Guide, Dated 2014-07-28, N-MAN-00120-1000
- Nuclear Projects Risk Management and Oversight (RMO) TOOL, N-GUID-09701-10123
- Presentation: "RQE Contingency Development", Dated 2015-06-24
- Integrated Contingency Estimate – Snapshot 3 (Final) dated September 30, 2015 – 'RQE Mgmt Summary – Contingency Snapshot 3.pdf'.

a) Please provide copies of any of the above documents not already provided in evidence.

Response

This following response has been prepared by KPMG:

a) The requested reports are attached.

ONTARIO POWER GENERATION

Plan

Internal Use Only	
Document Number: NK38-PLAN-09701-10006	Usage Classification: Information
Sheet Number: T-10	Revision: R000

Title:
RQE CONTINGENCY DEVELOPMENT PLAN

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RQE Contingency Development Plan

NK38-PLAN-09701-10006-R000

2015-06-04

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R000	2015-06-04	Initial issue.

1.0 PURPOSE

This plan outlines the guiding principles and overall process to develop the program contingency estimate in support of RQE. This plan compliments RQE Management Plan NK38-NR-PLAN-09701-10004.

1.1 Progression of the Contingency Continuum

Throughout the NR planning phase, life cycle contingency estimations have been created to support the business case submissions. As the program has progressed, and the quality and quantity of information related to risk and uncertainty has matured, the approach and rigor in development of contingency has progressed commensurately. Figure 1 provides a general overview of the Risk and contingency continuum within the context of the Refurbishment Program lifecycle phases and overall funding release strategy. The general concept is that as project definition improves, and more certainty is gained, risk and uncertainty associated with the estimate decreases.

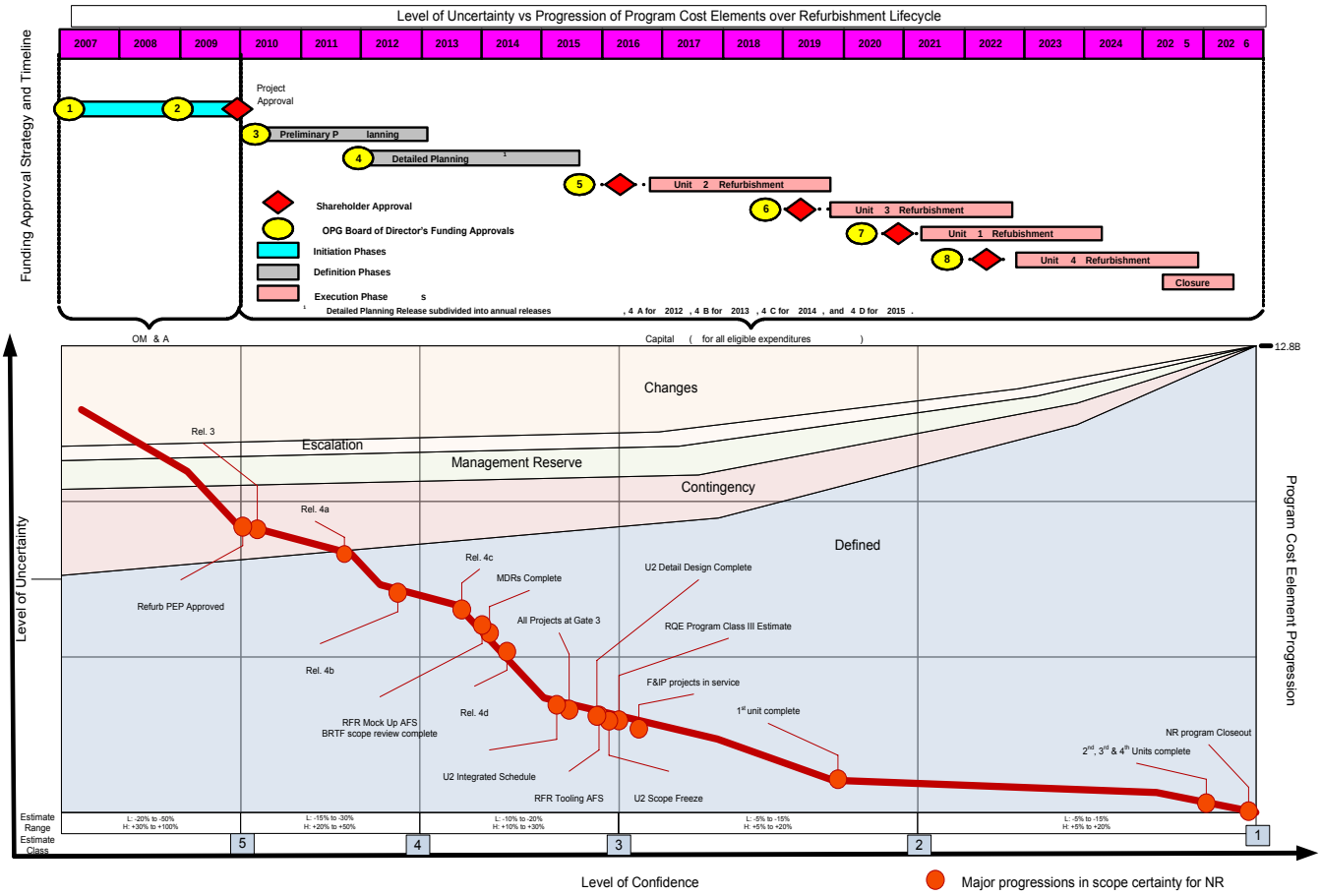

Figure 1— Refurbishment Program Contingency Continuum

1.2 Objectives

The objectives of this plan are:

i. Identify the basic principles and developmental references used to establish the contingency estimate for RQE,

ii. Describe the scalable process by which the contingency will be estimated for RQE, dependent on the degree and quality of definition of the individual bundle level and functional inputs at the time the RQE package is assembled,

iii. Describe the process and define the “buckets” into which the parts of the contingency estimate is split for the purposes of base-lining and facilitating the ongoing management of the contingency estimate, and

iv. Define the roles and accountabilities in the development of RQE contingency.

1.3 Interfacing Documents

This plan interfaces with the following supporting and parent documents that are directly applicable to the RQE processes and deliverables:

1	N-PLAN-09701-10223	P&C Functional Management Plan
2	NK38-REF-09701-10005	RQE Project Terms of Reference (TOR)
3	NK38-NR-PLAN-09701-10004	RQE Project – Management Plan
4	N-MAN-00120-10020-RISK-04	Nuclear Refurbishment Risk Management

2.0 DEVELOPMENT

2.1 RQE Strategy

The approach to contingency development for Release 4D, approved in November 2014 by the board of directors, is similar to previous NR releases and consisted of seven (7) “buckets”. These 7 sources of contingency have been consistently maintained to date; the purpose being to facilitate identification of plan over plan changes (i.e. “trace history”) for contingency in the business cases. For RQE, the sources of contingency are very similar with some minor integration to reflect the progression of the program. For example, contingent work is no longer an isolated bucket but rather has been integrated as a discrete risk. For a detailed outline of the sources of contingency for RQE, and the inputs required, refer to the NR Contingency Breakdown Structure in Appendix A.

Critical to assessing risks to objectives is ensuring that the project and program objectives themselves (including an approved and finalized scope, a supporting cost estimate and resource loaded logic tied schedule for that scope) are in place and established with a high degree of confidence. Trying to perform a detailed risk and contingency analysis on a base plan that has not yet solidified, or is absent of fundamental components, is an error prone exercise that will introduce confusion to

the process. These issues may include double counting items or inadvertently including risk items in the contingency estimate that are ultimately, after management review, built in to the scope of the base plan. In general, the concept of a "freeze date" for the base plan information is very important to the quality of the contingency estimate. The RQE data freeze date is June 30th 2015 and an RQE change management process, for changes made after June 30th must incorporate a risk review component.

The Refurbishment RQE Roadmap had set a targeted freeze date for the organization, which will be the key milestone for Contingency development activities. (See Appendix B – RQE ROADMAP with Contingency timeline)

2.2 Methodology

A scalable approach will be taken to calculating contingency for project bundles and functions (see Appendix B - Contingency Development by Projects Workflow). The rigor applied and method used (stochastic or deterministic) will depend on the state of the project bundle or function at the time the RQE package is assembled.

Where the base plan cost and schedule estimate is mature enough to allow it, @Risk and PERT Master will be utilized for modeling cost and schedule risk. The RQE development process requires all projects to go through (or be statused to the requirements of) Gate 3 by June 2015. The intent is, to the extent possible, to have the RQE contingency calculation be an aggregation of the life cycle contingency estimates individually generated for the project gate submissions, although it is anticipated that during integrated reviews a supplementary contingency development workshop effort will be required to "true up" the risk registers and define inputs. The RQE contingency calculation will cover the life cycle estimate for NR, i.e. 4 units cost and schedule impact.

Third Party Expertise in contingency development and modeling (PALISADE Corporation) will be retained in both a consultative and a working capacity to support RQE and ensure integrity of the modelling process. The third party expert will review the inputs generated by the risk management process, design the risk model, define the detailed modeling feed stock and execute and oversee the contingency modeling processes. PALISADE is the developer of the @RISK program and has performed this function for many capital projects.

2.3 Inputs

A checklist has been prepared (see Appendix C) and will be provided to the project and functional managers to support the contingency development process. This checklist shall be prepared and submitted to the risk department in advance of the contingency development workshops identified in Appendix B. The risk department will take these inputs and introduce them to the aggregate RQE contingency model for processing and definition of the contingency estimate.

3.0 CONTINGENCY DEVELOPMENT – MANAGEMENT REVIEW

3.1 Management Review

After the initial contingency development workshops are complete and a preliminary contingency estimate has been prepared, management reviews will be held to validate the overall adequacy of the RQE contingency estimate and ensure that the level of detail available for the estimate itself, and the input risks and uncertainties that comprise it, are reasonable and prudent. Reconciliation of the contingency estimate will be performed by the risk department in line with the RQE roadmap.

4.0 ROLES AND ACCOUNTABILITIES

4.1.1 Director of Planning and Controls (P&C)

The Director of P&C reports directly to the Senior Vice President, Nuclear Refurbishment. The Director of P&C is accountable for the RQE planning process and the preparation of the RQE Package.

4.1.2 Manager, Project Risk Management and Infrastructure

Oversees, assembles, and presents the RQE Contingency Estimate to NPET.

4.1.3 Section Manager, Project Risk Management and Infrastructure

Interfaces with project and functional teams to drive the delivery of inputs required to perform contingency calculation within established timeline. Ensures NR standards and guidelines are adhered to throughout the process.

4.1.4 Project and Functional Managers

Ensures NR risk standards and guidelines are adhered to throughout the process. Ensures risk registries within their project or function is up to date and accurate. Supports the requirements of the RQE contingency development process by providing inputs to the RQE risk and contingency development team.

4.1.5 Manager, Estimating

Supports quantification of risks and assists in determination of the three point estimates for the cost estimating uncertainty and discrete risks.

5.0 DEFINITIONS AND ACRONYMS

5.1 Acronyms

AACE	AACE International
BCS	Business Case Summary
BoD/BOD	Board of Directors
BOE	Basis of Estimate
ERM	Enterprise Risk Management
FMP	Functional Management Plan
NPET	Nuclear Projects Executive Team
NR	Nuclear Refurbishment
OPEX	Operating Experience
OPG	Ontario Power Generation
P&C	Planning & Controls
RMO	Risk Management and Oversight Tool
RQE	Release Quality Estimate
SME	Subject Matter Expert
SPOC	Single Point of Contact
S.V.P	Senior Vice President
TOR	Terms of Reference
V.P.	Vice President

6.0 REFERENCES

6.1 DEVELOPMENTAL REFERENCES

Ref #	Document Number	Document Name
1	AACE RP 40R-08	Contingency Estimating – General Principles
2	AACE RP 41R-08	Risk Analysis and Contingency Determination Using Range Estimating
3	AACE RP 57R-09	Integrated Cost and Schedule Risk Analysis Using Monte Carlo Simulation of a CPM Model
4	AACE Technical Paper, Kenneth K Humphreys	Project Risk Management, Advantages and Pitfalls

5	AACE Technical Paper, Iqbal Noor and Robert Tichacel	Contingency Misuse and other Risk Management Pitfalls
6	AACE Training Seminar, Kenneth K Humphreys	Managing Project Costs, Financial Risk, and Project Contingency
7	INPO 09-002	Excellence in Nuclear Project Management
8	INPO 09-007	Principles for Excellence in Nuclear Project Construction
9	Project Management Institute	Guide to the Project Management Body of Knowledge, 5th Edition

6.2 PERFORMANCE REFERENCES

Ref #	Document Number	Document Name
1	N-REP-00120.3-10000 (OPG Confidential)	Darlington Refurbishment Business Case Summary
2	N-PLAN-09701-10223	P&C Functional Management Plan
3	N-PROC-MP-0090	Modification Process
4	NK38-NR-PLAN-09701-10001 (All Sheets)	Darlington Refurbishment Program Structure
5	NK38-PLAN-09701-10235 (Draft)	Nuclear Refurbishment Project RQE Cost Estimate Plan
6	NK38-REF-09701-10005	RQE Steering Committee – Terms of Reference
7	NK38-REF-09701-RL030	Board of Directors Approval of Release Quality Estimate (RQE)
8	N-MAN-00120-10001 (All Sheets)	Nuclear Refurbishment
9	OPG-PROG-0006	Investment Management
10	NK38-GUID-09701-10023	Functional Management Plan Guideline
11	NK38-PLAN-00300-10000	Darlington Refurbishment Program Integrated Master Schedule
12	NK38-PLAN-09701-10097	Interface Agreement Between Nuclear Refurbishment And Darlington Nuclear
13	NK38-REF-09701-PG-00-1402	Darlington Refurbishment Program Milestone Definition Template - Issue Site Integrated Transition Plan
14	NK38-REF-09701-MSO0010	Darlington Refurbishment Program Milestone Definition Template Revise Cap\oversight Ownership Transfer Plan
15	NK38-REF-09701-OP2210	Darlington Refurbishment Program Milestone Definition Template - U2 Risk Mitigation Plans Prepared
16	NK38-REP-09701-0490147	Overall Planning Pre-execution Review For Maintenance Owner Support Services For Darlington Refurbishment Project
17	NK38-REF-09701-OP2220	Darlington Refurbishment Program Milestone Definition Template - U2 Refurb Outage Execution Organization Identified
18	NK38-REF-09701-OP2280	Darlington Refurbishment Program Milestone Definition Template - U2 Refurb Outage Pre-requisites Complete
19	NK38-MAN-09701-10005	Nuclear Refurbishment Planned Outage Management
20	D- FORM-10762	Darlington Refurbishment Program Milestone Definition Template
21	NK38-PLAN-09701-0502946	RQE Communication Plan
22	NK38-REF-09701- MPC1060	External Review of RQE (Cost and Schedule) Completed
23	NK38-REP-09701-10067	Darlington Refurbishment Transition Plan Strategy
24	NK38-REF-09701-RP180	Program Health Review Finished
25	Form number to be added	Contingency Development Job Aid

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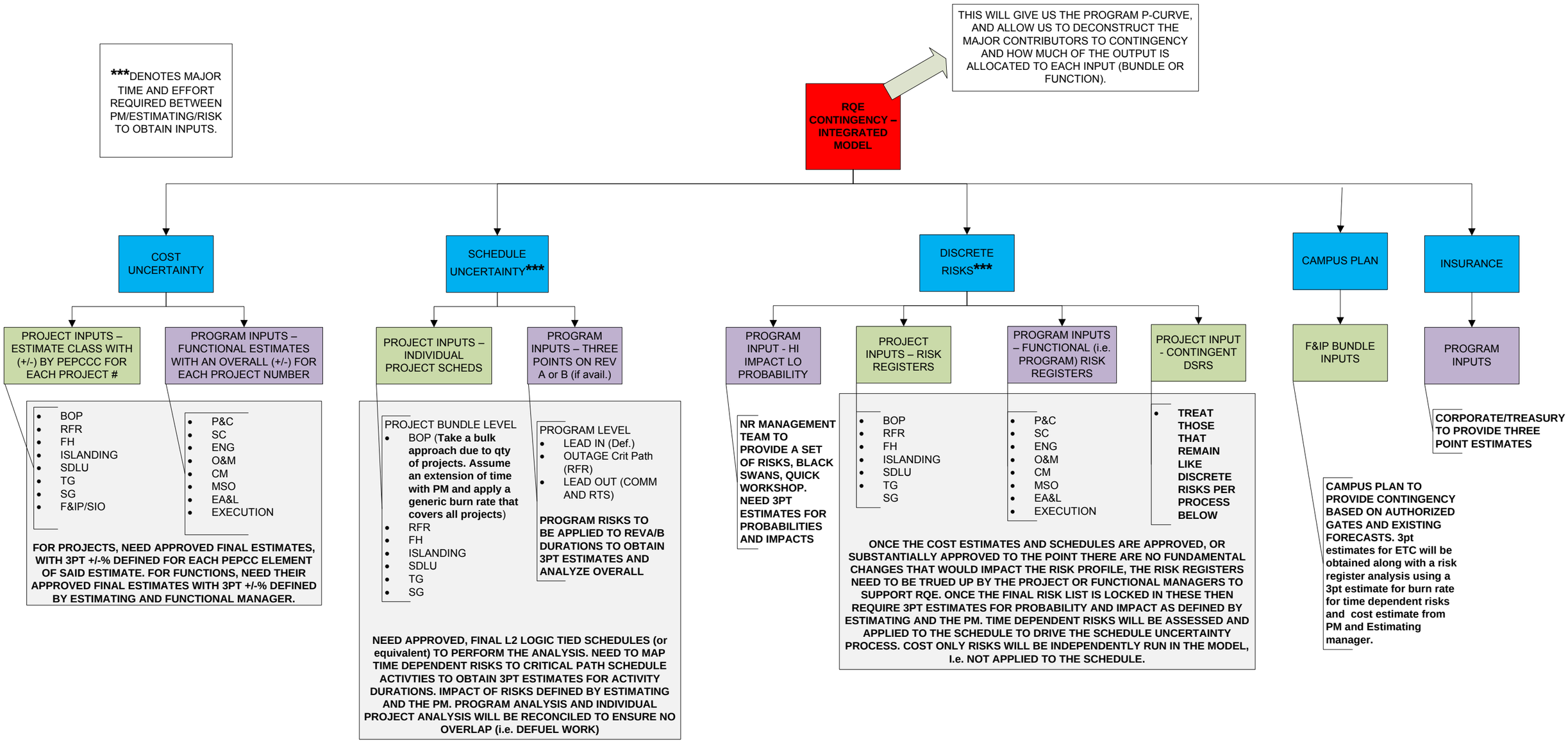
Sheet Number: T-10	Revision: R000

Title: RQE CONTINGENCY DEVELOPMENT PLAN

Appendix A: RQE CONTINGENCY BREAKDOWN STRUCTURE



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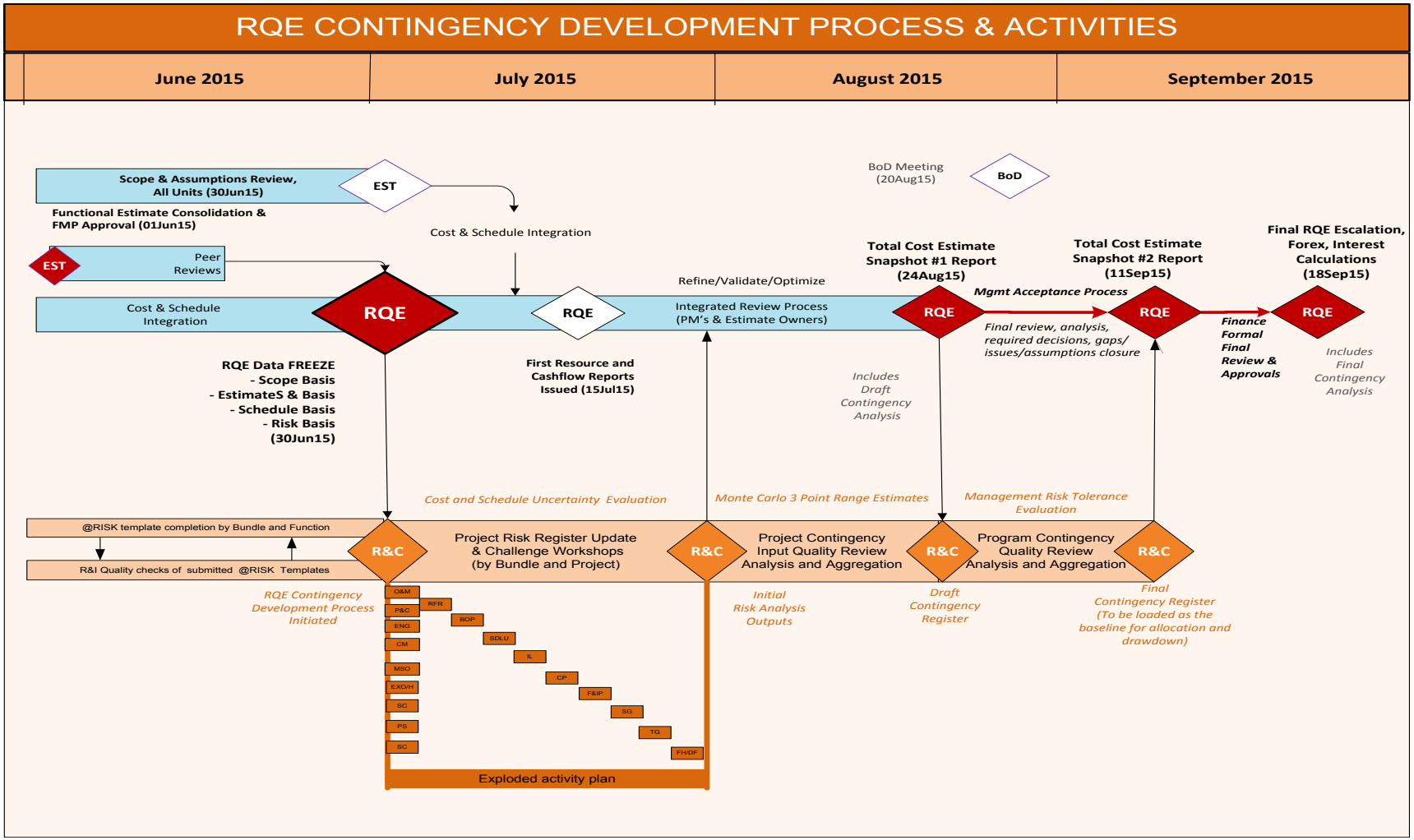
Sheet Number: T-10	Revision: R000

Title: RQE CONTINGENCY DEVELOPMENT PLAN

Appendix B: Risk Assessment & Contingency Development Process (Detailed View)



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Appendix C: Contingency Development Quality Checklist

No.	Activity Description	Responsible Party	Complete ?
1.0	**Risk Register**		
1.1	Risk register has been reviewed and updated as part of the approved and classified final estimates. • All risk descriptions contain event, cause and impact	Project/ Functional Team	☐
1.2	All Project risks and associated scoring have been updated in the RMO for current project maturity and cost estimates (reference heat map)	Project/ Functional Team	☐
1.3	Risks being mitigated have actions on the RMO Tool.	Project/ Functional Team	☐
1.4	Project @Risk Template have been completed in collaboration with the Risk & Infrastructure Organization for cost and schedule risks. • Probability and impacts fields have been updated in the according to current project maturity • Cost impact in $k • Schedule delay impact in days • Burn rate in $k/day	Project/ Functional Team	☐
1.5	Schedule Related Risks: • Risks are linked/mapped to a particular schedule activity • Residual risk impact is quantified and agreed	Project Team	☐
1.6	Cost Related Risks: • Risks are confirmed to have no schedule impact • Residual risk quantification basis is defined and agreed	Project/ Functional Team	☐
1.7	Interface check: • Confirmed that risks identified are not duplicated in other project bundles • Risks being carried are not related to any of the following: ○ escalation, interest, insurance, labour strike, etc (i.e. anything in program nature)	Project/ Functional Team	☐
2.0	**Cost Uncertainty Elements**		
2.1	Final estimates have been approved and classified by the Estimating Organization for each PEPCC Element	Project Team	☐
2.2	Final Functional direct costs have been reviewed with functional manager and accounted in the final estimates	Project Team	☐
2.3	Lifecycle costs of the project have been provided with approved final estimates for each PEPCC element	Project Team	☐
2.4	Lifecycle costs of the project are included within the Cost Uncertainty tab of the @Risk Template	Project Team	☐
2.5	Cost uncertainty does not overlap with risk impacts (@RISK Tab details)	Project Team	☐

No.	Activity Description	Responsible Party	Complete ?
3.0	**Schedule Uncertainty Elements**		
3.1	Final L3 Schedules have been approved and classified by the Scheduling and Estimating Organizations • Activities are logic tied • Activities are integrated with program level milestones • Successive unit schedules have been reviewed for activity replication errors	Project Team	☐
3.2	Schedule uncertainty does not overlap with risk impacts (@RISK Tab details)	Project Team	☐
4.0	**Contingent DSR Elements**		
4.1	Received base estimate from estimate team has been received for all Contingent DSRs	Project Team	☐
4.2	Probability of each contingent DSR occurring is identified	Project Team	☐

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Retention: **T-10**	Revision: **R000**

Title:
RQE CONTINGENCY DEVELOPMENT REPORT

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RQE Contingency Development Report

N-REP-09701-0556625

2015-08-20

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NR Infrastructure And Risk

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1.0 INTRODUCTION

1.1 Purpose

RQE Contingency Development Plan NK38-NR-PLAN-09701-10006 was prepared and approved in Q1 2015, establishing the approach for developing the RQE contingency estimate and describing the associated contingency development principles and processes.

This report documents the activities and results of the RQE contingency development process, the validation processes undertaken and the summarized outputs of the exercise. Further, this report documents the contingency development objectives, governance, procedures, process activities applied, including guiding check sheets, questionnaires, tools, models, and results of a series of focussed workshops that lead to defining the inputs used in the first view of the integrated RQE estimate, as provided in RQE "Total Cost Estimate Milestone Snapshot #1" milestone achieved August 20, 2015. The intent, with respect to the RQE contingency estimate, is that the final estimate and breakdown provided by the Monte Carlo Simulation associated with "snapshot #1" will be subject to refinement after undergoing executive review when the cost, risk and schedule inputs have been refined and validated through RQE integration activities which are in progress at the time of this writing.

2.0 OVERVIEW & BACKGROUND

2.1 Objectives

The objective of this report is to describe the activities, actions, and challenges performed by the Risk Management organization and the broader Refurbishment organization to meet the requirements of the risk management process from qualitative and quantitative standpoint during development of RQE contingency estimate.

2.2 Background

In February 2015, Palisade (proprietor of the @RISK Monte Carlo simulation engine) was retained to support a three phase approach to RQE contingency development. A senior consultant was engaged to a multi-phase on site model review and optimization effort. The objective of engagement of palisade was to ensure the model used in the development of the RQE contingency estimate exceeded industry best practice and rigor, and that the outputs of the model are validated and free from user error that may impact the end results. Palisade submitted a Phase one report that reviewed the model run for Release 4D and provided a set of optimizations that were fully incorporated to the RQE model.

In June 2015, the RQE Contingency Development Plan was finalized and published as per the RQE roadmap dates, incorporating a number of process and tool refinements captured as a result of:

- Refurbishment program process maturation
- RQE road mapping requirements

- RMO enhancements
- Risk and contingency lessons learned
- Palisades @RISK modeling multi-phased assessment reports

Upon sufficient maturation of the base estimates being prepared for RQE for all bundles of functions, the risk management team developed the input templates as well as a series of challenge workshops and supporting documentation to get the project teams and functional teams into the appropriate mindset to provide balanced inputs to the contingency model.

In parallel to the activities to obtain the detailed 3 point estimates for cost uncertainty and discrete risks from the broader NR organization, a number of other contingency input streams were pursued based on the requirements defined by the RQE contingency breakdown structure as follows:

- Ryan Smith, Dennis Curley and Derek McAuley lead the effort to develop the integrated assessment criteria and initial input data for schedule uncertainty aspects of the integrated model. This was subsequently reviewed by Gary Rose, Roy Brown, Mike Allen, and others to ensure appropriate schedule risks and uncertainty was being applied and that it meshed with the progression of critical program aspects, such as RFR R1 Class 2 submission.
- July 10th, Ryan Smith requested from Risk Oversight Committee members and external oversight support members a listing of high impact low probability risks (aka black swans) for consideration in the model. Feedback received was incorporated or dispositioned to existing items including in 4D analysis.
- Ryan Smith, Lisa Ren prepared contingency adequacy reviews with the Campus Plan projects to support forecasting exercises at the end of June and worked with the P&C Lead to obtain the contingency forecasts for F&IP/SIO projects (having largely “sunk” costs and a very dynamic execution environment required a more deterministic approach with estimates provided by project directors.)
- Ryan Smith and Steve Wiacek validated the BCS defined insurance uncertainty aspects with feedback from the corporate treasury of the integrated model and ensured these were incorporated into consolidated template.

2.3 Governance and Procedures

RQE Contingency Development Plan was issued with the expectations regarding process, timeline, procedure and contingency development input requirements. This document was used as the basis for engagement with project/function teams for the challenge workshops.

Risk group members were tasked to follow up and enforce the implementation of the NR risk management process, include the usage of RMO, Contingency Template, proper risk qualification and quantification practices. Overall engagement of the multiple tiers of oversight groups such as; Ministry of Energy, Board of Directors, Enterprise Risk Management, RPET, and NR Program/Functions is defined in various Centre Led Risk Organization governance documents and have been referenced in both the Contingency Development Plan and the RQE Management Plan as applicable .

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2.4 Analysis Tools and Models

Palisade @Risk senior consultants were engaged to bring in the industry best practice to the RQE Contingency development process and tools as per the SOW and reported process findings documented in the attached.

OPG 2 SOW 2015717.docx

OPG Findings 20150323.pdf

NR Infrastructure and Risk implemented a 3 phase model review and update to the Monte Carlo tools used for RQE contingency analysis.

Phase 1: Optimize and streamline modeling details to support RQE, allocate contingency $ to each risk and uncertainty item – February 2015.

Phase 2: Strengthen the modeling details, integrate schedule risk / uncertainty (via MS project), advanced reporting features – August 2015.

Phase 3: Periodical review and optimization of model by Palisade and ongoing support – August/September 2015.

Examples of RQE Contingency Template Enhancements above existing gate and previous release planning models:

1. Identification of unit specific risk impacts, efficiency gains, etc.
2. Maximum application of 3 point estimating including ranges of probability, burn rates, risk recurrence, etc.
3. Integration of program schedule with program risks and execution window uncertainties.
4. Robust and comprehensive reports sets (including disaggregation reports) to allow for clear and focused analysis of the outputs.

3.0 RQE CONTINGENCY DEVELOPMENT – REVIEWING THE CONTINGENCY BREAKDOWN STRUCTURE INPUTS

3.1 Preliminary Process Activities (Getting the Organization Ready)

All Risk Register items for the projects and functional groups were uploaded into an expanded RQE template spreadsheet, from the RMO tool and populated with the latest discrete risk and cost uncertainty information provided by projects at their Gate 3 meetings where available. The templates were placed in SharePoint and the link provided to the teams for collaboration, review and update for any deltas in the required RQE contingency development analysis data.

The objective for these preliminary challenge meetings with the project teams (before final submission of their risk registers and 3pt estimates) was communicating that they were in “safe zones” where the Manager of Infrastructure and Risk, and some peer SPOCs from the project

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team could challenge and calibrate project and functional groups on their risks, conservatism, and bias before it gets to Executive Review for the final contingency calculation.

In conjunction, the latest schedule data was pulled for a systematic and risk based review of programmatic critical path activities as described in section 3.3. This review was performed "off-line" from the workshops described in section 3.2 to ensure the right focus was given by the organization to the right contingency estimate aspects.

3.2 Cost Uncertainty and Discrete Risk – Challenge Session Workshops

As per the time line found in Appendix B of this document, NR Risk and Infrastructure set up a series of challenge and review workshops, starting with Functions and continuing with Projects to review risk based contingency items and cost uncertainty elements for an integrated assessment of overall contingency values. The RQE contingency development template, used in association with these challenge workshops, was updated with the assistance of Palisade to include the expanded 3 point estimate approximiations required for RQE contingency calculations as defined in Section 2.4 of this document.

The checklist (attached document) for the Contingency Development Plan defined the quality review criteria which were utilized to assess the contingency development process inputs, which were distributed in advance of the workshop. These checklists were not mandatory to complete the workshop process but were provided to the teams as guidelines and expectations for what lead in considerations should be made prior to the workshops. Projects and Functions were asked to come to the workshops with any opportunities identified the same way in the table (tagged as opportunity instead of risk which of course would be the bulk majority of line items for review). There were limited opportunities identified by the project or functional teams. Most (specifically functions) identified that in the development of their base estimates the opportunities available were fully applied and as such there we none reasonably foreseen that could be further applied to the RQE contingency development process.

3 point estimates for cost uncertainty was to be provided by the project team by Project # and PEPCCC element and not bundle (although bundle level rules could be applied to each project number if appropriate). Cost estimate PEPCCC was to be considered for cost to go only, and excluded LTD costs as they are already sunk and certain to ensure an appropriate representation of forward looking for contingency could be estimated. A comment and basis column was added at the end of each table to provide rationales and explanatory details regarding 3 point analysis. In most cases this was prepared in advance of the workshop and completed/adjusted after the workshop. At the time of this report revision the estimating organization is performing a cursory review of these bases for reasonability.

In preparation for each workshop, Projects and Functions were asked to ensure the following was completed prior to the meeting:

- Information provided in RQE contingency development template has been;
  1. Reviewed by their team and relevant stakeholders to ensure the gate 3 data is correct,
  2. Trued up to the latest project status,
  3. Completed with all additional RQE delta information and rationale comments

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- A quality check of the transactional aspects of your contingency information by using the following checklist. The checklist was a guideline to try to extract the highest quality risk and uncertainty inputs prior to the workshops to avoid obvious errors or improper inclusions.

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- The attached agenda was reviewed in the workshop to provide a standardized script for executing the challenge meetings. The agenda was circulated to the project and functional managers in advance to give them a sense of the focus areas of the challenge meetings.

Contingecy
rkshop Agenda ar

The team leads were asked to validate their submissions with their P&C Leads and Project/Functional directors prior to the workshop meeting. The reviews were conducted with a challenge panel which attended all meetings to coach and review the templates line by line with the project teams.

RQE Risk Contingency Development Workshops included involvement from;

- Risk key consultant Shoshanna Fraizinger
- The Risk Management Team members
  - Ryan Smith, Manager
  - Lisa Ren, Section Manger
  - Donna Flewell – Process Specialist
  - Mirela Courtney – Process Specialist
  - James Wu – Process Specialist
  - Atef Soliman Cost & Schedule Analyst

- Cost Estimates inputs provided by Mirela Courtney – Process Specialist

- Challenge Panel comprised of ;
  - Dennis Curley Outage Manager
  - Steve Wiacek Finance Controller
  - and Jim Carter, Modus
  - Andy Elliott, Functional Estimate Manager

- Along with project and function team representation.

Official Minutes were taken and later distributed to assist the teams with final update. These are attached as individual appendices to this document.

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3.3 Schedule Uncertainty

The overall program schedule was analyzed in three major segments (driven by critical path through the integrated schedule) as represented in the Rev A outage logic. These segments were based on the following:

1. Defueling activities – as described by technically driven estimate provided by the vendor (see ref. NK38-PLAN-35000-10005), i.e. “lead in”

2. RFR activities - as described by the vendor class 2 estimate (incorporating all the refinements provided by the rev 0, rev. 0’, rev 0 proxy and ultimately rev. 1 submissions) and;

3. Refurbishment lead out activities – utilising the logic of best and worst case scenarios of known integration and interface, Bruce lead out activity logic, OPEX incorporation based on comparisons of other facilities (ie; Wolsong, LePreau)

Forward and back pass analysis was performed and range estimates applied to estimated durations. These range estimates for uncertainty were confirmed to be aligned from the RFR Rev 1 submission. OPG owned and JV owned schedule based discrete risks were reviewed as part of the activities described in section 3.2 and where these were identified by Projects and Functions to have a) impact to Program critical path and/ or b) interface or integration aspects; these risk items were pulled into a vertical slice review against the major schedule segments and associated schedule uncertainty values to ensure there was no “double count” or contingency considerations being applied. Individual consultation with SMEs and outage manager continued from July through August and a workshop outlining preliminary results and challenge was held on Tuesday August 25th with VP Execution, Director of Planning and Control, Outage Manager, Project Director for RFR, Scheduling Manager and Risk Manager. The preliminary list was adjusted to result in the final schedule risk and uncertainty analysis presented in the RQE.

Burn rate details used in the risk analyses were programmatically defined and applied with the support of the finance and RQE organizations (for both the schedule uncertainty items and schedule impacting discrete risks). Burn rates for PMT and bundles were obtained from the master consolidated file and optimistic, most likely, and pessimistic critical path burn rates were provided. The results of these efforts will be refined at “snapshot #1, reflected in the RQE schedule issued in conjunction with the RL030 milestone and finalised for the L3 Rev. B schedule to be issued in Nov2015.

Initial outputs of this effort in support of RQE are provided for illustration as an appendix to this document.

3.4 Program Level Hi Impact/Low Probability Items (The Black Swan List)

Discrete Program level risks identified as high impact but low probability in release 4D were reviewed and categorised during the activities described in section 3.2 and 3.3. On July 10th, Ryan Smith requested from Risk Oversight Committee members and external oversight support members a listing of high impact low probability risks (aka black swans) for consideration in the

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model. Feedback received was incorporated or dispositioned to existing items including in 4D analysis.

The consolidated results were transferred to the RQE template and given the same analysis treatment for integrated modelling which again, will be refined at the "snapshot #1" milestone and finalised for RQE at the RL030 milestone. Initial outputs of this effort are provided for illustration as an appendix to this document.

3.5 Campus Plan Projects

Campus plan project contingency development inputs have been provided based on authorised gate information and existing forecasts. Only those P&M projects that are included in the refurbishment budget and have work remaining were addressed. The 4D contingency number for the included projects is $83M. This was the aggregate value of contingency that had been calculated at gates. An additional program contingency of $74M for risk ID 667 "Lack of Confidence in P&M Executed Project Estimates" was added to the gate contingency estimates to compensate for historical performance of cost overruns.

On June 25th, 2015 risk met with each project manager and performed a detailed challenge of their respective risk registers to conduct a contingency adequacy review forecast. The project managers assigned three point ranges to the "cost-to-go" estimates to support developing a cost estimate uncertainty component of contingency. The results of the risk quantification & ranging and estimate ranging were then submitted for Monte Carlo analysis. That resulted in a total contingency of $63M, with D2O at ~ $30M and EPG3 (which is still to be finalized) at $28M based on the updated project manager inputs. P&M's management assessed these values developed through the Monte Carlo and has made deterministic adjustments to support RQE. The risk team is awaiting the final submissions from P&M on the campus plan projects to understand and reconcile any deterministic adjustments made to the Monte Carlo output. P&M executive leadership are reviewing that deterministic contingency, and some adjustments are expected based on the dynamic nature of these projects – many of which are in advanced execution phase.

As was done in 4D, Program contingency associated with Risk ID 667 will be added to reflect the historic performance issues associated with Campus Plan projects to provide additional assurance.

3.6 Insurance Uncertainty

Insurance aspects of contingency have been contemplated in conjunction with discrete risk and cost values provided by Finance based on Program assumptions and planning basis defined by the BCS. These have been directly translated into the integrated template for overall modelling and RQE contingency calculations.

3.7 Quality Checks

Quality Checking was done by the risk management team members by completing quality and data integrity checks after the workshops:

a) First, the Estimating Review of the impacts and uncertainty ranges.

b) Confirm completion of actions, by reviewing the meeting minutes in detail by Risk log # to ensure the advice provided from the workshop panel was considered. The changes were implemented and reflected in the final submitted data for input into the Palisade @ Risk software.
c) Data entry errors were captured upon imputing of the three point estimates into the @Risk software and reviewed with the project teams as required. Inherent to the model, a built in quality check identifies if there are any three point estimates where the optimistic impact exceeds the most likely, pessimistic is less that optimistic, etc.
d) An additional check was to review the submitted spreadsheets vs. RMO registered Risk Log numbers, to ensure all items were captured in the risk register.
e) Senior consultant from the Palisade's software did a overall quality check of the physical model and the formulas. At the time of writing this report is preparing user manuals and final reports to ensure the model can be easily re-run for check estimate.

3.8 Current Status

The contingency development workshops took place as follows:

- July 13th – Project Contingency Work shop dry run with P&C leads.
- July 14th – Project Contingency Development Review Work shop – Turbine Generator
- July 16th - Project Contingency Development Review Work shop – Islanding
- July 20th Project Contingency Development Review Work shop –RFR
- July 20th Project Contingency Development Review Work shop – Operations & Maintenance
- July 21st Project Contingency Development Review Work shop – Engineering
- July 22nd Project Contingency Development Review Work shop – Shutdown Layup,
- July 22nd Project Contingency Development Review Work shop – Functional Departments
- July 22nd Project Contingency Development Review Work shop – Fuel Handling /Defueling
- July 23rd Project Contingency Development Review Work shop – Steam Generator
- July 23rd Project Contingency Development Review Work shop – Balance of Plant
- July 27th Project Contingency Templates due end of day to Risk Management Team

Interface and Integration activities took place as follows:

- July 27th – TEMPLATE FREEZE – all project and functional templates for contingency will be extracted for integration i Total Cost Snapshot #1.
- Week of July 27 - Risk department performs template integration to master model and quality check (Lisa Ren), checks and balances performed on actions and queries stemming from workshops.
- July 28th Risk Team completed Quality check of final templates, and uploading into Program Contingency template.
- July 29th Additional Cost Uncertainly for the Bundles and functions were uploaded
- July 29th NR Program level schedule Risk and uncertainly were identified

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- Insurance elements were incorporated in the master template
- August 10-14 Palisade review template.
- Interface and integration reviews utilising the Master model and template inputs from activities described in sections 3.2 – 3.7 were conducted for the first views in preparation for "snapshot #1" refinement.
- Quality Review of data entered by Risk team August 17 to 21
- Snapshot 1 prepared and communicated on Wednesday August 19th.
- Snapshot 1 contingencies were presented the week of August 24th as part of bundle integration reviews. Adjustments to contingency input sheets were prepared by risk organization and presented in the NPET review sessions.
- August 31st to September 4th Management Review
- August 31st to September 4th Palisades Risk Consultant analysis of results.

Bundle Integrated Review Meeting held to review final submissions, materials reviewed included scope reports, basis and assumptions, cost estimate summaries, schedules and preliminary contingency analysis.

- August 24 Bundle Integration Review – Balance of Plant
- August 25 Bundle Integration Review – Islanding
- August 25 Bundle Integration Review – Turbine Generator
- August 25 Bundle Integration Review – Steam Generator
- August 26 Bundle Integration Review – Fuel Handling/Defueling
- August 26 Bundle Integration Review – Specialized Projects
- August 27 Bundle Integration Review – Shutdown Layup
- August 27 Bundle Integration Review – RFR
- August 24 Bundle Integration Review – Balance of Plant (unique scope)

- August 24 Refurbishment Risk Oversight Committee (R-ROC) meeting
- September 1 – Risk Assessment of Critical Path with Director of Ops and Maintenance

- September 3rd to 9th NPEP Reviews of separate submissions by the bundles and functions
- Snapshot 2 provide September 4th
- September 4th Final Snapshot and Prep Contingency Review Workshop
- September 8th Overview of Key Risk Scores KPMG
- September 10th Integrated Contingency Estimate Review for NPET
- September 11th Input detail of Schedule Uncertainty RFR
- September 14th review of 3 point estimates with Outage Manager.
- September 15th New model walkthrough provided by Palisades.
- September 18th Final RQE alignment Meting
- September 24th Review S Curve

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4.0 CONCLUSION

The Refurbishment risk organization has performed activities in accordance with the principles of the development plan and outputs and process to obtain inputs are in alignment with the contingency breakdown structure diagram outlined in the contingency development plan.

With the inputs received so far, after preliminary calculation, path forward activities described as follows should ensure that the integrated contingency estimate values achieved at snapshot#1 will be well developed, risk informed and rationalised:

BOP: Detailed scrub and categorization of risks are completed. Risk group members are working closely with BOP to follow the process of identifying and quantifying risks in RMO (with cause, event and impacts).

Campus Plan Projects: Contingency $ approved by project director of CP project is used along with updated risk registers for CP projects.

Engineering: It is largely due to the magnitude of the risks identified and their # of reoccurrence. Risk group has reached out to Engineering to ensure the risk impact is properly quantified with strong basis. Also, to ensure the number of reoccurrence is reasonable.

Ops & Mtce: Contingency $ % is relatively conservative relating to the budget $ planned for out years. Risk group is following up with Ops & Mtce to further tighten the band for risk impact.

Black swan list (low probability, but high impact): This is being updated with new entries and reviewed against items submitted during the 4D release efforts.

NR program Schedule uncertainty or risks: The initial calculation is in. Second round of in-depth or reviews scheduled for Aug 11.

Palisade senior consultant was on site with the Risk group the week of Aug 10, validating the model setting, and inputs parameters, and fine tuning various reports; after which, draft contingency $ for bundles/functions/risks can be readily available.

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5.0 APPENDIX A - MINUTES OF MEETING

ONTARIO POWER GENERATION	NUCLEAR REFURBISHMENT MINUTES OF MEETING	INTERNAL USE ONLY	
MEETING TITLE:	RQE Contingency Development WorkShop – Turbine Generator	DEPT	Planning & Controls-RISK

PLACE	DEC – Conference Room 3D	DATE	June 14th	TIME	8:00 to 9:00

ATTENDEES

Participants	Title & Department
Ryan Smith	Manager Risk
Steve Wiacek	Finance Manager
Lisa Ren	Section Manager – Risk
S. Fraizinger	RQE
Peter Moore	Project Manager – Turbine Generator
Arber Puci	Project Engineer
Donna Flewell	Process Specialist – Risk
Pejman Asgaripour	Project Manager – Turbine Risk
Dennis Curley	Outage Manager

Meeting Agenda

Actions from the Meeting

(Listed by RMO RISK ID CONTINGENCY NUMBER below)

1. 13447 - IMS Delay, cost risk, delay on JV side, change of priorities, (external). Need a cause. Likely to occur, 30% is realistic.
   ACTION:
   - add rationale and comments regarding opex based risk item
   - need explicit details for cause/effect and impact in description
   - need probaility value review

2. 13446 - Action: Risk of materials, between JV & Alstom, Warehouse, potential loss of proper paperwork, causing delay of release of material. Cause, mitigate by enforcing the terms of the

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contract. (beef up the wording on this risk) the unique situation of a 3 party agreement. Does vendor, have any consequences that should be mentioned if delayed? Cause of delay of work, standdown costs. Don't have an integrated schedule. (material supply date) 40% prop 13446, needs a holistic review, JR.

3. 13443, Resource leveling, OPG core staff, to pay for full time FTE as, disposition this to a new assumption. That the decline in FTE should be covered by HR department. Interface with HR Program RISKS.

   ACTION: Ryan to perform interface check against HR functional risk because this a global risk item which may be best held at program level contingency. Project to disposition to new assumption to re-assign overflow resources and hold no contingency at project level as a result.

4. 13419, Alstom need meeting, EVENT, please clarify, Software qualification report not accepted by OPG, rejected due to non compliance of the specifications. Fixed price contract in this case. Cause, clarify impact. Mitigate with contingency. SQR issue, how is this impacting the schedule and cost? 40% is this correct? Risk should be lowered if confident that contract covers this, consider a cold body review. Contingency required for paying more money to Alstom if the dispute gets settled in their favour.
   ACTION: Event/ cause/impact clarity required in description. Re-evaluate probability value assignment (current is a tough sell)

5. 13309, Crane condition. "First of a kind" lift. May need to modify the crane for the lift, may cause a delay. Lower probability, consider, your research and put comments to explain your basis on this probability. Risk regarding reliability from past TG outage history.

6. 12401, 3 party agreement, total presumption of failure risk, remove. Risk is based on Alstrom history. Unless you can add an event cause and impact. Event= errors in quality problems, demonstrated quality issues, Cause, previous OPEX, keep at 5 to 10% lower probability. Add more to basis of decision. Draw the difference between the material quality issues. JR

7. 12302 Cause=first of a kind. <u>Possible duplication</u> of a JV risk. Ensure the schedule contingency considers, additional time as JV is in learning mode. Remove if it is a double count.

8. 11965 Trades from out of province, Review if this is a PROGRAM Risk, JR.

9. 11744 ISO Requirements for connection to the Grid, if unable to reconnect at commissioning. Please clarify, this is not a valid risk as stated, this is a presumption of failure. Unable to identify a Cause. Rewrite this risk. Cross reference and review for Program level list. Ensure the contact covers this with incentives or disincentives. Look at basis, characterize properly.

10. 11250 RISK OF INSPECTION work, discovery work, is this covered at program level? Clarify this is for parts or materials. Review if covered in management reserve. Keep at 20%, input from Darlington Turbine experience. Valid

11. 11242 FME Event, does JV carry the same risk? OPG pays for rework, review agreement. Inform residual risk of what needs to cover this? Could also be a duplicate? Reword, to cover what isn't already RISK that is not covered with the Aecon risk.

12. 11208 Technical internal delays and Station Delays to due to various emergent issues, cost impacts causing a burn down rate. Could be duplicate, could be too conservative, currently understated at 10%. Clarify Risk title or combine with 11744.

13. 13552 keep, good risk, RS.

14. 13553 clarify that this is first unit, more money for parts on the first unit, is this a duplicate of discovery of work. Ensure you describe the difference in the types of contingency, parts, resources or schedule.

15. 13575 DOCK issue, probability of 80%, no estimate at that time, add context in the comments section. Probably should be CCF not Risk. Create an item in base cost, create a DSR. Keep for Executive reviews. SH to add to RQE RISK.

16. 13531 Remove, presumption of failure not a risk, or reword to specific as a risk.

17. Review reset of the items for the above discussed email. Disposition any of these risks to assumptions, to proof you have done a analysis to make this lean.

18. Review 3 point estimates.

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ONTARIO POWER GENERATION	NUCLEAR REFURBISHMENT MINUTES OF MEETING	INTERNAL USE ONLY	
MEETING TITLE:	RQE Contingency Development WorkShop – Islanding	DEPT	Planning & Controls-RISK

PLACE	DEC – Gary Rose Office	DATE	July 16, 2015	TIME	12:30 to 2:00

ATTENDEES

Participants	Title & Department
Ryan Smith	Manager Risk
Steve Wiacek	Finance Manager
Lisa Ren	Section Manager – Risk
Donna Flewell	Process Specialist – Risk
Dennis Curley	Outage Manager
Jim Carter	Modus
Simon Burrell	Islanding
Joanne Mercieca	Islanding
Bert Boston	Islanding
Jeremy Morrison	Islanding
Sam Hassain	Islanding

Meeting Agenda Items

Reviewing Contingency Development workshop template items as follows:

11950 Containment Isolation in the Fuel Handling Duct could increase the critical path schedule, and lead to cost over runs due to fueling requirements. ACTION: Review the burn rate ($K/day) most likely at the program level this may be covered. Consider the number of occurrences for the full program. Review final 4 columns on spreadsheet.

112416 Creep of unknown Functional budget costs. ACTION: to move this to the program level, but keep as a risk with no contingency money attached. Move out as an assumption. Remove from final template and keep only risks that cost dollars assigned.

11915 Airlock Issues. Assumption of a 3 day delay in JV P50 contingency. D. CURLEY advises to remove this risk as it is covered at the Program level, under schedule delay. Given the high probability keep only a small contingency for OPG project issues. Ensure that the dedicated airlock operator program is in place should be able to lower the probability of occurrence. Action: Consider and review the burn rate at both the program and project level.

13254 D2O pre-req project will not complete on time at 90% probability. With over 50% probability his item is no longer a RISK but a project schedule change. Should disposition to CCF. Decide prior to REQ deadline next Friday.

11784 FME EVENT – good RISK, clearly written, check that it may be covered at the program level. Add a comment that JV is not covering this risk in their contingency.

13485 Hitting buried cables or pipes while anchoring stanchions for the barriers. Add notes stating that high probability of this occurring while drilling 3-4" several 100 times. Please provide basis/assumption for contingency money usage. Remove the word "rebar" from the notes, as this risk is not so much related to "rebar" issue. Check that this may be a duplicate risk and covered at the program level. Keep only cost of a residual risk.

11449 Containment Boundary – Risk of two day delay, this is covered at the program level schedule risk, doesn't need to be in both places. Review and validate burn rate.

13344/11449 Dennis and Ryan to review again for NR risks having post mitigation impact score under 9.

Reminder final submission is due end of next week, July 24th.
Contingency is not required for each RISK.
Plan to succeed.
Gate vs. Risk, both should align. Then calibrate from their too low or too high. Ensure items at the gate are reviewed as Risk items. Some items may need CCF and revise to align.

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ONTARIO POWER GENERATION

NUCLEAR REFURBISHMENT MINUTES OF MEETING

INTERNAL USE ONLY

MEETING TITLE:	RQE Contingency Development WorkShop – RFR			DEPT	Planning & Controls-RISK
PLACE	DEC – Conference Room 3D	DATE	July 20	TIME	8:00 to 9:00

ATTENDEES

Participants	Title & Department
Steve Wiacek	Manager Risk
Lisa Ren	Section Manager – Risk
S. Fraizinger	RQE
Dennis Curley	Outage Manager
Roy W. Brown	Sr. Director
Norton Thomas	Sr. Manager ERM
Steve Wong	RFR OSS
Mark Cira	Consultant
Sudhakar Pulgau	P&C Lead

Meeting Agenda Items

RFR RMO RISK ID#

12322.U2 End Fitting Waste Processing - First of a kind risks As a result of the first of a kind nature of the End Fitting waste processing with no existing operating experience, the risk is that there is more downtime of the tooling system than planned which negatively impacts the schedule during the Execution Phase. Most importantly a risk that the end fitting removal may be faster than the waste processing can handle and the waste processing overtakes and becomes the critical path.

Tool breakdown is more than we think, or tool use takes longer… risk is driven down in the other units by incorporating improvements in HP and procedure usage by people. Maybe tool redesign and process improvements to improve rates. Tool testing hasn't been completed enough to determine. Risk is based on OPEX. This is schedule risk only; contingency would be used for burn rates only. Schedule time for this is 29 days, risk ranked at 4, means doubling of activity time. 2x57% trains for EFR.
Impact should be assumed against one occurrence. Cumulative occurrence details should be captured in the recurrence columns. This should be revisited across all the risk entries provided. First of a kind aspect, probability reduces as units progress.

12322. U3 Unit 3, second unit.

12322 U1, U4, third and forth unit.

12442. U2 A new degradation mechanism drives new requirement to divert material/components from the reactor face to Lab for Analysis. As a result of a new degradation mechanism, additional requests from Station to divert additional material / components from the reactor face in the Vault to Lab for additional analyses (for example collecting sample garter spring for analysis) may occur during the Execution Phase. This could require changes to Tooling and Training. This means negative impacts on Refurb Schedule duration; however, incremental costs will be borne by the requesting organization.

12442. U3, 1, 4 Other 3 units
11111 Tool change control and management, As a result of the Lack of Change Control on Tooling leading to Unapproved Design Changes to tooling, the risk of unexpected damage to the reactor or failure to perform may occur in the Execution Phase, which would lead to negative effects on * RFR schedule * RFR cost
12439 As negotiation of Collective Agreements with the Unions of OPG will occur during the Execution Phase work, there is a risk of labour issues from PWU, Society and BTU unions causing interruption to work with negative impacts in the Execution Phase on * RFR Schedule

11150 The risk is that the vendor is unable to meet the contractual obligation due to vendor default.

12428 As a result of historical FME events, the risk of FME items sitting inside Concealed Areas that cannot be discovered/identified in Walkdowns may occur during RFR work in Execution Phase, which would lead to additional inspection / repair activities with negative impacts to * RFR cost * RFR schedule

11005 There is a risk that not all potential interfaces were identified by the detailed design for modifications. This risk has the potential to adversely affect the cost and schedule of modification installations. Potential unforeseen discoveries include: unit to unit as-built differences/tolerances, structures, cable trays, etc.

11476 As a result of Incomplete Engineering Package filling and insufficient documentation of software tools in Intellectual Property (IP)Escrow, combined with a contractor default, the risk of inability to tackle a technical issue may occur during the Definition / Execution phases, which would lead to negative effects on * RFR schedule * RFR cost

11325 4.8 Concealed Conditions
The examples include, but not limited to:
- CTSB Inspection Results;
- Feeder nozzle found unsatisfactory;
- Calandria tube contacting horizontal flux detector when they are moved;
- As-built configurations vary from design and drawings, while laser scan and walk down etc. did not identify the variations and the JV had done everything possible;
- Permanent bulkhead unexpected repairs identified during NDE;
- Unexpected deficiencies of existing EPs in shutdown cooling rooms, after due diligence of JV exercised;
- As-found “original construction” feeder flaws uncovered, after JV verification completes but could

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not identify those feeder flaws earlier;
- Unexpected changes to containment boundary from OPG/other vendors may cause interruption to containment isolation pressure test;
- Calandria Vessel discovery work requiring new tool and new method to remove the discovery materials;
- PT factures longitudinally, resulting in jagged end on the PT
13326 5.2 (a) Excusable Delays (> 3 days)
The examples include, but not limited to:

- Radiation conditions (tritium, alpha, debris, high activation product concentration, high radioactive debris/particles) higher than expectations causing delays in cleanup (> 3days);
- Fueling machine stops unexpectedly (> 3days) below the bulkhead of the Unit being refurbished with Labour Force in the vault working on critical path;
- Unplanned Fuel Handling activities affecting duct access (> 3days) applicable to critical path refurbishment work in the duct;
- Required upgrades/repairs/maintenance to OPG existing facilities (> 3days);
- Unexpected operating plant transients with impacts > 3days on critical path;
- Delay in completion of work required to be completed by OPG (or its vendors) (> 3days);
- Reactor not defueled on time as scheduled by OPG (> 3days);
- Delay in Breaker Open milestone (> 3days);
- Unavailability of OPG services - breathing air supply (> 3days)
- Loss of station power (OPG supply) to run JV equipment / tools (> 3days)
- D2O spills (> 3days)
- Activities in adjacent operating units (including testing and Safety Related System Test of adjacent operating units) causing interruptions in refurbishment work (> 3days)
- Interference from unexpected OPG Plant Operations activities (> 3days)- Notice to Proceed date moved (> 3days)
- Vault Equipment Airlock Malfunction causing interruptions in transitions and material movement (> 3days)
- CNSC work stoppage (> 3days)
- MOL work stoppage not due to JV's negligent work (> 3days)

13327 RFR has all in costs in budget. This looks like a program risk - action for program to review that finance captures all contractual escalation costs are covered in their escalation numbers. Due to some costs that are uncontrollable by OPG and JV, the risk of higher costs flown through JV to OPG may occur with negative impacts to the Execution Phase cost. The examples of cost above and beyond assumed escalation cost include the following, but not limited to:

Amendment to labour agreements such as Nuclear Project Agreements (NPA);
One or more unions not signing the labour agreements such as NPA;
Amendment to travel and boarding provisions;
Inadequate LOA allowances due to higher than expected out-of-province / international labour forces or

13329 As a result of OPG not meeting its obligations, there are risks of the RFR vendor making claims for additional costs, cost claim from schedule delay not covered in the Contract, in the Execution Phase.

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13330 As results of Retube Tool Platform (RTP) being the first-of-a-kind platform installed in the Darlington vault with various constraints, the risk of more downtime of the installation than planned may occur in Unit 2 with negative impacts on Execution Phase schedule.

13332 this is a new risk. There are disincentives in contract if the tools don't work, but this risk is there to cover the potential situation that costs are being paid for stand down costs to address tools fixed. Action for Steve Wong to send list of new risks in RMP to Dennis Curley so he can review and assess in the schedule review. This has both schedule and cost impact. working with the JV to determine what are the high risk tools and which procedures can be optimised As results of ineffective practices to maintain, test, spare tool quantity, stock spare parts for tools, store the tools physically, move the Special Tools supplied by the JV Fixed Price Contract, and to maintain configuration data to supply reliable tools, the risk of not meeting the demand of turnover of the Tools may occur in the Execution Phase with negative impacts on cost and schedule. This is a new risk. There are disincentives in contract if the tools don't work, but this risk is there to cover the potential situation that costs are being paid for stand down costs to address tools fixed. Action for Steve Wong to send list of new risks in RMP to Dennis Curley so he can review and assess in the schedule review. This has both schedule and cost impact.

13333 reviewed and found to be reasonable. Due to safety events or near-misses (events or near-misses not related to JV's negligent work), the risk of OPG stopping the work order(s) may occur with negative impacts on Execution Phase schedule.

13334. U2 probability of this should change to a 2 not a 4, and overall will change to an 8. This should include a cost impact - cost of body drop and on board/train new. May also have cost of additional shielding in successive units? Action on Steve to update template with correct probability and overall. Also review numbers in the successive units. Due to JV does not have adequate Radiation Protection Planning in the work practices (e.g. higher dose rates from the flask contents), the risk of more radiation protection work and potential radiation hazards may occur with negative impacts on Execution Phase schedule?

13334.U3,1,4 Second, Third and Fourth Unit, probability of this should change to a 2 not a 4, and overall will change to an 8. This should include a cost impact - cost of body drop and on board/train new. May also have cost of additional shielding in successive units?

13335 OPG Oversight needs underestimated, Due to unexpected oversight needs and attrition for RFR project, the risk of lack of OPG oversight processes may occur which leads to not noticing contractor performance issues with impacts on Execution Phase cost and schedule. Roy will review this item.
13336 CTSB is gouged or scratched during CT Removal, Calandria Tube Sheet Bore needs to be milled with negative impacts on Execution cost and schedule.

13565 - This is not the same as the other (which was for bulk retube work and this is for pre-req). Action on Steve -to fix scores and probability. This is all schedule and no cost impact (covered in burn rate)

13564- PTs have two different orders placed. Assumption is to use the lower cost order, but this covers the risk of having to use the higher cost order. This should be a cost risk, not a schedule risk (this should be a 4, 4, 1, 16). This is a one time shot cost, which is unknown until the proponents

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come in to procurement with the results of PPQ.

13568 - This is for the rest of the train related to EF. Scoring should be changed to 1,1,3 - action on Steve. More probability on schedule impact here because there is more time avail to be impacted. Look at the schedule impact details on this.

13426 - This is a new risk. First risk in a general environment related risk, this relates to an incremental issue. - A discrete occurrence versus a generic consideration - Action on Steve to update the description accordingly. Action on Steve to review the ratings and other scoring details for these successive units. Are we going to learn anything from the first unit that we can't apply to the others?

13427 - This is only schedule risk. Action -more analysis and transfer details in description etc, also the scores need to align and rationalised with scoring elements.

13428 - Check if this is a double count? - This is the risk associated with the P50 above the P90. The portion above is carried by us. This covers the JV's risk register above the P50. This is the risk associated with the fact that we are confident that their estimate is not going to be good and anything up to P90 over the JV P50, we will have to cover.

General notes:

Due to time, only high risk items have been reviewed here. (overall is greater than 10)

action to RFR to look at the sum of the radiation risk to quantify the total impact of the radiation risks on the program as a whole, same action again on tool risks in an amalgamated view against the whole program. (reasonability check)

13427 and 13428 - fundamental risks which have to stay regarding schedule impact until the JV sorts their T&C's.

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Report	Internal Use Only		
	Document Number: N-REP-09701-0556625		Usage Classification: Information
	Retention: T-10	Revision Number: R000	Page: 23 of 35

Title:
RQE CONTINGENCY DEVELOPMENT REPORT

ONTARIO POWER GENERATION	NUCLEAR REFURBISHMENT MINUTES OF MEETING	INTERNAL USE ONLY	
MEETING TITLE:	RQE Contingency Development WorkShop – Ops and Maintenance	DEPT	Planning & Controls-RISK

PLACE	DEC – Conference Room 3C	DATE	July 20	TIME	11:00

ATTENDEES

Participants	Title & Department
Ryan Smith	Manager Risk
Steve Wiacek	Finance Manager
Lisa Ren	Section Manager – Risk
S. Fraizinger	RQE
Donna Flewell	Risk
Andy Forsyth	Manager
Atef Soliman	Risk
Ian Forbes	Section Manager Ops
Dan Cowley	Ops NR
James Wu	Risk
Mike Stewart	RTS Manager
Andy Elliot	P&C Manager
Tom Carvin	NR Maintence Manager
Dennis Curley	Outage Manager
Eric Gould	Ext. Oversight
	Absent: Roger Daly

Meeting Agenda Items

759 Defuelling Cost Could Increase - 759 Defueling Cost Could Increase -Review Defueling Risks, possible double count of Risk. Recommend reword to clearly state up front the base plan for 4 crew and the risk of having to go to 5 crew. Risk probability of 50%, believe that there is a requirement of additional funding. Feel high probability of a 4 crew schedule is happening. Revisit this as a residual risk. Consider the risk recurrence, 0,0,0. Consider cost impact for all of refurbishment. Add note, no critical path impact, just a cost impact, also add to 3 point rational column, add detail on the $17m.

758 Chemistry Lab Support – Follow up with Roger Daly – Mr. Chemistry & Environment – unable to attend meeting

728 Acture Tritium Release – Follow up with Roger Daly – Mr. Chemistry & Environment – unable to attend meeting

724 Chemistry Control Procedure Review Risk – Follow up with Roger Daly – Mr. Chemistry &

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Environment – unable to attend meeting

718 Funds to cover shutdown maintenance backlog - Tom Carvin, explains about the maintenance backlog, not sure what that will be. Andy Elliot feels that this will be a station funding. Steve W confirms that is not funded by RF project. Not a Risk for contingency funds. Ryan Smith advises that should be managed as a Risk, not funded as a contingency item. Rephrase for problematic review but ensure it is part of the RF responsible for Business Planning process. Move out to Program Risk.

708 Materials budget for emergent broke-fix maintenance – Panel feels schedule impact is covered for broke-fix items at the program level. Keep this risk but rewrite the risk description, describe the cost risk and schedule impact on returning unit to the service, we have a requirement a budget for materials for broke fix. Make this a residual risk item only. Ryan Smith advises to involve the P&C lead to add to base plan, if unable to add to base plan, then make a 100% risk.

706 ERT Plan doesn't accommodate for islanded unit emergent issues.
Tom Carvin explains that this risk is for work that could be stopped for an ERT event. This may be a duplicate risk, RFR may have this covered in their RISKS, review. Add note to explain "Accept means that the plan is in place", Vendors have ERT in place should be 3,3,3. Add comments as to what you would do with the these contingency funds, eg. A residual use of these funds, are for schedule delay.

677 Availability of DN Authorized staff. A high level OPG RISK, with the station, the station holds this RISK as well. Cost is impacting the RF schedule, this contingency is for overtime. . State this is a residual risk for the event that we can't cover with augmented staff. Andy Elliot, says keep to a minimum, already covered at the program level. Probability should be lower as there is plan in place. Change the description to clarify the cost risk and the schedule risk, add in what mitigation plans are in place. Rational and comments add to 3 point estimate notes.

676 Inadequacy of D2O Storage, An Assumption that D2O is unsuccessful, not complete on time. No cost to Ops to Maintenance. Manage as a RISK only no contingency funds, the cost is a program risk. Make sure it is in the Execution Risk. Ops & Maintenance shouldn't be paying for this contingency plan. ACTION to move this to an Execution Risk - Ryan Smith

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565 Insufficient qualified radiation protection co-ordinations to support execution follow up with Jeff Schaefer. Check RFR Schedule Risks and Execution Risks. Can this be mitigated prior by hiring more people?

564 Large Potential woker Dose exposure - follow up with Jeff Schaffer. Check RFR Schedule Risks and Execution Risks.

555 Fire Risk - Duplicate with RFR Risks. Note this High Impact RISK, Dispostion to Black Swan risk, Action Ryan Smith

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ONTARIO POWER GENERATION	NUCLEAR REFURBISHMENT MINUTES OF MEETING	INTERNAL USE ONLY	
MEETING TITLE:	RQE Contingency Development WorkShop – Engineering	DEPT	Planning & Controls-RISK

PLACE	DEC – Conference Room 3D	DATE	July 21	TIME	2:30 – 4:00

ATTENDEES

Participants	Title & Department
Steve Wiacek	Finance
Lisa Ren	Section Manager – Risk
Ryan Smith	Manger Risk
S. Fraizinger	RQE
Donna Flewell	Risk
Atef Soliman	Risk
Ted Gado	Engineering
Alberto Casto	P&C Lead
Imtiaz Malek	Nuclear Safety Director
J. Carter	Modus

Meeting Action Items:
745 High volumes of 244 of Engineering Changes. Adjust or update this Risk Description to current. Currently no show stoppers. What is the impact? Schedule delay? Action: Carry as risk on first unit only. Don't carry the risks as contingency calculations. Panel review for duplicate risks in late engineering, is it covered in the project risks. Andy Elliot advises that there is a contingency is held for field engineering, also for discovery work. Create new Risks in RMO to have them appear in this template.

702 This may be not a risk. Rewrite to clarify as a residual risk, potential for invalidated assumption. Capture the cause. Add in the basis for the three point estimate, add a bulleted note. Action to Atef. No delay to critical schedule. Update to 0,0,0. Add an assumption to the RMO database. Cost is per occurrence. Adjust to maximum $1M (R) $2M(P) agreement to borrow Engineering from the Station, document in the rationale.

746 reconsider the costs, could be low. Should change scoring to reflect as all cost risk, should be 1,1,1. No affect to schedule. Addtional note: risk 746 would be incorporate into the Black Swan List.

723 add notes on OPEX to explain potential Scope growth, mitigation on most leaving a 10% risk, 3 point estimate realistic. This could hold up critical path, score 2 is realistic. Base description to include 4 holds points.

750 Add notes on the right to explain the three point estimate. Consider adding a Risk of staffing of Engineers, cost to obtain the required quality level engineers.

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ONTARIO POWER GENERATION	NUCLEAR REFURBISHMENT MINUTES OF MEETING	INTERNAL USE ONLY	
MEETING TITLE:	RQE Contingency Development WorkShop – Function group - Contract Management, Managed System Oversight, HR, Planning and Control	DEPT	Planning & Controls-RISK

PLACE	DEC – Conference Room 3D	DATE	July 22	TIME	11:00

ATTENDEES

Participants	Title & Department
Steve Wiacek	Finance
Lisa Ren	Section Manager – Risk
S. Fraizinger	RQE
Ryan Smith	Manager Risk
Donna Flewell	Risk
Jame Wu	Risk
Doug Semple	Director Contract Management
Kelly Reid	Manager Contract Management
Frank Dias	Manager MSO
Deepa Chatterjee	Manager P&C
Carrie Okizaki	Modus
Jim Carter	Modus
Derek McAuley	Manager P&C
Andy Elliot	Manager P&C
Lindsay Greenland	Manager P&C

Contract Management

714 Cause of the Risk, clarify, contracting strategy is not complete, write assumption uncertainly on the strategy of contracting, cause and impact is missing from the description. If the risk is realized the funds will be used to fund a team of people to execute the work program. Where are the risks to cover contract management EMSMA carried? Action to Risk team to follow up to find in project risk registers.

Increase in Scope of work, consider reoccurrence, rating is displaying expectancy of the event reoccurring, optimistically 0, most likely 1, pessimistic 2, consider the cost impact per occurrence, 6 million removed from their budget in 4D, clarify rational for contingency funds.

705 Reads as a duplicate, rewrite to describe the difference from 714, Explain the structural approach of the contract management. Action to Risk Department to review project risks for duplication. Projects are responsible for funding contract management administration. Write a rational to describe that the funds will be used for additional staff as required. Review risk reoccurrence. There is no schedule impact. Review project Risk Registers for Risks coverage in respect with claims from the contractor.

Managed System Oversight
764 Add a cause to the risk description, not enough resources, whatever is applicable, due to increase of scope. Add notes to residual risk rational. Change rating to reflect reoccurrence projections. Add information, on the 3 point estimate. Review projection on FTE estimates.

Planning and Controls
760 Reporting Resources, rewrite risk description to include the context, to include the cause, the nature of the work will change, based on OPEX from other projects, contingency fund will be used to fund additional resources, current risk score should reflect high probability, not impact to the schedule, add notes that this would have only one occurrence, per unit.

751 Foreign Exchange Rate move to an assumption in the database, remains in RMO, difficult to quantify, managed as a risk, but not asking for contingency funds.

711 IT infrastructure, Action to replace U2 breaker open to a check estimate. Cost of IT projects separate from IT Quality, create two Risks, mitigation strategy is very different. Update the probability to reflect this in both cases.

664 P&C Shortfall of resources, update description that a plan is in place, this risk item is for residual risk, to replace resources, potential of a onetime event, but cost estimate to cover this issue. 300, 1M, 3M. Update.

661 Beef up the description, Action Ryan Smith, review 3 point assumption, residual risk should be low, what would you do with the funds, potential affect to critical path, significant impact. Consider this as a Black Swan event. Business change based on data.

Human Resources
561 U2, Leadership not in place, impacting cost, schedule and quality, clarify that this is a program risk, cost impact of leadership change, push back on the schedule delay, severance not paid by the project, need more notes on rationale of this cost, add a assumption in the database that the leadership is right sized and we are not carrying any contingency to cover change.

Additional Items from Finance:
Insurance, Escalation, Interest, Risks are created, Action Steve to Risk Management, create assumptions from these Risks. Remove from the contingency spreadsheet.

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ONTARIO POWER GENERATION

NUCLEAR REFURBISHMENT MINUTES OF MEETING

INTERNAL USE ONLY

MEETING TITLE:	RQE Contingency Development WorkShop – Fuel Handling	DEPT	Planning & Controls-RISK

PLACE	DEC – Conference Room 1A	DATE	July 22	TIME	1:00 to 3:35

ATTENDEES

Participants	Title & Department
Ryan Smith	Manager Risk
Steve Wiacek	Finance Manager
Lisa Ren	Section Manager – Risk
S. Fraizinger	RQE
Donna Flewell	Process Specialist – Risk
Patrick Guevel	BMcD/MODUS
Peter Sharawy	SDC PM
Alejandro Osorno	P&C Lead
Devon Bekker	Fuel Handling
Catalin Butoi	Project Engineer
Greg Maggs	Project Manager
Sean Zhen	Fuel Handling
Tony Carito	Fuel Handling Project Manager

Meeting Agenda Items

12414 add more detail to the risk to the description, PO is issued, a revision of estimate, a variation to the standby time. Uncertainty around the standby estimate, or a discrete risk, explain that it is both. Review cost register, Risk team to follow up to ensure this is not a duplicate. Risk occurrence first unit only, should be removed from contingency once a trolley is assigned. Costs for CCF standby is what we would use for contingency. Consider the impact to the schedule; add notes, to rationalize why this will also affect the schedule. Add notes on where you got the price estimate.

Skipped to next highest probability risk of 50% due to long list of items to review

13381 ES MA Staffing Agreement, Unable to reassign work when dealing with vendor, as work is assigned based on schedule.

11980 Execution Delays due to scheduling logic, OPEX from other unit outages, they have had to remove Trolley from service due to lack of reliability, add notes on current mitigation, once vendor finishes detailed planning, then agreement needs to be made with the station. Risk is for combination of Reliability issues and schedule logic. Optimistically 2 occurrences, due to the fact that there is all unit piece of equipment, rationalize the thought process in the notes.

11684 Availability of PTF/SARF for defueling, 50% as the commissioning of SARF has not occurred; rewrite the description to true up a clarification is made. Program burn rate is not 2M a day, 500k p,

400K most likely, 300K optimistic. Ensure linked to program risk.

11099 Single Ended Flow Defueling not achievable, update the 3 point estimate, Gregg Maggs, optimistic and most likely should not be the same. Revisit after commissioning, consider mitigation due to the request for high contingency dollars.

Note: No Ops and maintenance duplication today on their Risk register, Steve Wiacek

13395 Price uncertainly in regards to replacement of inverters, update risk description to add a Cause, to add to event and impact.

12328 SDS , There is OPEX that there is signal grounding issues from past computer system installations. Impact to project critical path, the reoccurrence number represents a grounding problem for each computer system 23 times; provide details on your rational on the high estimates and the costs.

12323 Procurement Risk for the hardware, rewrite the risk may to state the residual risk, go away once the PO is in place, this work is complex and it is on critical path, extra money is to cover extra costs to get extra workers available once the hardware is ready.

Review remaining list, only keep items that require contingency funds, the rest create assumptions in RMO then, remove risk from contingency fund for RQE.

Steve Wiacek, opportunities, Are there any disincentives funds to take into consideration?. Response from Peter Sharandy, There is no cost impact recoup worth documenting.

13394 Vault Cooler Scope Change, this could be SRV, you would get the funding from the program contingency bucket, consider updating the trigger date, add a time that this Risk may go away.

Lisa Ren comments that there is a large number@ 90% have a schedule impact, review all to clarify rational, if not then, disposition these to “Assumptions” rather than Risk, if you can’t defend the details for contingency funds.

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ONTARIO POWER GENERATION	NUCLEAR REFURBISHMENT MINUTES OF MEETING	INTERNAL USE ONLY	
MEETING TITLE:	RQE Contingency Development WorkShop – Steam Generators	DEPT	Planning & Controls-RISK

PLACE	DEC – Conference Room 2D	DATE	July 23	TIME	9:00 to 11:00

ATTENDEES

Participants	Title & Department
Donna Flewell	Process Specialist – Risk
Jim Carter	Modus
Mike Lutz	SG – Project Engineer
Pejman Asgaripour	Project Manager
Peter Misev	P&C Lead
Ryan Smith	Manager Risk
Steve Wiacek	Finance Manager
S. Fraizinger	RQE
Dennis Curley	Outage Manager

Meeting Agenda Items Comments and Actions for Steam Generator;

Please write bulleted notes to describe the basis, Risk is incremental to meeting the Target Price. It was the choice to keep a detailed risk register on issues to cover things rather than affect the target price.

13450 Demobilize activities, carrying costs for the vendor, result of a late assumption, identify the cause of the risk, This item may not be valid in future, this is the risk to the current base plan. The residual risk of 75% is high, reconsider this to be incorporated in scheduled resources. Add note on your Mitigation strategy to share resources. Pessimistic score, correct this to reflect a onetime occurrence, most likely 3 more times on each unit. Remove the burn rate and add in the actual cost, no critical path impact. Provide notes that PMT is a % cost.
Action to the panel, Review all Risk Register as a whole to look at RISKS to total cost carry extra contingency for no work times.

13448 Originally change to the schedule window, change from B&W to incorporate IMS, which extended the schedule, add notes to describe that you need these funds now, no resolution want to carry in contingency funds rather than change baseline, comments to describe that this issue may be resolved too pre-mature to ask for the baseline change, schedule delay show the actual cost impact amount not a burn rate.

13302 Foreign Material enters Steam Generator, secondary side, add notes based on OPEX at Pickering, similar to

11925 Clarify the Risk, consider adding this a Risk to Manage only don't keep in the template for contingency funds. Or make it a residual risk to cover IMS tube plugging. Lower the risk because this did happen recently at Pickering and they should be aware, so less likely to occur.

13340 Steam Generator Primary side maintenance and inspection execution window conflict, What is the Event, Cause, impact, for any reason RFR gets delayed, which pushes the timing of the window, they are struggling to find a window, window could also be split, Update recurrence notes to explain that this a onetime occurrence, once the schedule is ironed out, 3,1,0 remains. Schedule should reflect strategy, to mitigate, remove burn rate, to increase cost rather than lengthen overall schedule. Add comments to explain.

11294 Magnetite contamination event, Low probability, High impact, consider this as a black swan items, OPEX notes required. Capture high RISK to the schedule.

13414 Legacy of FME in the Steam Generation, cost impact is high, adjust cost to reflect per occurrence. Know FME pieces in four boilers, comments to add explain why you feel this, OPEX that something has moved that it is discovered FME.

12317 The event of SG Manway manipulator not available for use. Program Risk, how does it impact the costs, Action Steve W will review at the program level. Possible Black Swan, add to station Action: to review cost of obtaining a secondary manipulator.

Reminder to add your additional Risk for outstanding DCRs.

Ryan Smith consider the comments to PEPCI elements, Monday is the deadline for final comments.

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ONTARIO POWER GENERATION	NUCLEAR REFURBISHMENT MINUTES OF MEETING	INTERNAL USE ONLY	
MEETING TITLE:	RQE Contingency Development WorkShop – Balance of Plant	DEPT	Planning & Controls-RISK

PLACE	DEC – Conference Room 1A	DATE	July 23	TIME	1:00 to 3:00

ATTENDEES

Participants	Title & Department
S. Fraizinger	Section Manager – Risk
Donna Flewell	Project Manager – Turbine Generator
Dennis Curley	Outage Manager
Terri Keggenhoff	Finance
Daniel Greene	BOP
Katie Stewart	BOP
Scott Guthrie	BOP
Mitch Carpentier	BOP
Grant Hillier	KPMG
Andy Elliot	P&C

Meeting Agenda Items

Scott GUTHRIE reviewed all projects to cross reference all project risks, doesn't feel he can have this full review complete by Monday. Would like to assign radar numbers to each line item, some items are not in the RMO tool to date. Action to Ryan Smith answer questions on How will phase one contingency be used, if they are able to return portions that are un-used, as Risks go away? Worried that once thing are set, it does get opportunity to hand back the risk reserve but keep his budget. Asking for more time to review risk register, add rationale. He has a budgeted for contingency, with a terminal approach, wants to have an end product to match this. Ryan Smith please provide the current new Change Management procedure and how it handles Contingency.

118654 Scope Increase Risk, Cause inspections are showing a scope increase, response strategy, contingency money is to cover additional scope, is this based on 1321 outage OPEX, current risk score 3,3,1, mitigation score should drop, the residual risk should be there to cover post mitigation. Think about ranking the likely hood of the probability, Rank the optimistic values, as a onetime occurrence, separate out the cost impact, show now schedule as zero.

13578 Add detail to assumptions, describe the black and white issue, add as a straight cost impact, zero out the schedule impact, one time occurrence.

Andy Elliot, the process will make it easy to draw down on the contingency by the project lead. SG wants to manage their own risks. Andy Elliot comments that the current gate process covers the

ability to manage the contingency.

13266 pressure boundary cover for AA and VFD Replacement, 12, 15, 17, reflects per unit.

13297, if you were given contingency fund it would be overtime by ANO, OSS resources, to pay overtime for station staff, schedule impact not clear, tag station interface risk item.

13263, PHT pumps require repairs, 50% probability, this recently has been lowered, update this in the notes. This should show a schedule impact, a big dollar value, update the dollars to reflect optimistic.

13315, Risk of Nuclear Safety Report, change the description, should read as a risk to our design based on vendor submission.

13369 Vault work interferes with JV works, schedule impact is this accurate? Is this a cost risk, Potential program Risk, paying for people standing around no work time.

13361 Passing 2 33810 – V1, the probability should be lowered on this one.

Item # below 13368 (no number) Action to ensure to add all items to RMO database, Procurement of Additional portable driers, why is this BOP project, Dennis Curly asks, this should be a Potential station interface item. Roy Brown could have a contract in place to cover this item. Action to risk team to review as this is a potential duplication risk.

How quickly can we deal with the updates completely by the bundle, do a Monte Carlo analysis? Action Ryan Smith to assist the BOP team to come up with a strategy to meet the Monday and lock down of the Risk Register.

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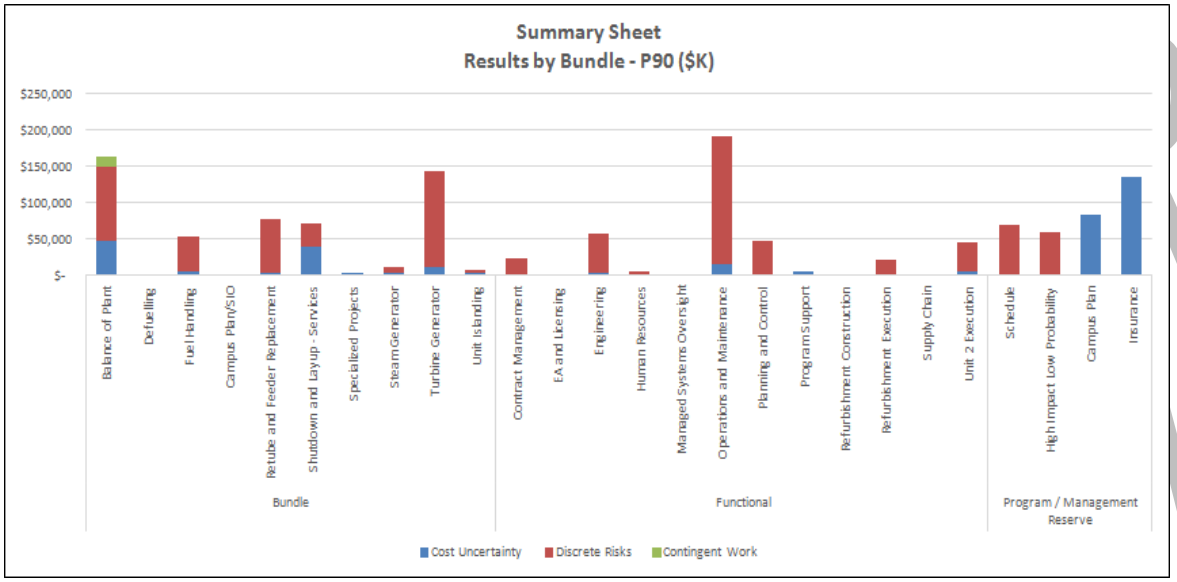
6.0 APPENDIX B: NR RQE CONTINGENCY REPORTS



Summary Sheet

Summary Sheet Results by Bundle - P90 ($K)

Display	P90	Ref Column 14 Cost Uncertainty	15 Discrete Risks	16 Contingent Work	16 Total
Bundle	Balance of Plant	$ 47,464	$ 101,038	$ 15,640	$ 164,142
	Defuelling	$ 862	$ -	$ -	$ 862
	Fuel Handling	$ 5,753	$ 48,459	$ -	$ 54,212
	Campus Plan/SIO	$ -	$ -	$ -	$ -
	Retube and Feeder Replacement	$ 3,137	$ 73,233	$ -	$ 76,371
	Shutdown and Layup - Services	$ 39,890	$ 32,087	$ -	$ 71,977
	Specialized Projects	$ 2,903	$ -	$ -	$ 2,903
	Steam Generator	$ 2,834	$ 8,691	$ -	$ 11,524
	Turbine Generator	$ 11,106	$ 131,699	$ -	$ 142,805
	Unit Islanding	$ 2,526	$ 5,777	$ -	$ 8,303
Functional	Contract Management	$ 497	$ 22,733	$ -	$ 23,230
	EA and Licensing	$ 967	$ -	$ -	$ 967
	Engineering	$ 3,904	$ 52,667	$ -	$ 56,571
	Human Resources	$ 160	$ 5,233	$ -	$ 5,393
	Managed Systems Oversight	$ 33	$ 2,167	$ -	$ 2,200
	Operations and Maintenance	$ 16,189	$ 176,138	$ -	$ 192,326
	Planning and Control	$ 1,152	$ 46,800	$ -	$ 47,952
	Program Support	$ 5,242	$ -	$ -	$ 5,242
	Refurbishment Construction	$ -	$ -	$ -	$ -
	Refurbishment Execution	$ -	$ 21,771	$ -	$ 21,771
	Supply Chain	$ 981	$ -	$ -	$ 981
	Unit 2 Execution	$ 4,874	$ 41,300	$ -	$ 46,174
Program / Mana	Schedule	$ -	$ 69,867		$ 69,867
	High Impact Low Probability		$ 59,007		$ 59,007
	Campus Plan	$ 83,195			$ 83,195
	Insurance	$ 134,729			$ 134,729
	Total	**$ 368,398**	**$ 898,666**	**$ 15,640**	**$ 1,282,704**

Report

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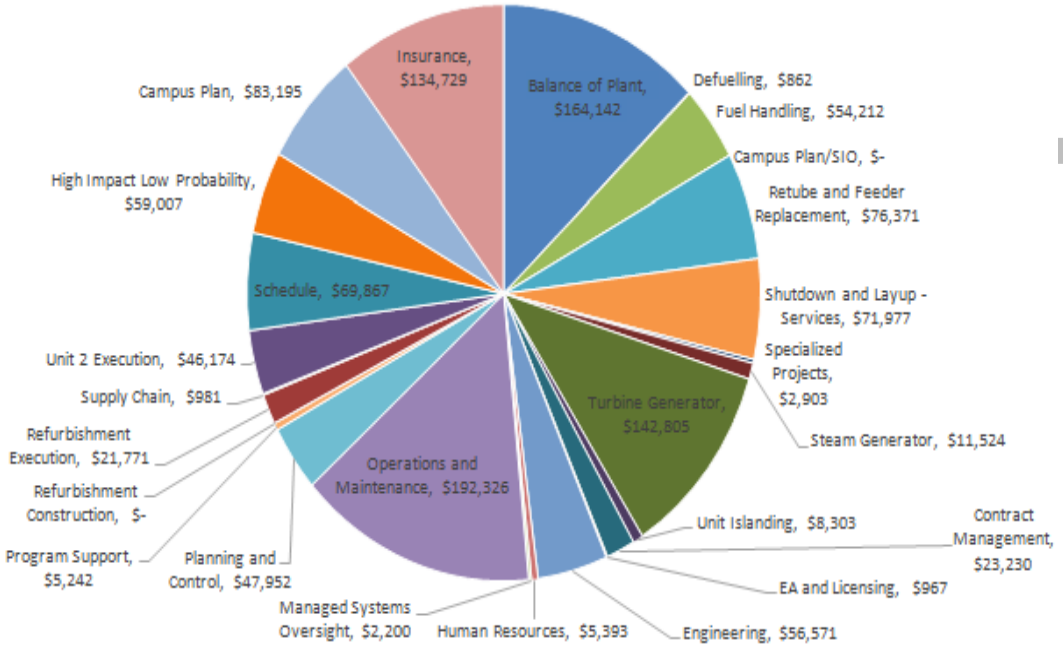
Document Number: N-REP-09701-0556625		Usage Classification: Information
Retention: T-10	Revision Number: R000	Page: 35 of 35

Title:
RQE CONTINGENCY DEVELOPMENT REPORT

	Bundle / Project	Cost Uncertainty	Discrete Risks	Contingent Work	Cost Uncertainty	Discrete Risks	Contingent Work	Cost Uncertainty	Discrete Risks	Contingent Work
Project Bundle	Balance of Plant	$ 47,464	$ 101,038	$ 15,640	$ 47,464	$ 101,038	$ 15,640	$ 47,464	$ 101,038	$ 15,640
	Defuelling	$ 862	$ -	$ -	$ 862	$ -	$ -	$ 862	$ -	$ -
	Fuel Handling	$ 5,753	$ 48,459	$ -	$ 5,753	$ 48,459	$ -	$ 5,753	$ 48,459	$ -
	Campus Plan/SIO	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Retube and Feeder Replacement	$ 3,137	$ 73,233	$ -	$ 3,137	$ 73,233	$ -	$ 3,137	$ 73,233	$ -
	Shutdown and Layup - Services	$ 39,890	$ 32,087	$ -	$ 39,890	$ 32,087	$ -	$ 39,890	$ 32,087	$ -
	Specialized Projects	$ 2,903	$ -	$ -	$ 2,903	$ -	$ -	$ 2,903	$ -	$ -
	Steam Generator	$ 2,834	$ 8,691	$ -	$ 2,834	$ 8,691	$ -	$ 2,834	$ 8,691	$ -
	Turbine Generator	$ 11,106	$ 131,699	$ -	$ 11,106	$ 131,699	$ -	$ 11,106	$ 131,699	$ -
	Unit Islanding	$ 2,526	$ 5,777	$ -	$ 2,526	$ 5,777	$ -	$ 2,526	$ 5,777	$ -
	Total Bundle	**$ 116,474**	**$ 400,985**	**$ 15,640**	**$ 116,474**	**$ 400,985**	**$ 15,640**	**$ 116,474**	**$ 400,985**	**$ 15,640**
Functional	Contract Management	$ 497	$ 22,733	$ -	$ 497	$ 22,733	$ -	$ 497	$ 22,733	$ -
	EA and Licensing	$ 967	$ -	$ -	$ 967	$ -	$ -	$ 967	$ -	$ -
	Engineering	$ 3,904	$ 52,667	$ -	$ 3,904	$ 52,667	$ -	$ 3,904	$ 52,667	$ -
	Human Resources	$ 160	$ 5,233	$ -	$ 160	$ 5,233	$ -	$ 160	$ 5,233	$ -
	Managed Systems Oversight	$ 33	$ 2,167	$ -	$ 33	$ 2,167	$ -	$ 33	$ 2,167	$ -
	Operations and Maintenance	$ 16,189	$ 176,138	$ -	$ 16,189	$ 176,138	$ -	$ 16,189	$ 176,138	$ -
	Planning and Control	$ 1,152	$ 46,800	$ -	$ 1,152	$ 46,800	$ -	$ 1,152	$ 46,800	$ -
	Program Support	$ 5,242	$ -	$ -	$ 5,242	$ -	$ -	$ 5,242	$ -	$ -
	Refurbishment Construction	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
	Refurbishment Execution	$ -	$ 21,771	$ -	$ -	$ 21,771	$ -	$ -	$ 21,771	$ -
	Supply Chain	$ 981	$ -	$ -	$ 981	$ -	$ -	$ 981	$ -	$ -
	Unit 2 Execution	$ 4,874	$ 41,300	$ -	$ 4,874	$ 41,300	$ -	$ 4,874	$ 41,300	$ -
	Total Functional	**$ 34,000**	**$ 368,808**	**$ -**	**$ 34,000**	**$ 368,808**	**$ -**	**$ 34,000**	**$ 368,808**	**$ -**
Program / Management Reserve										
	Schedule	$ -	$ 69,867		$ -	$ 69,867		$ -	$ 69,867	
	High Impact Low Probability		$ 59,007			$ 59,007			$ 59,007	
	Campus Plan	$ 83,195			$ 83,195			$ 83,195		
	Insurance	$ 134,729			$ 134,729			$ 134,729		
	Total Program	**$ 217,924**	**$ 128,873**	**$ -**	**$ 217,924**	**$ 128,873**	**$ -**	**$ 217,924**	**$ 128,873**	**$ -**
	Total	**$ 368,398**	**$ 898,666**	**$ 15,640**	**$ 368,398**	**$ 898,666**	**$ 15,640**	**$ 368,398**	**$ 898,666**	**$ 15,640**
	Total for Percentile			**$ 1,282,704**			**$ 1,282,704**			**$ 1,282,704**

Total Cost by Bundle



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ONTARIO POWER GENERATION

Manual

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Document Number: **N-MAN-00120-10001**	Usage Classification: **N/A**
Sheet Number: **RISK**	Revision: **R00**

Title:
Nuclear Projects Risk Management

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Nuclear Projects Risk Management

N-MAN-00120-10001-RISK-R000
2015-03-30

Order Number: N/A
Other Reference Number:

Internal Use Only

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Riyaz Habib
Director
Projects and Modifications

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Revision Summary

Revision Number	Date	Comments
R00	2015-03-30	Major Revision to the document to address the integration of the draft P&M Risk Guide RISK-G-01 and to incorporate direction of the new Risk Management and Oversight (RMO) tool. Integration of all NR manuals (RISK-07, RISK-08) regarding assumptions and decisions management into a single document.
R003	2014-06-28	Updated the Risk Management Process to include Key Risk Areas and the related sponsors' responsibilities
R002	2014-03-24	Integrate N-MAN-00120-10001-Risk 05 (contingency development) to create a consolidated single document. Removed the cost control/change control/reporting sections for contingency. Non-intent updates to provide clarification or context as requested by manual users.
R001	2013-07-07	Minor updates
R000	2012-07-25	First Issue

1.0 DIRECTION

Risk management is a systematic approach to identifying, analyzing, and responding to project risks. The goal of risk management is to proactively identify and manage risks in order to deliver projects safely, with quality, on time and on budget. This document provides direction to projects for both day-to-day risk management activity as well as the risk management preparations for authorization packages presented at funding gates/committees.

2.0 SCOPE

A graphic depicting the “inputs to” and “outputs of” risk management activity that fall under the scope of this document is outlined below. The sections of this manual are structured in alignment with this diagram.

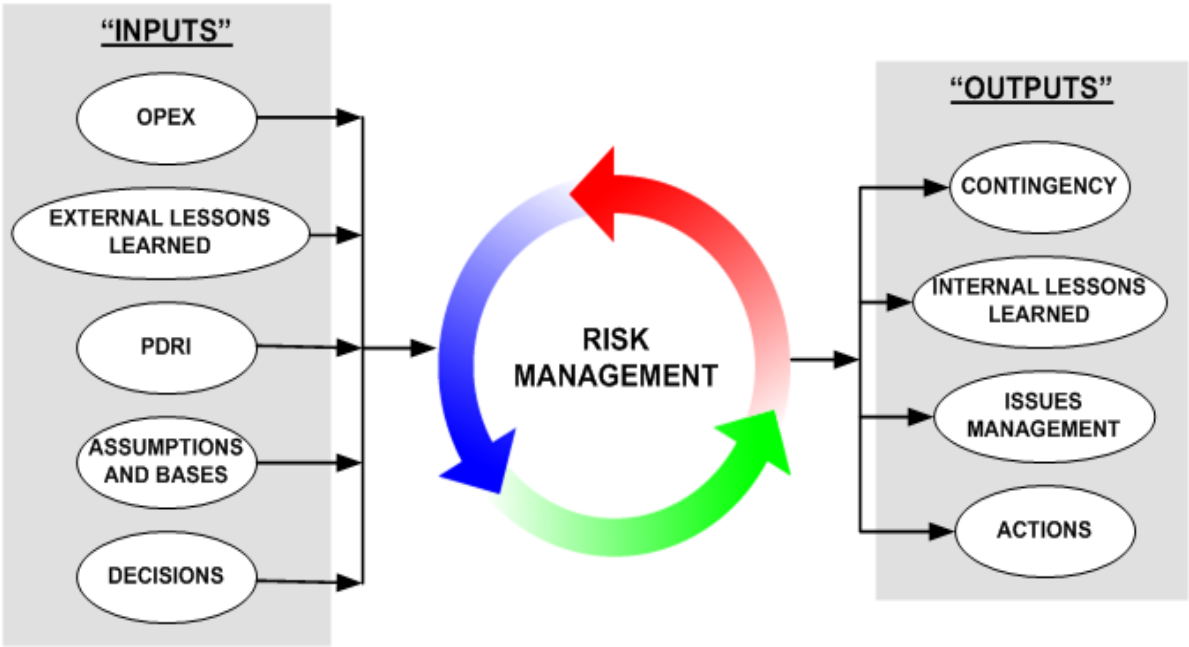


Figure 1: The Risk Management Process

2.1 Risk Management and Oversight Tool (RMO)

The Risk Management and Oversight (RMO) tool is an application project managers will use to perform risk management activity for projects. The Project Management Office (PMO) is the owner and administrator for this tool and provides training, support, and guidance to the organization. This manual does not include detailed direction for using the RMO tool. For details on how to use the RMO tool, refer to *N-GUID-09701-10123, Risk Management and Oversight Tool*.

2.2 PMO Role

The PMO Risk Department will provide guidance to the project managers in the application and interpretation of the requirements outlined in this manual. The support provided exists both in the day-to-day application as well during preparation of funding approval packages (e.g. Gate Review Board). The PMO risk department will perform oversight of the RMO contents on behalf of the Nuclear Projects organization and will prepare reports, metrics, self-assessments, and other such analyses from time to time to monitor the effectiveness and use of the processes outlined in this manual. Annually a consolidated report will be prepared incorporating a strategic review and identification of any corrective actions.

Additional project controls support and deliverables, where applicable, are outlined in the appropriate section of this manual.

3.0 RISK MANAGEMENT INPUTS

Risks to project objectives can be identified from a number of sources. If these sources of risk are not considered both in the development of the initial risk profile as well as during ongoing risk management activity the ability for the project manager and senior leadership to make informed decisions about the project may be adversely impacted.

3.1 Operating Experience (OPEX) and External Lessons Learned

OPEX is information ***gained through experience*** that should be retained for future use. Depending on the observation made, OPEX could be a valuable technique, a best practice or a successful outcome you wish to repeat or an undesirable result you wish to avoid. When applicable OPEX is recognized, the project manager is then equipped with the knowledge to incorporate it into their baseline cost and schedule or manage it as a risk.

The Nuclear Projects process complies with *OPG N-PROC-RA-0035, Operating Experience Process*. This base standard has an operational focus. For project risk management, the goal is to look beyond operational events and seek out events that have happened both in nuclear and non-nuclear projects that may present risks to the project that is being undertaken.

OPEX obtained through RA-0035 process is added to the RMO database by the PMO and dispositioned by the designated department or project. Anyone with access to the RMO tool can add an OPEX event under the OPEX tab. The PMO can assist the project manager in searching for specific event types and populating the RMO OPEX library with new information that will be helpful to others.

Lessons Learned (LL) are similar to OPEX items, in that they have a foundation in past events. A lesson learned however ***goes beyond an individual event to provide key insights and clearly identify the causal factors that contributed to a positive or negative outcome.*** The RMO tool contains a searchable lessons learned library, with major lessons learned categorized as Programmatic Lesson Learned (PLL). Each PLL

is assigned an owner within Nuclear Projects whose accountability is to ensure that proper actions are developed, assigned, and are monitored to completion.

3.1.1 Project Manager Direction

Project managers should be up to date on the content of the OPEX and LL libraries as they conduct their day-to-day risk management activities. Good practice would be to establish periodic reviews of OPEX and LL within their project teams during regular risk reviews.

Prior to any funding gate a detailed review of the RMO OPEX and LL library must be performed and any items that were considered in the preparation of the baseline cost and schedule or resulted in a project risks shall be identified. A summary of the review performed shall accompany the gate or funding approval package in the form of a narrative in *N-FORM-11652, Nuclear Projects Risk Management Input Assessment*.

PMO Role

The PMO Risk Department receives external OPEX from the central nuclear OPEX coordinator. The OPEX received has been pre-screened as per *N-GUID-04947.02-10000 External Events Screening Guide* and is determined to be relevant to Nuclear Projects. These items are populated in the RMO tool by the PMO risk department. The PMO risk department will also proactively seek out external and internal project related OPEX events through a variety of sources identified in Appendix A. The PMO risk department provides oversight support and disseminates significant information in real time through email communications. The PMO risk department creates programmatic lessons learned (PLL) based on significant OPEX and presents them to CARB.

3.2 Project Definition Rating Index (PDRI)

The Project Definition Rating Index (PDRI) is an industry best practice front end planning tool that helps assess the level of project scope definition and stakeholder alignment during the critical formative stages of the project. The objective of a PDRI is to identify gaps in scope definition early on, prior to committing significant funding to the project. The gaps in understanding or definition identified in the PDRI workshop shall be closed by the project manager prior to proceeding further (i.e. prior to submitting the funding package for approval). At minimum if the gaps cannot be resolved the project manager can use the insights gained in the PDRI session to inform the project risk register.

The requirement for a project to undertake a PDRI workshop is defined by the gating process. The PMO Risk Department can assist the project manager in executing a PDRI workshop by providing resources and facilitation.

3.3 Assumptions and Project Bases

Assumptions are factors in the planning process that are considered to be true, real, or certain, without proof or demonstration. Assumptions are ***not completely defined in project documents*** but are required in order to develop the cost and schedule estimates for projects.

Project bases are ***documented descriptions of how an estimate, schedule, or other plan component was developed*** and defines the information used in support of development.

To the extent possible when preparing funding approval packages, the use of assumptions shall be minimized. It is important when preparing the cost and schedule estimates to disposition assumptions so that the project plan being presented has been validated and is supported by project bases. Any residual assumptions that cannot be dispositioned or built into the cost and schedule as a project basis shall be entered into the RMO assumption log and reviewed during preparation of the project risk register. Assumptions are to be populated in the RMO tool, and can be initiated by any Nuclear Projects personnel with access. Project bases that are not documented in other project documents (such as the basis of estimate) shall also be documented in the assumptions log in the RMO tool.

3.3.1 Assumption Revision or Closure

Assumptions can be closed when they are no longer relevant or when they are known to be incorrect or invalid. New or modified assumptions that impact other projects directly, or those that are widely applicable (i.e. “program” level assumptions) shall be broadly communicated by the initiating project manager in order to bring awareness to those affected departments or projects. For example, an assumption pertaining to contracting or resourcing strategies may have a wide ranging impact on projects already in flight therefore strategic, effective communication is imperative.

3.3.2 Project Manager Direction

Prior to submission of funding approval packages, the project managers shall populate the assumptions log in RMO. These assumptions shall be assessed to determine if they introduce risk to the project and require entry to the project’s risk register. A summary of the assumptions made shall accompany the gate or funding approval package in the form of a narrative in *N-FORM-11652, Nuclear Projects Risk Management Input Assessment*.

The project managers shall keep up to date on the content of the assumptions log as they conduct their day-to-day risk management activities, and assess risks against assumptions made. Good practice would be to establish periodic reviews of the RMO assumptions log for any new programmatic assumptions made or any assumptions made for projects that may impact the subject project. The project manager shall re-validate their assumptions on a regular basis and at minimum at funding approval gates or when initiating the change control process.

3.4 Decisions

Documented decisions form a part of the project basis. Decision records are critical for maintaining an auditable trail for Nuclear Projects and assist in "telling the story" of the projects. In most cases, decisions exist in the form of approved documentation generated by following existing approved processes (the modifications and the engineering change control processes, Engineering or Operational Decision Making, for example). Decisions made under the execution of these processes do not need to be duplicated in the RMO tool.

Project decisions that should be entered into the RMO are those that are not covered by existing processes. These decisions tend to be strategic in nature and arise when there is not a clear path forward but rather a number of possible options to achieve the project's objectives. Too often, these decisions are made informally without the appropriate authority and are not communicated effectively, resulting in adverse impacts on the projects. These decisions shall be documented in a DRAS *(Decision Record and Analysis Summary) N-FORM-11390* and entered into the RMO tool once approved. A control document number shall be obtained for the DRAS and the DRAS shall be submitted to records in parallel with being added to the RMO decision log.

This decisions process and associated N-FORM is flexible and may be applied to provide structure to a number of different project departments for a number of different types of decisions. While all decisions documented in a DRAS shall be recorded in the RMO tool, this manual will not provide direction for all the various possible applications.

3.4.1 Project Manager Direction

There is no strict prescription or threshold for entering decisions in the RMO tool. If there is confusion regarding the appropriateness of preparing a DRAS, contact the PMO risk department for support and guidance. As a general rule, the project manager should use judgment and input decisions in the RMO tool if:

a) The decision forms a fundamental aspect of the project basis and is not documented elsewhere as part of approved project processes, and/or
b) The decision would assist external and internal personnel in understanding the rationale and the considerations made in establishing the project plan, and is not documented elsewhere as part of approved project process.

In all cases, decisions must be validated with sufficient authority to ensure prudence and facilitate alignment among multiple organizations. Where a decision has a financial impact, the DRAS approver must have the authorization to approve the decision based on OPG-STD-0017, Organizational Authority Register. At minimum, for decisions that impact (or have the potential to impact) other OPG organizations, the Stratum IV manager of that department, or their delegate, shall review and comment. It is the project manager's accountability to ensure this happens. Any DRAS that results in a change of scope to the project must be submitted to the appropriate project review board/committee for authorization prior to approval. Any employee can initiate a decision in the RMO tool provided it is supported by an approved DRAS.

To the extent possible when preparing funding approval packages, the practice of documenting decisions is encouraged. The objective when preparing the cost and schedule estimates is to formally document decisions to support the project basis. A summary of the decisions made and recorded in RMO in the development of the project plan shall accompany the gate or funding approval package in the form of a narrative in *N-FORM-11652, Nuclear Projects Risk Management Input Assessment*. Good practice would be to establish periodic reviews of the RMO decisions log for any new decisions made that may impact the subject project and following up on any impacts if required.

Owners of the decisions recorded in the RMO tool shall review these decisions quarterly and update the project risk register as appropriate. Decisions that impact multiple organizations shall be broadly communicated by the decision owner in order to bring awareness to those affected departments or projects.

4.0 RISK MANAGEMENT

Project managers are accountable to apply the risk management (RM) practices identified in this section to their projects. The PMO Risk Department will provide tools, guidance, training, and support to the project managers.

The RM process includes the following fundamental steps:

(a) **Planning** – defining how to conduct risk management activities for the project or program.
(b) **Identification** – determining events that may affect the project objectives and documenting their characteristics.
(c) **Assessment** – analyzing and prioritizing identified risks based on probability and impact (qualitative), and estimating the potential cost and schedule implications of the risks to the approved objectives if they were to occur (quantitative).
(d) **Treatment** – determination of the most appropriate risk response to reduce threats to project objectives, or exploit opportunities to improve project performance.
(e) **Monitoring and Control** – implementing risk response plans, monitoring identified risks, identifying new risks, and evaluating risk process effectiveness throughout the project life cycle.

4.1.1 Risk Management Planning

A Risk Management Plan (RMP) describes how risk management responsibilities structured and performed. Each project should prepare a standalone RMP or have a section dedicated to risk management within its Project Management Plan (PMP). Where the project is a subset of a larger program, referencing the program RMP or PMP and documenting any specific project deviations or details to the parent plan is acceptable.

Included in RMPs are the following sections:

- **Risk Management Methodology** - defines the approach, tools, and data sources that may be used to perform risk management on the project.
- **Roles and Responsibilities** - defines the risk management leads, support personnel, and other team members including their responsibilities and accountabilities to ensure compliance with the risk management process.
- **Monitoring and Control** – definition of when and how often the risk management process will be performed, including the establishment of major risk management activities to be included in the project schedule. Monitoring and update frequencies will reflect the phase of the project life cycle (i.e. the execution phase will require a focused effort to stay on top of risks with more frequent updates).

4.1.2 Risk Identification

Risk identification is an iterative process because new risks may evolve or become known as the project progresses. The risk profile presented to support contingency development in a funding approval package is a “point-in-time” snapshot. Failure to perform ongoing risk management activity is negligent from a project management perspective and will result in adverse impacts to the individual project and the overall portfolio.

A number of techniques or forums may be used to identify risks. The project team and functional and external stakeholders should be involved in the process so they can develop and maintain a sense of ownership and responsibility for the risks and associated actions.

Tools and techniques to identify risks include, but are not limited to:

(a) Facilitated workshops
(b) Structured Interviews with experienced project team members, stakeholders and SMEs.
(c) Project Definition Rating Index (PDRI) Workshops
(d) OPEX and Lessons Learned Review
(e) Basis of Estimate (BOE) Review; review of assumptions and constraints in the BOE can be used as a source for risk identification.
(f) Project Schedule Review; review of near critical, critical path and schedule float in schedule assumptions can be used as a source for risk identification.
(g) Review of a standard risk breakdown structure for potential risks (Refer to Appendix C)

4.1.2.1 Common Pitfalls in Risk Identification

There are five common pitfalls in risk identification that leads to inefficiencies in managing risks:

(a) Identifying Risk Without Clear Project Objectives

Effective risk identification requires a high quality project plan with clearly defined cost, schedule, quality, and safety objectives. Without this, one cannot effectively identify risk to these objectives and items raised will be based in speculation and not facts. This can lead to initiating actions too early, team confusion, and create a perception that risk management is not an effective use of time or resources.

(b) The Presumption of Failure

Too often project and functional managers submit project plans (scope, cost, schedule, resources) for approval that they do not believe are reasonable and achievable. Further, a large risk register may be viewed as a means to indicate to the approval board that the project ''is not easy'' or has been unsuccessful in the past. This presumption of failure creates too many risks to effectively manage and a lack of clear prioritization for the team. A project risk register is not a repository to capture known shortcomings of an underdeveloped project plan.

(c) Identifying Issues as Risks

Issues are events that have 100% probability of occurring, or have occurred already and require resolution. As such, these are not preventable risk events but rather issues that should be addressed. Identifying issues as risks may distract the project managers and prevent them from focusing on the adverse impacts that are truly preventable.

(d) Business-as-Usual Risks

Events that will be addressed in the normal course of conducting work are termed Business-as-Usual items. These are items that have a process, plan or organization in place to address them, but the concern is that the execution may be “less than adequate”. Examples of poor use of Business-as-Usual risks include:

- “Project Managers may not meet milestones”.
- “Oversight plan may not provide complete details to provide guidance for oversight.”

In general, in order to be a risk there has to be impact to the objectives of the project plan. Business as usual items may truly present a risk to the project but the cause and the impact must be clearly identified in the risk description in order to be effectively managed.

(e) Vague or Misleading Risk Titles and Risk Descriptions

Risk titles that are vague or misleading may result in response plans that do not address the real risk that the project is facing.

4.1.2.2 Risk Titles

Risk titles describe the event and the context of the event.

"*There is a risk of insufficient welders available** <event> **to support Execution** <context>"***

4.1.2.3 Risk Descriptions

Risk descriptions should be comprised of the risk ***event***, the ***cause*** of the event, and the ***impact*** of the event on project objectives. The absence of any one of these critical items would preclude the item from being added to the risk register due to the inability to define a proper risk treatment.

"There is a risk of insufficient welders available <event> **to support Execution due to competition with other large industrial projects in the province** <cause>**, resulting in a delay that will impact the critical path by 30 days** <impact>**".**

4.1.2.4 Opportunities

An opportunity is an event that, if it is implemented or occurs, increases the likelihood of achieving project objectives. An opportunity must demonstrate a clear benefit to achieving a project objective *in sufficient magnitude to offset the risk presented by changing course*. Opportunities identified in the SharePoint log "Opportunities Inbox" will be reviewed periodically by the PMO risk department and reported in the Risk Oversight Committee meetings for further consideration. In all instances where opportunities are identified as valid, they are to be pursued with focus (i.e. exploited to the extent possible).

4.1.3 Risk Assessment

4.1.3.1 Risk Register

A project risk register is a living repository of risks and is the project manager's tool for identifying, assessing, monitoring, and updating project and program risks. The RMO tool contains the risk registers for all nuclear Projects – it is the working tool and also provides storage and backup of all risks and the associated logs. Risks included in the risk register should include ***all project life cycle risks*** that can be properly defined, without speculation, bias, or other such features identified in section 4.2.1.

4.1.3.2 Qualitative Scoring of Risks

Qualitative risk scores assist those inside and outside project team in quickly determining the biggest risks to the project. A "heat map" scoring approach is taken based on the probability of occurrence, schedule impact and financial impact of a risk (refer to Figure 2). After the probability, financial impact and schedule impact scores are determined the risk score is calculated by multiplying the probability score with the financial or schedule score, whichever is highest. The heat map scoring is standard for probability and schedule impact, but scaled to four categories for cost assessment criteria based on magnitude of the project and financial impact of the risk. This scaled

approach allows all project managers to qualitatively assess and prioritize risks to their project, with the understanding that a high risk to a $500K project is not as impactful as high risk to a $100M refurbishment project that has the same score.

Impact Score						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
RED = Major Risks YELLOW=Significant Risks GREEN = Minor Risks		**1**	**2**	**3**	**4**	**5**
		Probability Score				

Figure 2: Generic Heat Map identifying the potential qualitative risk scores for Nuclear Projects

Refer to Appendix D for the risk assessment criteria/scale and guidelines for how to use the heat map.

4.1.3.3 Urgency

Urgency is another qualitative risk measure that assists project managers in prioritization. In the RMO, an urgency score shall be applied for each risk. The measure of urgency for risks in Nuclear Projects is as defined below:

Urgency Score	Approximate Timeline for risk response	Urgency Assessment Criteria
1	> 1yr	Risk treatment activities complete or risk not required to be addressed for the foreseeable future
2	6 months – 1 yr	Risk can be addressed in the long term and risk treatment will still be effective
3	1-6 months	Risk should be addressed in the midterm for risk treatment to be effective
4	Within 1 month	Risk must be addressed immediately for the risk treatment to be effective

4.1.3.4 Quantitative Risk Analysis

Quantitative risk analysis is the process of assigning a dollar value to the effect of identified risks on overall project objectives. Quantitative risk analysis is performed on risks that have a significant qualitative residual risk score and require contingency funding. Not all risks qualitatively scored and managed per this process will require contingency (refer to Section 5.1 for guidelines). Wherever possible, the estimating

group should be engaged in supporting the determination of the cost impact of a risk to the project plan. If the quantification of risk exceeds the cost benefit argument for the project, the viability of the project should be revalidated.

4.1.4 Risk Treatment

Risk treatment requires effort to develop a plan to minimize the risk and implement response actions where appropriate. All risks in the risk register should have one of the following risk responses:

- **Avoid** – Obtain information to better define the risk source, eliminating the risk entirely. In this case the residual risk score should be reduced compared to the current risk score to reflect the level of confidence in the ability to avoid this risk.
- **Transfer** – Shifting some or all negative impacts of a threat to a third party (e.g. to a contractor via contract terms and conditions). If this response is chosen, the risk owner is still accountable to manage this risk on an ongoing basis. In this case the residual risk score should be less than the current risk score due to the consequence of the risk being transferred to a third party.
- **Mitigate** – Take actions to reduce the probability and/or impact of an adverse risk event to be within acceptable limits. In this case the residual risk score should be less than the current risk score due to mitigation actions being taken.
- **Accept** – Take no action and accept the possibility that the risk could occur. In this case the residual risk should reflect the current risk score, because nothing is being done to reduce the risk. Accepting risk may result in significant cost impacts, as such the risk owner is required to gain the endorsement of the responsible project director prior to selecting this response.
- **Monitor** – Periodically assess the risk through the normal course of project execution until, a) clear mitigating actions are identified, or b) a more appropriate risk response is identified. In this case the residual risk should reflect the current risk score, because nothing is actively being done to reduce the risk.

An informal cost-benefit analysis may be performed to evaluate the appropriate of the risk response. For example, if the cost to mitigate the risk is greater than accepting the probability and the impact of the risk “as-is”, then the risk response should be “Accept” and not “Mitigate”.

4.1.4.1 Evaluating the Effectiveness of Risk Responses

All risks in the risk register should have three risk scores:

(a) **Pre-Response Risk Score** – the score assuming that the risk will be accepted. This is a one-time assessment at the ‘’point of discovery” of the risk.

(b) **Post-Response Risk Score** – the score of the residual risk assuming the risk response is completed successfully. This score is subjective and based on the confidence level of the risk owner in the effectiveness of their risk response. This post response score is a gauge of how manageable the risk owner believes the risk is.

(c) **Current Risk Score** – the score reflecting the current status of the risk. This is the primary measure of risk exposure for the purpose of planning and risk metrics/response analysis.

4.2 Risk Monitoring and Control

4.2.1 Risk Reviews

The risk owner identified in the RMO tool has complete accountability for the content of their risks in the tool and for the implementation regular reviews of these risks. This is true even if they have delegated their authority to update or manage the risk to others. Each risk owner shall perform, at minimum, monthly risk reviews to:

- Ensure risk responses are optimal based on the latest information;
- Ensure mitigation actions are on track and status the actions in the actions log in the RMO tool and initiate new actions where warranted;
- Determine if the assumptions related to the risks are still valid and update in the Assumptions log in the RMO tool, if applicable;
- Determine if the risk characteristics have changed;
- Determine if new risks should be identified;
- Determine if risk has been realized or has expired and can be closed in the RMO Tool (with justification).
- Assess, modify and validate the risk score and any other applicable fields (such as owner, comments, etc.) in the risk register as required.

4.2.2 Risk Reporting

Risk reporting is performed in line with monthly or quarterly reporting cycles. The content of risk reports can be taken directly from the RMO Tool using the Business Intelligence (BI) report engine. For senior management and external stakeholder reporting, the PMO risk department may make the the risk wording in the RMO tool more concise to align with the level of detail required in the specific reporting vehicle.

Examples of reporting vehicles for risk include:

- Risk Dashboard
- Key Risk Area Summary Report
- Program Reports
- Quad Charts
- NOC (Nuclear Oversight Committee) Reports
- Quarterly ERM (Enterprise Risk Management) Reports
- User Reports (“boxed” reports) from BI

4.2.2.1 Risk Metrics

In order to assess the effectiveness RM in Nuclear Projects, the PMO risk department will prepare metrics. The Risk Dashboard will contain the primary metrics that will identify trends and allow comparisons of risk across the projects, functions, and Nuclear Projects as a whole. As risk management is a qualitative measure, with no focus on achieving a quantitative “target”, metrics prepared shall be geared towards process compliance only. As the risk management practice in Nuclear Projects evolves and matures, additional metrics may be introduced.

4.2.3 Key Risk Areas

Key Risk Areas are used to group risks from different projects which may impact major, overarching Nuclear Projects objectives. Each Key Risk Area is assigned a senior management sponsor who is responsible for providing oversight of the Key Risk Area to ensure that it is effectively being managed as a whole. Key Risk Areas are intended to provide a cross-cutting look at high level risk areas which need increased visibility and attention within Nuclear Projects. It is important to note that not all risks in the RMO Tool need to be categorized under a Key Risk Area.

The Sponsor of a Key Risk Area is required to champion the risk management process to ensure that, as an aggregate, the Key Risk Area is being addressed ***efficiently*** and ***effectively*** in order to minimize impact on NR objectives. It is expected that the Key Risk Area Sponsor is:

- ***Knowledgeable of*** and ***able to communicate*** the general “health” and status of the Key Risk Area at the R-ROC and in other major communication vehicles, as required.
- ***Proactive in initiating change in their Key Risk Area*** to improve the efficiency and effectiveness of the NR response.
- ***Available to provide the strategy/rationale*** for the requested change to the individual risk owners, when required.
- ***Rigorous in follow up*** to ensure sponsor directives have been implemented.

5.0 RISK MANAGEMENT OUPUTS

Effectively managing the outcomes of realized risks is critical to recovering project objectives. Ineffectively managing realized risks can create a snowball effect where distractions result in loss of focus on the remaining risks leading to their eventual impact on the project.

5.1 Contingency

Contingency is a tool to manage uncertainty and risk throughout the life of a project. The contingency reserve should be proportional to the project size, duration, complexity, risk exposure and tolerance, prior experience with the work, and

confidence levels set by management. ***Contingency is not a tool to compensate for an underdeveloped project plan.***

Contingency covers the *known unknowns* in a project. Specifically, these are the uncertainties associated with a schedule and cost estimate, as well as the discrete risk events that impact the objectives defined by these fundamental products. Any contingency development exercise requires a high quality, vetted estimate and schedule. Without a high quality project plan, one cannot effectively identify risks or the level of uncertainty. Without a high quality risk register and well understood uncertainty profile, one cannot effectively calculate an appropriate contingency estimate. It is the expectation that the project plan presented for contingency analysis is reasonable and achievable and endorsed by necessary stakeholders during its development.

The PMO risk department will work with the project managers to develop an appropriate project contingency estimate. Contingency should be calculated in advance of submitting the funding approval package to the approving board/committee but after the development of the cost and schedule estimate. Once approved, ongoing contingency adequacy reviews should be performed through the PMO risk department in line with Section 5.1.5.

Management Reserve (MR) is an amount of the project's calculated contingency withheld for management control purposes.

5.1.1.1 Discrete Risks

Risk events have cost, schedule, quality, or safety impacts, all of which can be characterized into potential financial consequences.

The cost score should indicate the direct cost impacts resulting from the realization of the risk exclusive of time dependent costs. Using three point estimates to establish ranges of possible outcomes for risks, the impact of the discrete risks can be modelled in a Monte Carlo simulation to estimate the amount of contingency required to address these specific events.

The schedule score identified on the risk register indicates the impact to a project's critical path, usually expressed in "days" and easily translated to dollars based on burn rates. This approach to schedule contingency (i.e. burn rate x days delay) is high level approach and is less precise than range analysis on a CPM schedule, which is the preferred method. This approach uses a Monte Carlo methodology and assigns three point estimates to critical path project activities considering the risks identified.

5.1.1.2 Cost Estimate Uncertainty

Cost estimate uncertainty is a function of estimate class and is an implicit risk to project objectives. For example, a point estimate built upon conceptual design information is only assumed accurate within a very broad range and may have many potential outcomes. Uncertainty in estimates is expected to decrease over time as the project definition improves and the project matures. Appendix E Table 1 identifies the ranges of uncertainty associated with estimate class definition as defined by AACE.

The determination of the size of the contingency fund must take into the account the estimate accuracy and project phase.

Cost growth areas typically covered by estimating uncertainty contingency are more general than those covered by discrete risks, and include items such as:

- Minor errors in omissions in the estimating process (e.g. precise quantity is only known during execution)
- Variability of productivity (e.g. estimating based on execution in the summer, but actually executed in the winter)
- Variability in wages (e.g. labour agreements expiring during execution)
- Variability in prices (e.g. material prices assumed)

Effort must be made to ensure the factors covered by cost estimating uncertainty are not duplicated in the project risk register. Using three point estimates, the impact of the cost estimate uncertainty can be modelled in a Monte Carlo simulation to estimate the amount of contingency required to address these events.

Estimate uncertainty does not capture variability in scope.

5.1.2 Risk Tolerance and Confidence Levels

Risk tolerance is the degree, amount, or volume of risk that an organization is willing to accept. Nuclear Projects risk tolerance is informed by a number of contributors including the experience and instinct of the project management team, past performance of similar projects, and stochastic methods.

In stochastic risk analysis, it is often expressed in a percentage value called a confidence level. For example, a P50 value on a Monte Carlo contingency estimate means that a project manager can be 50% confident that the contingency allocated is sufficient to address the risks and uncertainties defined for the project.

In managing a portfolio or program of projects, the concept of confidence levels can be useful in managing contingency funds. For example, for a given project's contingency analysis, the following structure could be employed to support the approval authority of contingency funding. This is for illustrative purposes and may be applied differently for different funding streams and risk tolerances within the Nuclear Projects organization.

Contingency $ at Confidence Level	Up to P50 (Current Phase Risks and Uncertainties)	Up to P50 (Future Phase Risks and Uncertainties)	P50 →P70 (All Risks and Uncertainties)	P70→P90 (All Risks and Uncertainties)
Treatment Upon Project Approval to Proceed	Released to Project	Allocated to Project but not Released	Allocated to Project but not Released to	Allocated to Management Reserves

		to Project	Project	
Authorization for Release to Project	N/A	VP Nuclear Projects	VP Nuclear Projects	SVP Nuclear Projects

Table 1: Example of how contingency developed for a specific project feeds into portfolio or program management

5.1.3 Probabilistic Analysis of Uncertainties

Monte Carlo simulation is a form of probabilistic analysis. It is a method to predict the impact of defined risks and uncertainties using project simulations. Gathering the three point estimates required for the Monte Carlo method can be quick and simple or rigorous, and should be commensurate to the overall magnitude or cost of the project. For example, small projects can use the projects manager's judgment for inputs but large projects should be done with rigor and inputs from knowledgeable personnel. Poor quality inputs to the Monte Carlo (including choosing a misrepresentative probability distribution, or omissions of key risks) will produce misleading results – "garbage in, garbage out".

The PMO risk department will perform the Monte Carlo analysis for risk and uncertainty inputs defined by the project manager. All contingency requests in support of funding approval packages are required to have a supporting Monte Carlo analysis.

The general steps to executing the Monte Carlo contingency analysis are as follows. The PMO risk department can help provide direction and guidance to project teams where required:

(a) Confirm the basis of analysis. The project scope, schedule, and estimate should be well defined/finalized with minimal anticipated changes.

(b) Conduct risk screening to determine which risks are warranted to have contingency allocated against them. Not all risks are suitable for contingency allocation. Appendix E Table 2 provides a guideline on how risk screening should be conducted.

(c) Gather inputs for probabilistic analysis. This involves obtaining three point estimates (Most Likely, Optimistic, and Pessimistic) for residual risk impacts, cost uncertainty, and the logic tied critical path schedule activities.

(d) Run Monte Carlo simulations using software and analyze the results. Results will be presented as S-Curves or in other tabular forms/reports generated from the Monte Carlo tool.

(e) Determine the size of contingency required for the determined level of confidence.

(f) Reassess the inputs if required based on the outcome of the analysis and iterate steps (a) through (e).

5.1.4 Monte Carlo Analysis - Limitations

Monte Carlo project predicts the impact of the identified risks and uncertainties by running simulations to identify the possible outcomes of the project. This technique helps in forecasting the likely outcome of a project, thereby helping decision makers and project managers in make informed decisions.

Monte Carlo contingency analysis is not intelligent. It will not compensate for omissions or errors in the risk registers or estimates that are submitted for analysis. The output of a Monte Carlo considers only those risks and uncertainties the project manager has identified as an input to the process.

5.1.5 Contingency Adequacy Review

The owner of contingent funds should re-evaluate the amount of contingent funds required as the project progresses. Contingency funds defined in funding approval packages are “point-in-time” estimates that reflect the project risk profile in that instance. As the project progresses, risks will be retired and new risks will emerge. It is critical that the contingency estimate is updated to reflect this and maximize the organization’s flexibility in managing these funds.

Contingency reviews should be conducted at the following checkpoints:

(a) Gate submission, including gate refreshes; BCS submission or superseding BCS submission

(b) Upon initiation of the project change control process;

(c) Release planning;

(d) Risk realization, especially a risk with high demands for funds;

(e) Unexpected event requiring high demands for funds;

(f) Significant change in the risk register;

(g) Significant deviation from the planned usage of contingency

(h) Alongside regular cost forecasting as defined by the PMO cost control department.

Note that the contingency adequacy review (or contingency assessment during normal forecasting activity) may reveal that there is too much contingency or not enough contingency allocated to the project. The project manager should return contingent funds that are no longer required via change control. If additional funds beyond what has been approved at the gate or release are required, then the function manager or project manager should request additional funds via change control process.

5.1.6 Refurbishment Contingency Development

All projects being executed within the Nuclear Projects organization, including refurbishment projects, are required to comply with this manual. However, for Nuclear Refurbishment, a white paper will prepared for each release period detailing how the contingency estimate is assembled. This white paper will be governed by this manual but will contain sufficient detail and additional considerations commensurate to the magnitude of the project.

5.2 Internal Lessons Learned

Internal lessons learned (ILL) are valuable because they ***provide real time, directly applicable experiences that other project managers can use when establishing their project plans.*** ILL usually take the form of detailed reports prepared upon project completion as defined in the modifications process. While this is valuable the objective of the ILL process is to share lessons both large and small in an effective way with minimal administration. Management and documentation of ILL is conducted electronically in the RMO Lessons Learned library.

ILL entries can be generated by Nuclear Projects staff for the purposes of sharing non-confidential OPEX and Lessons Learned from their department, project, a specific task, pre-post job debriefings, oversight activity, benchmarking trips, meetings, human performance observations or any other source.

5.2.1 Project Manager Direction

All project managers shall proactively document important lessons learned throughout the project life cycle to support improved project performance within the Nuclear Projects organization. Project managers will notify the PMO risk department to ensure lessons are documented and disseminated properly to increase awareness among the Nuclear Projects organization and improve management decision making.

PMO Role

The PMO Risk Department actively solicits real-time feedback on ILL throughout the organization, ensures accessibility to all members of the project and ensures standards, quality and completeness is accomplished. PMO Risk Department will provide simple templates for the project management team and prepare communication products (reports, emails, articles) for dissemination to the Nuclear Projects organization and its vendors.

5.3 Issues Resulting from Realized Risks

An issue is defined as ***a point or matter in question or in dispute***. For projects, issues that arise usually surface gaps that must be addressed in order to achieve project safety, quality cost, and schedule objectives. Project issues can occur when risks are realized, assumptions made during the development of the project plan are

proven to be invalid, or as the result of project authorization to proceed at risk with an underdeveloped plan.

Issues ***are not the normal challenges encountered in the progression of project planning and execution***. Similar to risks, issues generated from realized risks – as defined in this manual - must demonstrate the potential to impact approved project objectives.

5.3.1 Project Manager Direction

Management of issues resulting from realized risks have one of two outcomes:

- A recovery plan is prepared and implemented with the target of achieving the approved plan, or
- The issue cannot be recovered and impacts the ability to execute the approved plan, resulting in a need to modify the plan (i.e. move milestones, increase costs beyond contingency).

When an issue of this type arises a Station Condition Record (SCR) shall be raised to document the issue as an adverse condition. In most cases this SCR will be trended D4 and closed out to recovery actions input to the RMO action log or to the change control process, as appropriate, wherein the issue will be managed to closure. Any actions generated in the RMO action log associated with an issue of this type shall reference the SCR. As defined by the requirements of the SCR process, and depending on the severity of the issue, actions inside the SCR process may be required. In this scenario, the actions do not need to be duplicated in the RMO actions log.

The project manager, depending on the severity and possibility of repeat occurrence, shall work with the PMO risk department to generate an internal lesson learned for distribution by the PMO.

5.4 Actions

Project actions not included in an existing managed system (project schedule, business plan, action tracking, etc.) will be documented and managed in the RMO action log. This action log can take the place of Microsoft excel or word files that project managers may be using to track actions.

Nuclear Projects action sources should be diverse and comprehensive and may include, but are not limited to, meeting actions, audit response actions, actions to mitigate risks, actions to validate assumptions, actions arising from assumptions, decisions, issues, oversight, OPEX and lessons learned implementation actions. Actions that are part of the normal course of executing project work such as day to day individual accountabilities and “business as usual” actions should not be included in the log.

5.4.1 Reporting

User reports can be generated by anyone at any point in time. These online business intelligence (BI) reports may be communicated from time to time in meetings or other forums. PMO risk department will administer these reports and facilitate project team access to them, in real time. Change to reports will occur from time to time as required.

6.0 ROLES AND ACCOUNTABILITIES

6.1.1 Senior Vice President and Vice Presidents in Nuclear Projects

Champion the risk management process in Nuclear Projects.

6.1.2 Project Managers and Directors

Apply this manual to all projects being executed by the Nuclear Projects organization.

6.1.3 Project Team

Support project managers and directors through application of this manual.

6.1.4 PMO Risk Department

Support project team members in the application of this manual and the RMO tool. Maintain this manual and provide guidance, training, and support to project teams. Support Nuclear Projects executives by providing oversight and reporting of the risk management program in Nuclear Projects.

7.0 ACRONYMS

AACE	Association for the Advancement of Cost Engineering
BOE	Basis of Estimate
CARB	Corrective Action Review Board
CCF	Change Control Form
CII	Construction Industry Institute
COG	CANDU Owners Groups
DRAS	Decision Record and Analysis Summary
ERM	Enterprise Risk Management Team
LL	Lessons Learned
MR	Management Reserve
NOC	Nuclear Oversight Committee
NR	Nuclear Refurbishment
OAR	Organizational Authority Register

OPEX	Operating Experience
OPGN	Ontario Power Generation Nuclear
PDRI	Project Definition Rating Index
PMO	Project Management Office
RBS	Risk Breakdown Structure
RM	Risk Management
RMO	Risk Management and Oversight Tool
RMP	Risk Management Plan
SCR	Station Condition Record
SME	Subject Matter Expert
SRB	Scope Review Board
WBS	Work Breakdown Structure

8.0 RECORDS AND REFERENCES

8.1 Governing Documents

Any controlled documents which may be produced as a result of this document should be managed in accordance with N-PROC-AS-0003, Controlled Document Management.

Any records which may be produced as a result of this document should be managed in accordance with N-PROC-AS-0042, Quality Assurance Records.

The following records may be generated by use of this document and shall be registered in appropriate document management system in accordance with the following table.

Record Created	Associated Form Number	QA Record? Y/N	Filing Information/Retention (Asset Suite Type/ Sub-Type)
Risk Input assessment Form	N-FORM-11652	N	File in Asset Suite as a record. RRC NO2-0049 Retention: 10 years after completion of the overall Refurbishment program.
Decision Record and Analysis Summary Form	N-FORM-11390	N	File in Asset Suite as a record. NK38-LIST-09701-XXXXXXX RRC NO2-0049 Retention: 10 years after completion of the overall Refurbishment program.

8.2 References

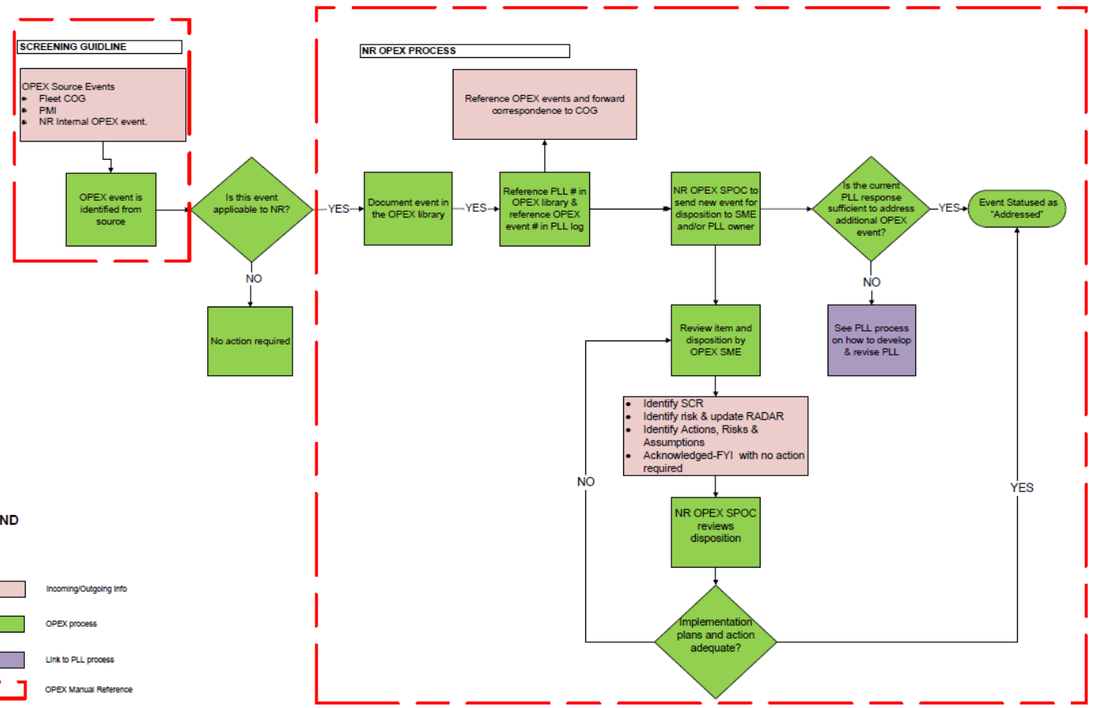
- WANO-GL 2003-01, Guidelines for Operating Experience at Nuclear Power Plants
- N-STD-AS-0028, Project Management Standard
- N-PROC-RA-0035, Operating Experience Process
- N-PROC-RA-0022, the Station Condition Record (SCR)
- N-PROC-AS-0003, Controlled Document Management
- N-GUID-04947.02-10000, External Events Screening Guide
- OPG-STD-0017 , Organizational Authority Register
- OPG-PROC-0094 , Enterprise Risk Management Process
- Construction Industry Institute. Applying Probabilistic Risk Management in Design and Construction Projects. Implementation Resource 280-2. June 2012.
- Project Management Institute. Project Management Body of Knowledge (PMBOK Guide), Fourth Edition. 2008

Appendix A: OPEX and Lessons Learned Resources

The following are OPEX and Lessons Learned resources available for use by all NR employees. Please contact your SME or the NR OPEX SPOC for assistance to setup newsfeeds or alerts.

- **CANDU Owners Group Weekly Screening Meeting (COG WSM)**
    - COG OPEX Database, COG Newsgroups and COG Publications
    - Station Condition Records (SCRs) database
    - World Association of Nuclear Operators (WANO)
    - Institute of Nuclear Power Operators (INPO)
    - International Atomic Energy Agency (IAEA)
    - Electric Power Research Institute (EPRI)
    - Safety Flash Report
- **NR Internal OPEX events**
    - Risk Assessment Database and Register (RADAR)
    - OPG Self Assessment Database
- **Other Sources**
    - Project Management Institute (PMI)
    - INPO Project Management
    - Professional Journals / Newspapers
    - Lessons Learned Reports from other projects (Asset Suite)
    - Benchmarking visits to other stations and employees' experience with similar projects

Appendix B: OPEX Flowchart



Appendix C: Sample Risk Breakdown Structure

COMMERCIAL	BUSINESS PLAN	BUSINESS CASE
		FEASIBILITY
		ECONOMIC INCENTIVES / BARRIERS
		MARKET / PRODUCT
		STANDARDS / PRACTICES
		OPERATIONS
		COMPETITION
		INTEREST RATES
		TAXES / TARIFFS
	FINANCING / FUNDING	SOURCES AND FORM OF FUNDING
		FOREIGN CURRENCY FLUCTUATIONS
CONTRACTUAL	COMMERCIAL	ESTIMATE UNCERTAINTY
		PAYMENT TERMS
		INSURANCES
		LIABILITIES
		INTELLECTUAL PROPERTY
		PERFORMANCE GUARANTEES
		FOREIGN CURRENCY FLUCTUATIONS
		CHANGE MANAGEMENT
		NOTICE REQUIREMENTS
	PROJECT SCOPE	SCOPE DEFINITION
		TECHNOLOGY
		HAZARDOUS MATERIALS
		HEALTH & SAFETY
		UTILITIES / OFFSITES
		SITE SELECTION & CLEAR TITLE
		APPROVALS / PERMITTING
CLIENT	CLIENT	RELATIONSHIP
		CLIENT SPECIFIC REQUIREMENTS
		APPROVAL OR PREAPPROVAL PROCESS
		PAST EXPERIENCE
		INTERFACE REQUIREMENTS INCL. PMC OR OWNERS ENGINEER
TECHNICAL	ENGINEERING & DESIGN & EXECUTION	ENGINEERING / DESIGN PROCESS
		ORGANIZATIONAL STRUCTURE
		PLANNING & PROCEDURES
		EXECUTION PLANNING
		TECHNOLOGY SELECTION
		PARTNERS
		HIGH VALUE ENG'G / DESIGN SERVICES (HVEC)
		HOME OFFICE SCHEDULE
		RESOURCES
		PROJECT MANAGEMENT
		CONSTRUCTABILITY

EXTERNAL	TAX / TARIFF	TARIFFS / DUTIES
		VALUE ADDED TAX
		LEGAL ENTITY ESTABLISHMENT
		APPLICATION OF TAX LAWS AND ENFORCEMENT OF CHANGES
		TECHNOOGY TAX
		PERSONAL INCOME TAX
		CORPORATE INCOME TAX
		TAX EQUALIZATION
		CHANGE IN FISCAL / MONETARY POLICY
		MISCELLANEOUS TAX
	GEOGRAPHICAL	COUNTRY / AREA
		NATURAL DISASTER
		FORCE MAJEURE
		WAR / INSURRECTION
		SOCIAL UNREST / VIOLENCE
		GOVERNMENT PARTICIPATION & CONTROL
		RELATIONSHIP WITH GOVERNMENT & OWNER
	CULTURE	TRADITIONS & PRACTICES
		PUBLIC OPINION
		RELIGIOUS DIFFERENCES
	LEGAL	LEGAL BASIS
		LEGAL STANDING
		GOVERNING LAW / FORMALITIES / LANGUAGE
		CONTRACT TYPE & PROCEDURES
		ENVIRNMENTAL PERMITTINGS
		CORRUPT & USINESS PRACTICES
	POLITICAL	NATIONALISM & EXPROPRIATION
		GOVERNMENT OR POLITICAL INSTABILITY
PROCUREMENT	SOURCING & SUPPLY	LOCATION / LOGISTICS / DELIVERY
		LONG LEAD EQUIPMENT (LLE) DELIVERY
		ENGINEERED EQUIPMENT PRICING
		PACKAGED EQUIPMENT SYSTEMS
		BULK MATERIALS / COMMODITY PRICING
		SUBCONTRACTORS
		IMPORTING & CUSTOMS

CONSTRUCTION	CONSTRUCTION	SAFETY DURING CONSTRUCTION
		CLIMATE
		WORKFORCE AVAILABILITY
		CONSTRUCTION PERMITTING
		CONSTRUCTION DELIVERY METHOD - SUB / DIRECT HIRE
		GENERAL CONTRACTOR AVAILABILITY
		CONTRACTOR PAYMENTS
		CONSTRUCTION SCHEDULE
		WORKFORCE LOGISTICS & SUPPORT
		COMMUNICATIONS / DATA TRANSFER
		QUALITY
	STARTUP	TRAINED WORKFORCE
		FACILITY TURNOVER
		FEEDSTOCK & UTILITIES
PRODUCTION/ OPERATIONS	PEOPLE	OPERATIONAL SAFETY
		SECURITY
		LANGUAGE
		HIRING / RETAINAGE
	LEGAL	GOVERNING LAW / OPERATIONAL LIABILITY
		PERMITTING
		INSURANCE
		EXPATS
		ENVIRONMENTAL COMPLIANCE
	TECHNICAL	LOGISTICS & WAREHOUSING
		SUPPLY CHAIN
		DATA SECURITY
		RELIABILITY
		FACILITY MANAGEMENT
	MAINTAINANCE	INFASTRUCTURE SUPPORT
		TECHNICAL SUPPORT
		QA/QC
		OPERATIONAL SHUTDOWNS

Appendix D: Program and Functional Risk Assessment Criteria/Scale

Nuclear Projects Risk Assessments Scale

Risk Attribute	Definition	1 (Minimal)	2 (Minor)	3 (Notable)	4 (Substantial)	5 (Major)
Probability	The probability that a risk will occur	<20%	20%-40%	40%-60%	60%-80%	>80%
Schedule Impact	The impact that a risk would have on the project critical path	No Delay	< 1 Week	1-2 Weeks	2-6 Weeks	>6 weeks
Financial Impact						
Refurbishment: Program (Functions)	Financial consequences of a risk should it occur	<$50M	$50M-$100M	$100M-$200M	$200M-$400M	>$400M
Refurbishment: Projects (Bundles)	Financial consequences of a risk should it occur	<$1M	$1M-$10M	$10M-$50M	$50M-$200M	>$200M
AISC Projects: <$1M	Financial consequences of a risk should it occur	<$50K	$50K-$100K	$100K-$300K	$300K-$500K	>$500K
AISC Projects: $1M - $5M	Financial consequences of a risk should it occur	<$200K	$200K-$500K	$500K-$1M	$1M-$2M	>$2M
AISC Projects: $5M - $10M	Financial consequences of a risk should it occur	<$400K	$400K-$1M	$1M-$2M	$2M-$4M	>$4M
AISC Projects: $10M - $20M	Financial consequences of a risk should it occur	<$700K	$700K-$2M	$2M-$4M	$4M-$8M	>$8M
AISC Projects: >$20M	Financial consequences of a risk should it occur	<$2M	$2M-$5M	$5M-$10M	$10M-$20M	>$20M

Appendix E: AACE Estimate Class and Expected Accuracy Ranges

Table 1 - AACE Estimate Class and Expected Accuracy Ranges

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Notes: [a] The state of process technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 30% level of confidence) for given scope.

Figure E-1: AACE Estimate Class and Expected Accuracy Ranges

Table E-2 - Optimal Response based on Risk Probability and Impact

Quadrant	Description	Optimal Response	Contingent Funds Assignment?
Low Impact, Low Probability	• Essentially negligible • In the unlikely condition that it does arise it should be possible to deal with it simply and with minimal impact	• Monitored to determine that the impact or likelihood does not increase	No
High Impact, High Probability	• Management should determine if project should proceed or if the benefits of taking the risks is justified	• Budget for mitigating actions in the project scope to lower the probability and impact of the risk	Yes – for the residual risk post-mitigation
Low Impact, High Probability	• Uncertainties from common sources in a project (e.g. cost of labour, materials, actual duration of activities, productivity, etc.) • Each of these uncertainties alone would have little impact, but the cumulative effects may have impact	• Reduce uncertainties in estimates by obtaining additional information or improving work processes • Budget for mitigating actions in the project scope to lower the probability and impact of the risk, if reasonable to do so	Yes – for the residual risk post-mitigation
High Impact, Low Probability	• Rare occurrences • Difficult to assign probabilities based on past events • Cannot be effectively funded by contingency, especially if maximum impact is realized	• Budget for mitigating actions in the project scope to lower the probability and impact of the risk, if reasonable to do so	Case-by-case basis. If yes, should be covered by Management Reserve

Appendix F: Outputs of the Monte Carlo Method

Several standard outputs are available to provide project managers with insights to cost, and even schedule predictability in their projects. These graphical representations of results allows for robust means of communicating risk, and provides additional data to support decision making and identify the possible outcome of decisions.

Figures F-1 and F-2 are graphs depicting the results of a Monte Carlo simulation defining the probability distribution of cost and schedule outcomes based on input assumptions. This type of information is useful for understanding the expected cost/duration and the range/dispersion of the projected cost and durations.

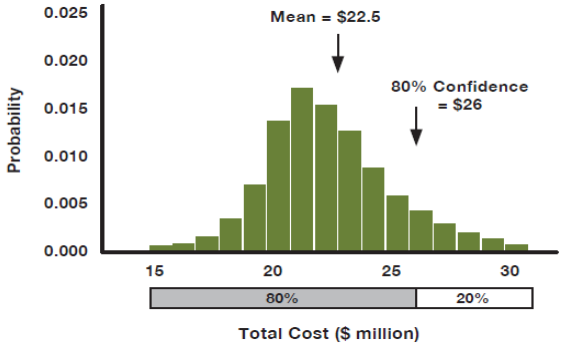


Figure F-1: Sample Probability Mass Function on Project Costs

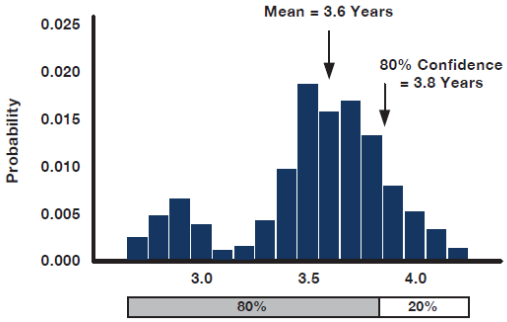


Figure F-2: Sample Probability Mass Function on Schedule Duration

Confidence in Cost or Schedule

The cumulative probability functions shown in Figure F-3 provide the same information shown in Figure F-1, but in a cumulative manner. The cumulative functions provide a quick reference for the mean (P50) and a confidence level in the estimate or schedule.

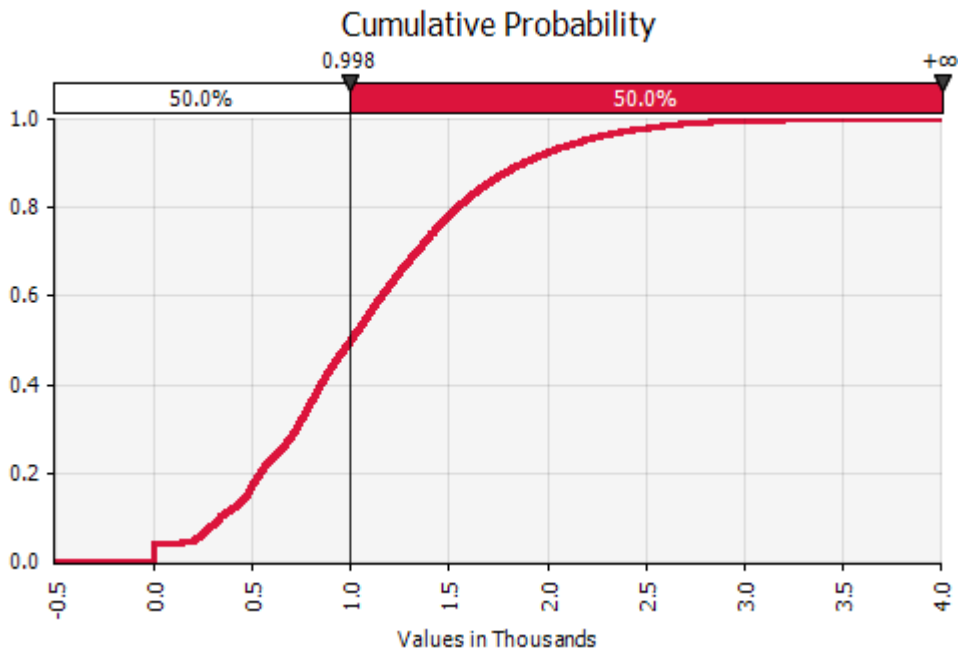


Figure F-3: Sample Cumulative Probability Function on Project Costs

Identification of Risks with the Greatest Impact

Sensitivity analysis is a primary modelling output that can be used in the valuation of the impacts of individual risks. Figure F-4 Sample Sensitivity Analysis on Project Risks provides a sensitivity analysis in the form of a “tornado diagram”. Tornado diagrams depict the influence of individual risks and highlight the greater contributors to the overall risk. Using this information, project managers or function managers can spend more effort on mitigating the risks that has the higher impact on the success of the project/function.

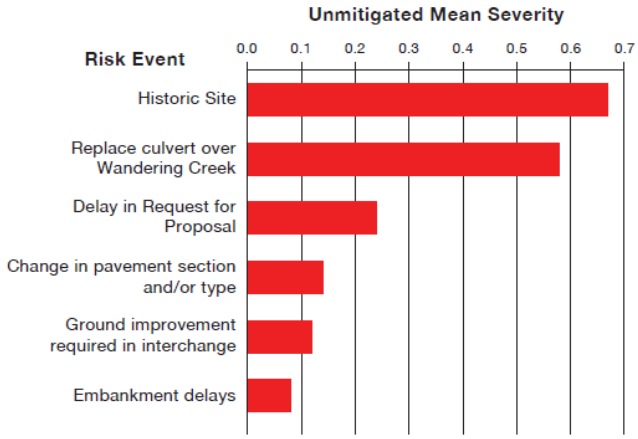
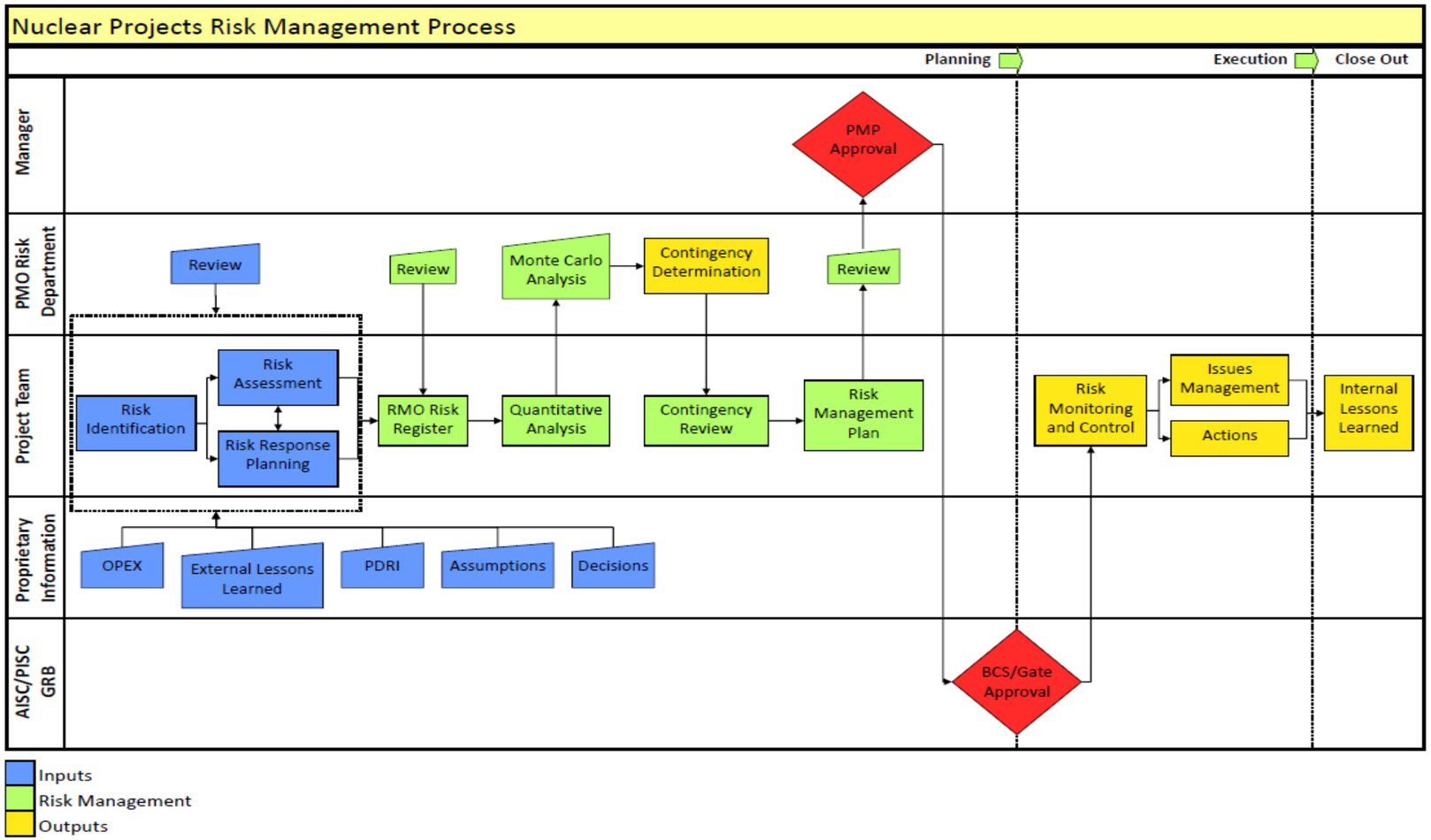


Figure F-4: Sample Sensitivity Analysis on Project Risks

Appendix G: Risk Management Process



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Manual

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Document Number: **N-MAN-00120-10001**	Usage Classification:
Sheet Number: **RISK-04**	Revision: **R003**

Title:
NUCLEAR REFURBISHMENT RISK MANAGEMENT & CONTINGENCY DEVELOPMENT GUIDE

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Nuclear Refurbishment Risk Management & Contingency Development Guide

N-MAN-00120-10001-RISK-04-R003
2014-07-28

Order Number: N/A
Other Reference Number:

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R000	2012-07-25	First Issue
R**003**1	2014-07-28	Major Revision to the document to provide additional guidance to the NR Risk Management Process to supplement the Program Risk Management Plan. Also aligned probability and impact risk assessment scale to the Corporate risk assessment scale.
R002	2014-03-24	Integrate N-MAN-00120-10001-Risk 05 (contingency development) to create a consolidated single document. Removed the cost control/change control/reporting sections for contingency. Non-intent updates to provide clarification or context as requested by manual users.
R003	2014-06-28	Updated the Risk Management Process to include Key Risk Areas and the related sponsors' responsibilities

1.0 DIRECTION

This document provides guidance for risk management activities within Nuclear Refurbishment (NR) and is to be used as a supplemental guide to the Refurbishment Program Planning & Control Management Plan NK38-NR-PLAN-09701-10001 Sheet 2.

2.0 RISK MANAGEMENT PROCESS

The risk management process is in place to increase the probability and impact of positive events, and decrease the probability and impact of negative events, with the overall goal of successfully achieving the safety, quality, cost and schedule objectives of NR.

The risk management process include the following fundamental steps:

a) **Risk Management Planning** – the process of defining how to conduct risk management activities for the project/program

b) **Risk Identification** – the process of determining which risks may affect the project and objectives documenting their characteristics

c) **Risk Assessment** (Qualitative and Quantitative) – the process of analyzing and prioritizing risks based on their probability and impact, and estimating the potential cost and schedule implications.

d) **Risk Response Planning** – the process of developing options and actions to reduce threats to project objectives

e) **Risk Monitoring and Control** – the process of implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness throughout the NR life cycle.

2.1 Risk Management Plan

A Risk Management Plan describes how risk management will be structured and performed for the NR Program or its individual project bundles and funtional groups.

Each project execution bundle should prepare a Project Risk Management Plan (RMP), referencing events of the Refurbishment Program Planning & Control Management Plan NK38-NR-PLAN-09701-10001 Sheet 2 and documenting any specific project variances to the program risk management process outlines in them.

Included in Project/Bundle Risk Management Plans are the following sections:

(1) Risk Management Methodology

Defines the approach, tools, and data sources that may be used to perform risk management on the project.

(2) Roles and Responsibilities

Defines the lead, support, and risk management team members for each type of activity in the risk management plan and clarify their responsibilities.

(3) Budgeting

Assign resources, estimate funds needed for risk management for inclusions in the base cost of the project.

(4) Timing

Defines when and how often the risk management process will be performed through the NR life cycle and establish risk management activities to be included in the project schedule.

(5) Risk Categories

Provides a structure that ensures a comprehensive process of systematically identifying risks to a consistent level of detail. A Risk Breakdown Structure (RBS) may be used as a tool to organize project risks hierarchically, where risks are arranged by category and subcategory, identifying the various areas and causes of potential risks. An example is shown in Figure 1.

(6) Applicable Probability and Impact Matrix

See Appendix C for the Risk Assessment Criteria/Scale for Program and Project Risks.

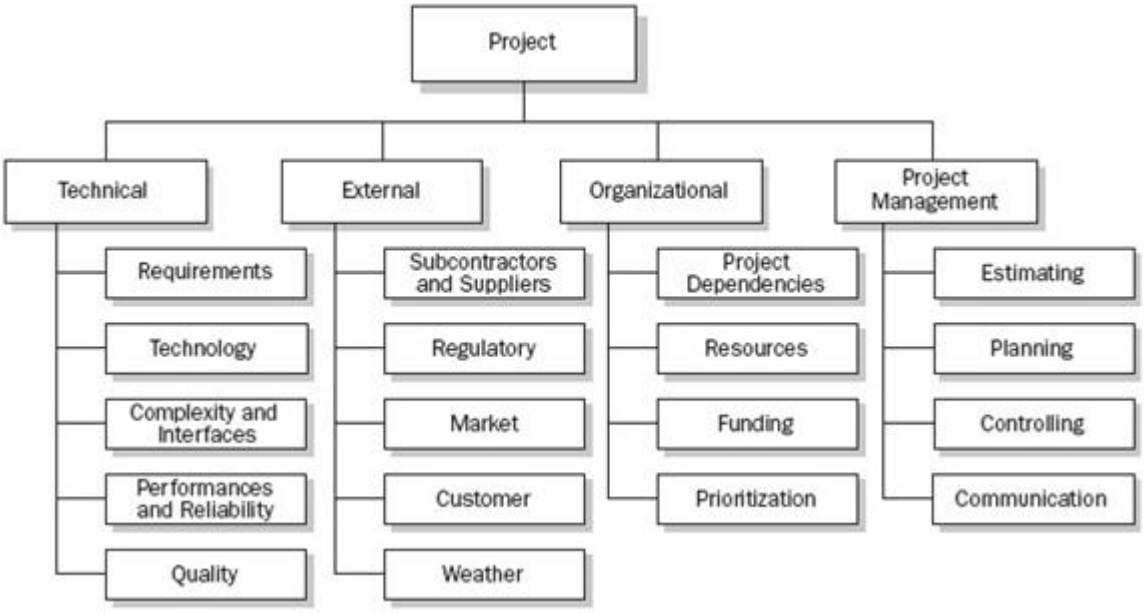


Figure 1 Sample Risk Breakdown Structure

2.2 Risk Identification

Risk identification is an iterative process since new risks may evolve or become known as the project/program progresses.

A number of techniques or forums may be used for the identification of risks. In all cases, the project team & function is involved so they can develop and maintain a sense of ownership and responsibility for the risks and associated risk response actions.

Tools and techniques to identify risks include, but are not limited to:

(b) Facilitated workshops; forums where participants brainstorm ideas about risks, and then identify, categorize, and further define them. Workshops can be facilitated by the NR Risk Section, the P&C lead, the project manager or a third party as approved by the NR risk section manager.

(c) Structured Interviews with experienced project team members, stakeholders and SMEs.

(d) Project Definition Rating Index (PDRI) Workshops

- A Construction Industry Institute (CII) tool

- A facilitated forum where participants assess the readiness of the project to proceed by answering a list of standardized and categorized questions. Workshops can be facilitated by the NR Risk Section, the P&C lead, or a third party as approved by the NR risk section manager.

(e) OPEX Review (Refer to N-MAN-00120-10001 Risk 06)

(f) Key Assumptions Review (Refer to N-MAN-00120-10001 Risk 07)

(g) Basis of Estimate (BOE) Review; review of assumptions and constraints in the BOE can be used as a source for risk identification.

(h) Project Schedule Review; review of near critical, critical path and schedule float in schedule assumptions can be used as a source for risk identification.

2.2.1 Common Pitfalls in Risk Identification

There are four common pitfalls in risk identification that leads to inefficiencies in managing risks:

(1) The presumption of failure of the base plan;

(2) Identifying Issues as Risks;

(3) Business-as-Usual Risks; and

(4) Vague or misleading Risk Titles and Risk Descriptions

2.2.1.1 The Presumption of Failure

Too often project and functional managers submit base plans (scope, cost, schedule, resources) for approval that they do not believe are reasonable and acheivable. The risk register submitted alongside the base plan then becomes a bulky list of items that are not true risks, but rather items designed to compensate for the known deficiencies or challenges of the base plan. Further, a large risk register may be viewed as a means to indicate to the approval boards that the project ‘’is not easy’’ or has been unsuccessful in the past. This presumption of failure creates too many risks to effectively manage and a lack of clear priortization for the team.

2.2.1.2 Identifying Issues as Risks

Issues are events that have 100% probability of occurring, or have occurred already and require resolution. As such, these are not risk events, but rather, issues that the project or functions should address or monitor. Hence, risks that have been realized are considered as issues. Identifying issues as risks may distract the project or function managers and prevent them from focusing on the adverse impacts that are truly preventable.

2.2.1.3 Business-as-Usual Risks

Events that will be addressed in the normal course of conducting work are termed Business-as-Usual risks. These are items that have a process, plan or organization in place to address them, but the concern is that the execution may be “less than adequate”.

Examples of poor use of Business-as-Usual risks include:

- “Project Managers may not meet milestones”.
- “Oversight plan may not provide complete details to provide guidance for oversight.”

In general, in order to be a risk there has to be impact to the objectives of the base plan. Business as usual items may truly present a risk to the base plan but this impact must be clearly identified in the risk description in order to be effectively managed.

2.2.1.4 Vague or Misleading Risk Titles and Risk Descriptions

Risk titles that are too vague or misleading may result in risk response plans that do not truly address the risks that the project/program are facing. The following are guidelines to follow when drafting risk titles and risk descriptions:

a) Risk Titles

(1) Risk titles describe the **event** and the **context** of the event.

- E.g. “There is a risk of insufficient welders available <*event*> to support Execution <*context*>”

(2) Risk titles should not include potential impact, especially if there are multiple impacts (as these should be characterized under Risk Description instead)

b) Risk Descriptions

(1) Risk descriptions should be comprised of the risk **event**, the **cause**, and the **impact** of the event.

- E.g. “There is a risk of insufficient welders available <*event*> to support Execution due to competition with other large industrial projects in the province <*cause*>, resulting in a delay that will impact the critical path by 30 days<*impact*>”.

2.2.2 Risk Register

A risk register is a living repository of risks. There are two risk registers for the NR. The Program Risk Assessment Database and Register (RADAR) and Project RADAR. See Appendix A for steps to create, update, and close risks. See Appendix B for descriptions of the fields contained in the database

2.2.2.1 Risk Register Administration

(a) Program and project RADAR is administered by the P&C Risk Section. Program RADAR contains risks that apply to the entire NR program and risks that are related to the functions. Project RADAR is managed by each individual project bundle and is overseen and supported by the P&C Risk Section.

(b) Read and Write Access to the RADAR logs are controlled by an administrator, contact the P&C Risk Section if read/write access is required.

(b) Risks cannot be deleted from RADAR. Risks entered in error should be closed with a note to indicate that the risk was entered inadvertently.

2.3 Risk Assessment

Risk Assessment is the process of analyzing the risks on their probability and impact. Risks can be assessed qualitatively, quantitatively, or both. Assessment of risk is a critical step that facilitates prioritization of risk response.

2.3.2.1 Qualitative Scoring of Risks

Qualitative scores are based on probability of occurence, schedule impact and financial impact of a risk. These scores are assigned based on a standard Risk Assessment Criteria/Scales for the purpose of consistency and ease of priortization.

There is a set of criteria for Program Risks, and another set of criteria for Project Risks. See Appendix C for the Risk Assessment Criteria/Scale.

After the probability, financial impact and schedule impact scores are determined. The risk score is calculated **by multiplying the probability score with the financial or schedule score, which ever is higher.**

2.3.2.2 Heat Map

Figure 2 shows a heat map representing the severity of a risk based on probability and impact.

Impact Score						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
RED = Significant Risks YELLOW = Major Risks GREEN = Minor Risks		**1**	**2**	**3**	**4**	**5**
		Probability Score				

Figure 2: Heat Map

2.3.3 Quantitative Risk Analysis

A quantitative risk analysis is the process of assigning a dollar value to the effect of identified risks on overall project objectives. Quantitative risk analysis is performed on risks that have a significant qualitative risk and require contingency fund allocation. Not all risks qualitatively scored and managed per this risk management process will qualify for contingency (refer to Section 3.0). Wherever possible, the estimating group should be engaged in supporting the quantificaton (cost impact) of a risk to the base plan.

2.4 Risk Response Planning

Risk response requires effort to develop a plan to minimize the risk and implement response actions. All risks in the risk register should have one of the following risk responses:

- Avoid – Obtain information to better define the risk source, eliminating the risk entirely.
- Transfer – Shifting some or all negative impacts of a threat to a third party (eg. to a contractor via contract terms and conditions). If this response is chosen, the NR risk owner is ***still accountable*** to manage this risk on an ongoing basis.
- Mitigate – Take actions to reduce the probability and/or impact of an adverse risk event to be within acceptable limits.
- Accept – Take no action and accept the possibility that the risk could occur.

- Monitor – Periodically assess the risk through the normal course of project execution until, a) clear mitigating actions are identified, or b) a more appropriate risk response is identified.

2.4.1 Evaluating the Effectiveness of Risk Responses

All risks in the risk register should have three sets of risk scores:

(a) Pre-Response Risk Score – the score assuming that the risk will be accepted. This is a one-time assessment at the ‘’point of discovery” of the risk.

(b) Post-Response Risk Score – the score of the residual risk assuming the risk response is completed successfully. This score is subjective and based on the confidence level of the risk owner in the effectiveness of their risk response. This post response score is a gauge of how manageable the risk owner believes the risk is.

(c) Current Risk Score – the score reflecting the current status of the risk. This is the primary measure of risk exposure for the purpose of planning and risk metrics/response analysis.

2.4.2 Considerations in Risk Response Planning

Prior to selecting a risk response for an identified risk, the following items should be considered:

a) An informal cost-benefit analysis may be performed to evaluate the effectiveness of the risk response. If the cost to mitigate the risk is greater than accepting the probability and the impact of the risk “as-is”, then the risk response should be “Accept” and not “Mitigate”.

b) The seemingly appropriate risk response strategy for one project or function cannot come at the detriment of another (or the NR program as a whole) unless supported by a cost benefit analysis. Contact NR Risk Section for guidance if required.

2.5 Risk Monitoring and Control

2.5.1 Risk Reviews

The risk owner has complete accountibillity for the content of their risks in RADAR, even if they have delegated their authority to update or manage the risk to others. Each risk owner shall perform, at minimum, monthly risk reviews to:

(a) Ensure risk responses are optimal based on the latest information;

(b) Ensure mitigation actions are on track and status the actions in the Actions Log;

(c) Determine if the assumptions related to the risks are still valid and update in the Key Assumptions Log, if applicable;

(d) Determine if the risk characteristics have changed;

(e) Determine if new risks should be identified;

(f) Determine if risk has realized or expired and can be closed in RADAR (with justification).

The Risk Owner should be notified of all changes on a risk if the updates are being performed by a delegate.

2.5.2 Risk Reporting

Risk reporting is performed in line with monthly or quarterly reporting cycles. The content of risk reports can be taken directly from RADAR using the Business Intelligence (BI) report engine. The P&C Risk section will perform oversight of the functions and bundles to ensure consistency between RADAR and the risk content in report submissions. For senior management and external stakeholder reporting, the P&C Risk Section may make the RADAR wording more concise to align with the level of detail required in the specific reporting vehicle.

Examples of reporting vehicles for risk include:

- Risk Dashboard
- Key Risk Area Summary Report
- Program Reports
- Quad Charts
- NOC (Nuclear Oversight Committee) Reports
- Quarterly ERM (Enterprise Risk Management) Reports.

2.5.2.1 Risk Metrics

In order to assess the effectiveness of the NR Risk Management Program, the Risk Section, will prepare metrics. The Risk Dashboard will contain the primary metrics that will identify trends and allow comparisons of risk across the projects, functions, and the program as a whole. As the risk management practice in NR evolves and matures, additional metrics will be introduced.

2.5.3 Key Risk Areas

Key Risk Areas are used to group risks from different functions/bundles which may impact major NR objectives. Each Key Risk Area is assigned a senior management Sponsor who is responsible for providing oversight of the Key Risk Area to ensure that it is effectively being managed as a whole. Key Risk Areas are intended to provide a cross-cutting look at high level risk areas which need increased visibility and attention within Refurbishment. Important to note that not all risks in RADAR need to be categorized under a Key Risk Area.

2.5.3.1 Key Risk Areas - Sponsors

The Sponsor of a Key Risk Area is required to champion the risk management process to ensure that, as an aggregate, the Key Risk Area is being addressed ***efficiently*** and ***effectively*** in order to minimize impact on NR objectives. It is expected that the Key Risk Area Sponsor is:

- ***Knowledgeable of*** and ***able to communicate*** the general "health" and status of the Key Risk Area at the R-ROC and in other major communication vehicles, as required.
- ***Proactive in initiating change in their Key Risk Area*** to improve the efficiency and effectiveness of the NR response.
- ***Available to provide the strategy/rationale*** for the requested change to the individual risk owners, when required.
- ***Rigorous in follow up*** to ensure sponsor directives have been implemented.

3.0 INTRODUCTION TO CONTINGENCY DEVELOPMENT

Contingency is a tool to manage uncertainty and risk throughout the life of a project. Contingency development is an integral part of estimating, scheduling and risk management processes. Contingent funds to address uncertainty and risk in a project should be proportional to the project size, duration, and complexity, risk exposure and tolerance, prior experience with the work, and confidence levels set by management. In all cases, contingency development is predicated on a high quality base plan and a high quality risk register. Without a high quality base plan, one cannot effectively identify risks. Without a high quality risk register, one cannot effectively identify contingency. It is the expectation that the base plan is reasonable and achievable and endorsed by necessary stakeholders in advance of requesting contingency calculations

3.1 Characterization of Uncertainties

Uncertainties in a project can be characterized as *knowns*, *known unknown* and *unknown unknown* situations or conditions. Depending on the outcome, uncertainties may manifest as risks or opportunities.

- When we are aware of a range of potential outcomes inherent in an activity, these situations are *knowns*. For example, an estimate built upon conceptual design information is assumed as inaccurate, but with an expected range of potential outcomes based on past experiences.

- A *known unknown* is an acknowledged situation that could affect the activity, but its potential for occurrence is not immediate, nor would one normally expect it in the course of the activity. For example, the potential for a serious safety incident is known, but would not be expected based on the safety measures taken at the work site.

- The *unknown unknown* situations are extraordinary events that one cannot have reasonably foreseen.

The overall principle of contingency determination and contingency management within NR is that all contingency allocation and contingency drawdown must be justified and approved. No “general” or “unallocated” contingency is permitted except for addressing *unknown unknowns* in NR, which is managed at the program level and not at the individual project level.

3.2 Classification of Contingent Funds

There are two main classifications of contingent funds to address different types of uncertainties – contingency and management reserve.

3.2.2 Contingency

Contingency is used to cover the *knowns* and *known unknowns* in a project. Specifically, these are the uncertainty and variability associated with a schedule and cost estimate, as well as the discrete risk events identified in the risk register.

Risk owners are accountable for selecting the most appropriate risk response and executing the mitigation strategy with the goal to eliminate or lower the probability and impact of a risk. Contingency is only allocated for the accepted risks and residual risks, which are the remaining impacts of an event despite mitigation attempts, assuming that the mitigation strategy is executed successfully. Further, the risk owner should not carry contingency for risk items that:

a) would result in a fundamental change to the base plan (e.g. directed change, scope change) where the change control process should be used.

b) could not be recovered or fixed via application of additional project funding.

Contingency at NR is further sub-divided into Project Contingency and Program Contingency to address uncertainties in project bundles and functional groups, respectively. It is not intended for changes in scope or extraordinary major social or natural events such as war, strikes, flood and earthquakes, which are addressed by Management Reserve.

3.2.2.1 Estimate Uncertainty

Estimate uncertainties are the *knowns* in a project, and are fundamental contributors to cost growth. They are a function of, but not limited to, the quality of the project scope definition, the project's life-cycle status, and the degree to which the project uses new or unique technologies.

The uncertainty in estimates is expected to decrease over time as the project definition improves and the project matures. Appendix D illustrates how estimate accuracy changes as the project gains maturity in the definition of their project deliverables. The determination of the size of contingency must take into the account the estimate accuracy and project phase. As the project progresses, the high and low ranges of the estimate should converge on the final cost.

Costs typically covered by contingency due to estimate uncertainty are:

- Minor errors in omissions in the estimating process (e.g. precise quantification is only known during execution)
- Variability of productivity (e.g. estimating based on execution in the summer, but actually executed in the winter)
- Variability in wages (e.g. labour agreements expiring during execution)
- Variability in prices (e.g. material prices assumed)

Note that estimate uncertainty does not cover variability in scope.

3.2.2.2 Discrete Risk Events

Risk events are the *known unknowns* in a project. These can be represented as probabilistic distributions that identify the likelihood of the risk event occurring with separate distributions that describe the consequence or impact to the project if the event occurs. Risk events have cost and schedule consequences. The schedule consequences identified on the risk register should indicate the impact to a project's critical path, usually expressed in "days". The cost consequence should indicate the direct cost resulting from the realization of the risk, as well as the indirect overhead costs incurred during the critical path delay. (For example, the schedule impact to the risk of dropping a turbine spindle into the ocean is 30 days of critical path delay. The cost impact is the sum of the cost to send the spindle for repair and the overhead cost of retaining resources while waiting for work to continue)

3.2.3 Management Reserve

Management Reserve is the contingent funds for *unknown unknowns, or* unplanned changes to project scope and cost, such as natural disasters or prolonged labour strikes. It is an amount for discretionary management purposes outside the defined scope of the project.

3.3 Risk Tolerance and Confidence Levels

Risk tolerance is the level of uncertainty that an organization is willing to accept. It is often expressed in a percentage value called a confidence level. (E.g. a P50 value on a contingency estimate means a project manager is 50% confident that the contingency allocated is sufficient to address the risks in the project). Confidence levels are also useful in managing a program of different projects. For example, a project can be assigned a P50 level of contingency, and the difference between P70 and P50 can be kept at the program level as added assurance in case the project manager runs out of contingency funds.

3.4 Guidelines to Contingent Fund Development

Contingency fund determination should be conducted before each request for contingency funding, including gate submission and during the release planning process.

3.5 Project Contingency Constituents

The Project Manager, with support from Planning and Control (P&C) Leads matrixed to them, is responsible for determining the amount of Project Contingency required. Project contingency is made up of the following constituents:

(1) Cost uncertainty of the project work scope (identified by project bundle and by gate)

(2) Discrete risks (identified by project bundle and by gate) in the project risk register

The amount of contingency required for each constituent should be determined with inputs from knowledgeable personnel.

3.6 Program Contingency Constituents

The Risk section, P&C is responsible for determining the amount of Program Contingency required. Program contingency is made up of the following constituents:

(1) Cost uncertainty of the functional work scope (identified by release and function)

(2) Discrete risks in the program risk register (identified by release and function)

(3) Assurance on the Project Contingency already released (i.e. if a P50 confidence level contingency is released to the project manager to manage discrete risks, then the program may retain the difference between a P70 and P50 value as added assurance)

(4) Unreleased portions of Project Contingency yet to be released.

The amount of contingency required for each constituent should be determined with inputs from knowledgeable personnel.

3.7 Management Reserve Constituents

Management Reserve will be determined by calculating the amount of funds required to reach the confidence level specified by senior management of NR. Management reserve will also consider overall schedule uncertainty of the NR Program, and a distinct set of discrete risks outside of the project/program risks in RADAR.

3.8 Summary of Contingent Fund Structure

A white paper is prepared by NR manager, Infrastructure, for each release period detailing how contingency is assembled. Contact NR manager, Infrastructure, for further information.

3.8.2 Probabilistic Analysis of Uncertainties

Monte Carlo simulation, or probabillistic analysis is a method to analyze the impact of risk and uncertainities using multiples simulations. Gathering information for the Monte Carlo method must be done carefully with input from knowledgeable personnel. Poor quality inputs to the Monte Carlo (including choosing a misrepresentative probability distribution) will produce misleading results. Contact the P&C Risk Section for guidance on which probability distribution function to use and how to interpret the results.

Whether it is the contingency to address estimate uncertainty or risk events, the general steps of the Monte Carlo method include:

(1) Confirm the basis of analysis. The base plan (cost/scope/schedule) should be well defined/finalized.

(2) Conduct risk screening to determine which risks are warranted to have contingency allocated against them. Not all risks are suitable for contingency allocation. Appendix E provides a guideline on how risk screening should be conducted.

(3) Gather input for probabilistic analysis. This involves obtaining three point estimates (Most Likely, Optimistic, and Pessimistic) for residual risk impacts and cost and schedule estimates. Contact the P&C Risk and Estimating groups for support.

(4) Run Monte Carlo simulations using software and analyze the results. The results can be presented as a cumulative probability distribution of total cost, in the shape of an S-curve, similar to the one depicted in Figure 5-5.

(5) Determine the size of contingency at the determined level of confidence.

3.9 Monte Carlo Analysis

Monte Carlo project analysis involves determining the impact of the identified risks and uncertainties by running simulations to identify the possible outcomes of the project. A random sampling is performed by risk and uncertainty inputs to generate the S-curve. This technique helps in forecasting the likely outcome of an event and thereby helps in making informed project decisions. See Appendix F for Outputs of the Monte Carlo Method

3.10 Guidelines to Contingency Funding Management

The usage of contingent funds must be carefully tracked, monitored and reported to ensure that there are sufficient funds to address NR risks throughout its life cycle. Since the risk profile of the NR program is constantly changing as a result of completing work, realizing risks, identifying new risks and completion of mitigation plans, the contingent funds should also be subjected to regular reviews and adjustments. It is expected that contingent fund usage (ie. Drawdowns) and requirements and schedule for increased or decreased contingency is performed a part of a robust life cycle cost forecasting process (N-MAN-09707-10001-PC-15).

3.10.2 Monitoring/Oversight of Contingent Funds

Contingent funds at NR are finite resources, so its use must be monitored, tracked and evaluated as a part of the project control and monitoring cycles. In addition to forecasting activity, a contingency review should be conducted whenever the risk profile of a project or function undergoes a significant change to determine if the remaining contingent funds can adequately address the remaining risks in the project. The P&C Risk Section will perform oversight of contingency use, and periodically assessthe status of contingency funding in comparison to the NR risk profile. For more information on contingency drawdown, refer to N-MAN-00120-10001 Sheet PC-12.

3.10.3 Contingency Adequacy Review

The owner of contingent funds should ensure that guidelines for contingency development are followed rigorously and re-evaluate the amount of contingent funds required as the project progresses.

Contingency reviews should be conducted at the following checkpoints:

(1) Gate submission, including gate refreshes;

(2) Release planning;

(3) Risk realization, especially a risk with high demands for funds;

(4) Unexpected event requiring high demands for funds;

(5) Significant change in the risk register;

(6) Significant deviation from the expected usage of contingency allocated to a function or bundle under items (1) or (2).

Note that the contingency adequacy review (or contingency assessment during normal forecasting activity) may reveal that there is too much contingency or not enough contingency. The project or function manager should return contingent funds that are no longer required via a CCF. If additional funds beyond what has been approved at the gate or release are required, then the function manager or project manager should request additional funds via a CCF or a gate refresh, respectively. See N-MAN-00120-10001 Sheet PC-12 and N-MAN-09701-10001-PC-15 for additional information.

4.0 ACRONYMS

BOE	Basis of Estimate
CII	Construction Industry Institute
ERM	Enterprise Risk Management Team
NR	Nuclear Refurbishment
NOC	Nuclear Oversight Committee
PDRI	Project Definition Rating Index
P&C	Planning and Control Organization, Nuclear Refurbishment
RADAR	Risk Assessment Database and Register
RBS	Risk Breakdown Structure
RMP	Risk Management Plan
CCF	Change Control Form
WBS	Work Breakdown Structure
AACE	The Association for the Advancement of Cost Engineering

5.0 RECORDS AND REFERENCES

5.1 Records

Any records which may be produced as a result of this document should be managed in accordance with N-PROC-AS-0042, Quality Assurance Records.

The following records may be generated by use of this document and shall be registered in an appropriate document management system in accordance with the following table.

Record Created	Associated Form Number	QA Record? Y/N	Filing Information/Retention (Asset Suite Type/ Sub-Type)
Risk Management Plan	N-TMP-10010	N	Indexed in Asset Suite Controlled Document N-PLAN-SCI-xxxxx RRC NO2-0049 Retention: 10 years after completion of the overall Refurbishment program

5.2 References

5.2.1 Performance References

N-MAN-09701-10001-PC-15

N-MAN-00120-10001-PC-12.

N-MAN-00120-10001-RISK -06	Darlington Refurbishment Risk Management
OPG-PROC-0094	Enterprise Risk Management Process
N-MAN-00120-10001-RISK-07	NR Actions, Issues, Decisions, and Key Assumptions Management
N-MAN-00120-10001-GRB	Nuclear Projects Gated Process

5.2.2 Developmental References

Construction Industry Institute. Applying Probabilistic Risk Management in Design and Construction Projects. Implementation Resource 280-2. June 2012.

Project Management Institute. Project Management Body of Knowledge (PMBOK Guide), Fourth Edition. 2008

US Department of Energy. Risk Management Guide. DOE G413.3-A. January 12, 2011.

OPG-PROC-0094 Enterprise Risk Management Process

Appendix A: Create, Update and Close Risks in RADAR

A.1.0 INITIATING AND ONGOING MANAGEMENT OF A RISK

Risks may be documented by any NR staff with permitted access to RADAR (Sharepoint List):

(a) Initiator:

(1) Confirms that the identified risk does not contradict or duplicate any existing risks in the Program and Project RADAR. Consults local Risk SPOC for assistance on Project Risks and the NR P&C Risk Section for Program Risks if assistance is required.

(2) Consults with internal team members, the P&C Risk Section, and other stakeholders to help characterize the risk and select the appropriate response.

(3) Selects the appropriate list in Sharepoint to enter the risk information.

- Program Risks → Program RADAR
- Project Risks → Project RADAR

(4) Selects “New Item”, and then characterizes the risk by filling out all available information. See Appendix B for a guide to fields in RADAR.

(5) Assigns one single owner to the risk and confirm their acceptance of the ownership. For Program Risks, the risk owner should be a Strat V or above, and the delegate of the risks should be a Strat IV or above. For Project Risks, risk owner should be a Strat IV or above, and the delegate of the risks should be a Strat III or Strat II or above

(6) Once the risk has been entered into RADAR, Click “OK” to save and return to the list of risks.

(b) The Risk Owner with the support of Risk Delegate and Risk SPOC:

(1) Monitors and periodically reviews the risk monthly, at a minimum, as per this process.

(2) Develops and assigns actions with target completion dates to action owners according to the risk response, as required.

(3) Raises new and/or updates existing Key Assumptions, Actions, Issues and Decisions as a result of the approved risk. Ensures Key

Assumptions, Actions, Issues and Decisions are identified and managed in alignment with N-MAN-00120-10001-RISK-07 Actions, Issues, Decisions and Key Assumptions.

(4) Notifies other impacted organizations and/or the P&C Risk section if there is a significant change to the risk profile or a significant new risk.

(c) NR P&C Risk Section

(1) Provides oversight and support throughout.

A.2.0 CLOSING A RISK

Risks may be closed when they are entered in error, are no longer relevant to NR, have expired (not anticipated to happen), or if the risk has been realized (event should now be recorded as an Issue with a recovery plan). When closing a risk, the following process should be followed:

(a) Local Risk SPOC, P&C Lead, Delegate or Risk Owner:

(1) Selects the risk entry in RADAR and select “Edit Item”.

(2) Updates the risk, set the Risk Status field to “Closed”, and provides written justification for closure in the “Status Notes” field.

(3) Raises new and/or updates existing or initiates new Key Assumptions, Actions, Issues and Decisions as a result of the approved closure of the risk as per N-MAN-00120-10001-RISK-07. Risks should be generated and/or updated in alignment with this process.

(b) The risk owner with the support or Risk Delegate or Risk SPOC:

(1) Ensures that the risk closure is justified.

(2) Ensures that the risk response plans, strategies and actions are completed and statused accordingly.

(c) NR P&C Risk Section:

Provides oversight and support to the initiator.

Appendix B: RADAR Field Guide

Fields	Definition and Guidelines
Action #	Reference action numbers from the Actions Log related to the risk
Assumption #	Reference Key Assumption numbers from the Actions Log related to the risk
Comments	Miscellaneous comments.
Current Financial	Current Financial Impact Score (1 to 5)
Current Probability	Current Probability of risk occurrence (1 to 5)
Current Schedule	Current Schedule Impact Score (1 to 5)
Current Score	Current Risk Score (Probability x higher of Financial or Schedule Impact Score)
Date Last Reviewed	Date of the last time the risk was reviewed.
Decision #	Reference Decision numbers from the Actions Log related to the risk
ERM Risk	Check this box if this risk is reported to the ERM.
Gate	The gate number associated with the source of funding for contingency.
Impacted NR Organizations	Information regarding Risks affecting multiple Organizations is captured here.
Initiator	The employee who requested for the Risk to be created
Issue #	Reference issue numbers from the Actions Log related to the risk
NOC Risk	Check this box if this risk is reported to the NOC.
NR Owner Organization	The NR organization that the risk owner belongs to
P6 Activity ID	Reference Activity ID from theP6 Schedule related to the risk
Phase	The NR project phase in which the risk is expected to realize
Post Response Financial	Financial Impact Score (1 to 5) after application of risk response plan
Post Response Probability	Probability of risk occurrence (1 to 5) after application of risk response plan
Post Response Schedule	Schedule Impact Score (1 to 5) after application of risk response plan
Post Score	The anticipated Risk Score (Probability x higher of Financial or Schedule Impact Score) after the risk response plan has been successfully implemented. Also known as the residual risk score.
Pre Response Financial	Financial Impact Score (1 to 5) before application of risk response plan.
Pre Response Probability	Probability of risk occurrence (1 to 5) before application of risk response plan
Pre Response Schedule	Schedule Impact Score (1 to 5) before application of risk response plan
Pre Response Score	Risk Score (Probability x higher of Financial or Schedule Impact Score) before application of risk response plan

Fields	Definition and Guidelines
RBS 1	Risk Breakdown Structure Field #1. Can be used to differentiate sub-bundles or however the project/function chooses to categorize risks.
RBS 2	Risk Breakdown Structure Field #2. Used to categorize the risk into one of the Key Risk Areas.
Risk Delegate	The Strat IV for Program and Start III or II for Project Risks (at a minimum) that has been delegated risk owner's responsibilities.
Risk Description	A detailed description of the risk, consisting of the event, the context of the event, and the adverse impacts should the risk realizes.
Risk Impact Post Response	Brief description of the residual risk. Align description with the "Post Financial", "Post Probability", "Post Schedule", and "Post Score" fields.
Risk Impact Pre-Response	Brief description of the risk if nothing is done or if risk was accepted "as-is". The description should align with the "Pre Financial", "Pre Probability", "Pre Schedule", and "Pre Score" fields.
Risk Owner	The Strat V for Program and Strat IV for Project Risks (at a minimum) accountable for the risk - also responsible for developing the risk response and assigning actions to actions owner as part of the risk response plan
Risk Response Status	Status of the Risk Response as Not Started, In Progress (On Track, At Risk or Late) or Complete.
Risk Response Strategy & Status Notes	A summary of the overall risk response strategy. The action to mitigate the risk is attributable to the strategy. This strategy will also be presented in risk reports.
Risk Response TCD	The potential date when the risk response is expected to be complete
Risk Response Type	Avoid, Transfer, Accept, Mitigate, Monitor
Risk Status	Status of the Risk as Active, Pending Approval, Closed or Closed-BAU.
Risk Status Notes	Brief explanation on the current status of the risk.
Risk Trigger End Date	The potential end date when the risk is expected to expire.
Risk Trigger Start Date	The potential start date when the risk is expected to realize.
Risk Trigger Event	A future event or milestone that signifies risk realization. (e.g. If there is a risk of not having work scheduled into the VBO, then the VBO scope freeze date may be the trigger event.
Station Risk	Apply to Station-Related Risks only. Reference Station Risk Title.
Station Risk ID	Apply to Station-Related Risks only. Reference Station Risk ID.
Station Risk Owner	Apply to Station-Related Risks only.
Title	Short title of the risk consisting of the event and the context of the event.
Urgency	Scale based on when the Risk in question needs to be mitigated. Used to assist with Risk prioritization.

Appendix C: Risk Assessment Criteria/Scale

C.1.0 PROGRAM AND FUNCTIONAL RISK ASSESSMENT CRITERIA/SCALE

Risk Attribute	Definition	1 (Minimal)	2 (Minor)	3 (Notable)	4 (Substantial)	5 (Major)
Probability	The probability that a risk will occur	Improbable (<20%)	Unlikely (20%-40%)	Possible (40%-60%)	Likely (60%-80%)	Probable (>80%)
Financial Impact	The financial consequences of a risk should it occur	Minimal (<$50M)	Minor ($50M-$100M)	Notable ($100M - $200M)	Substantial ($200M - $400M)	Major (>$400M)
Schedule Impact	The impact that a risk would have on the overall program schedule should it occur	Minimal (No impact to critical path)	Minor (<2 weeks delay to critical path)	Notable (2 weeks – 2 months delay to critical path)	Substantial (2-6 months delay to critical path)	Major (>6 months to critical path)

C.2.0 PROJECT EXECUTION RISK ASSESSMENT CRITERIA/SCALE

Risk Attribute	Definition	1 (Minimal)	2 (Minor)	3 (Notable)	4 (Substantial)	5 (Major)
Probability	The probability that a risk will occur	Improbable (<20%)	Unlikely (20%-40%)	Possible (40%-60%)	Likely (60%-80%)	Probable (>80%)
Financial Impact	The financial consequences of a risk should it occur	Minimal (<$1M)	Minor ($1M-$10M)	Notable ($10M - $50M)	Substantial ($50M - $200M)	Major (>$200M)
Schedule Impact	The impact that a risk would have on the project bundle schedule should it occur	Minimal (No impact to critical path)	Minor (<1 weeks delay to critical path)	Notable (1 weeks – 2 weeks delay to critical path)	Substantial (2-6 weeks delay to critical path)	Major (>6 weeks to critical path)

C.3.0 URGENCY ASSESSMENT CRITERIA/SCALE

Urgency Score	NR Timeline for risk response	Urgency Assessment Criteria
1	>1yr	Risk treatment activities complete or risk not required to be addressed for the foreseeable future
2	6 months – 1 yr	Risk may still be addressed in the long term and risk treatment will still be effective
3	1-6 months	Risk should be addressed in the medium-term for risk treatment to be effective
4	Within 1 month	Risk must be addressed immediately for the risk treatment to be effective

Appendix D: AACE Estimate Class and Expected Accuracy Ranges

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Notes: [a] The state of process technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

Table 1 - AACE Estimate Class and Expected Accuracy Ranges

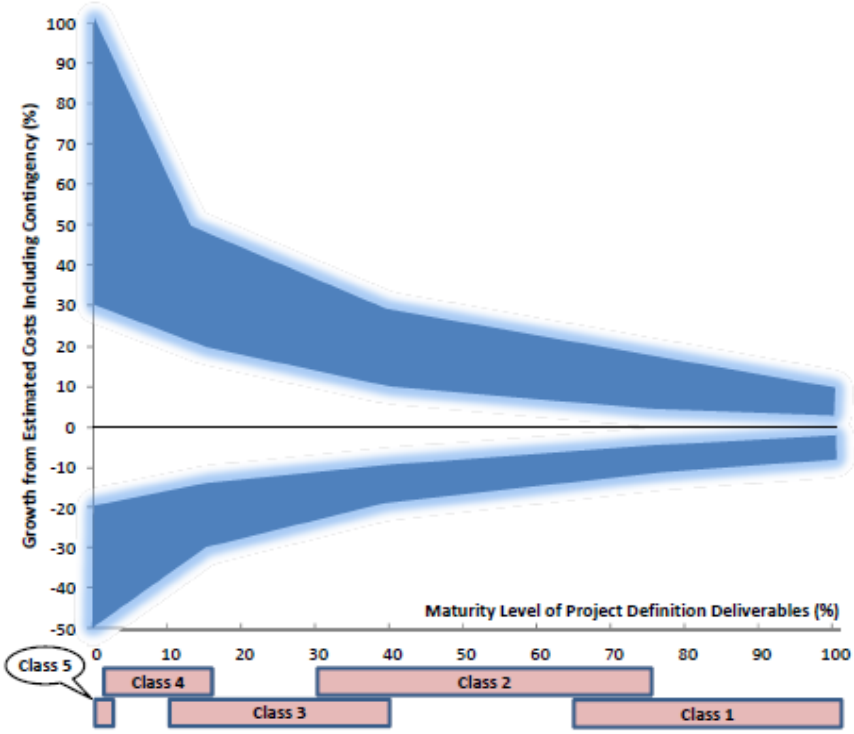


Figure 5-1 AACE Estimate Class and Expected Accuracy Ranges

Appendix E: Guidelines to Risk Screening

Following the identification of risks that can potentially affect the project, it is important to differentiate those risks that are minor and thus should not require significant further attention from those that require follow-up, analysis, active mitigation and management. Similarly, not all risks are warranted for contingency allocation. One commonly used risk tool is shown in figure 5-2 .It allows assigning a risk to one of four quadrants based on a qualitative assessment of its relative impact and the probability of its occurrence. Table 3 summarizes the optimal risk response dependent on the qualitative assessment.

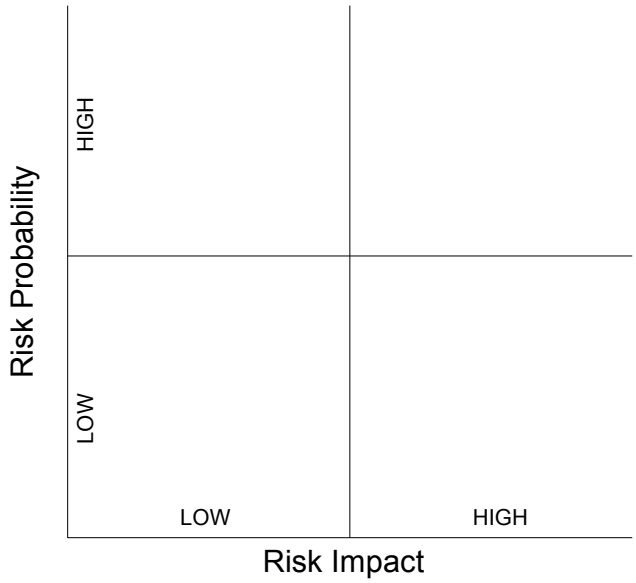


Figure 5-2 Risk Probability and Impact Matrix

Quadrant	Description	Optimal Response	Contingent Funds Assignment?
Low Impact, Low Probability	• Essentially negligible • In the unlikely condition that it does arise it should be possible to deal with it simply and with minimal impact	• Monitored to determine that the impact or likelihood does not increase	No
High Impact, High Probability	• Management should determine if project should proceed or if the benefits of taking the risks is justified	• Budget for mitigating actions in the project scope to lower the probability and impact of the risk	Yes – for the residual risk post-mitigation

Quadrant	Description	Optimal Response	Contingent Funds Assignment?
Low Impact, High Probability	• Uncertainties from common sources in a project (e.g. cost of labour, materials, actual duration of activities, productivity, etc.) • Each of these uncertainties alone would have little impact, but the cumulative effects may have impact	• Reduce uncertainties in estimates by obtaining additional information or improving work processes • Budget for mitigating actions in the project scope to lower the probability and impact of the risk, if reasonable to do so	Yes – for the residual risk post-mitigation
High Impact, Low Probability	• Rare occurrences • Difficult to assign probabilities based on past events • Cannot be effectively funded by contingency, especially if maximum impact is realized	• Budget for mitigating actions in the project scope to lower the probability and impact of the risk, if reasonable to do so	Case-by-case basis. If yes, should be covered by Management Reserve

Table 2 Optimal Response based on Risk Probability and Impact

Appendix F: Outputs of the Monte Carlo Method

Several standard outputs are available to provide project managers with insights to cost, and even schedule predictability in their projects. These graphical representations of results allows for robust means of communicating risk, and provides additional data to support decision making and identify the possible outcome of decisions.

Figures 5-3 and 5-4 are graphs depicting the results of a Monte Carlo simulation defining the probability distribution of cost and schedule outcomes based on input assumptions. This type of information is useful for understanding the expected cost/duration and the range/dispersion of the projected cost and durations.

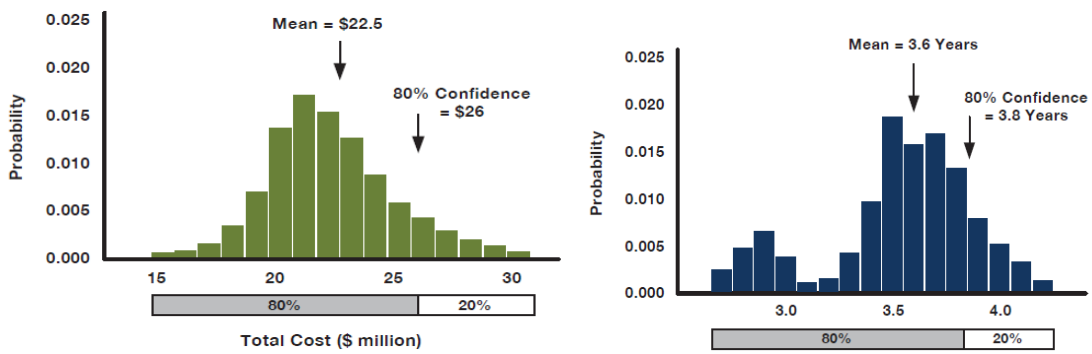
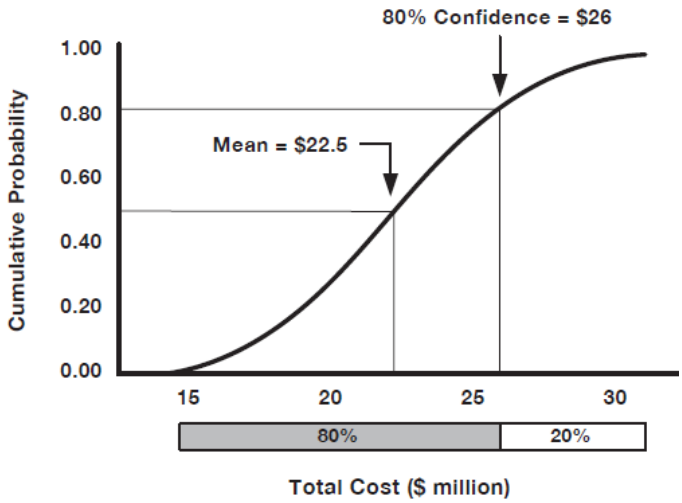


Figure 5-3 Sample Probability Mass Function on Project Costs; Figure 5-4 Sample Probability Mass Function on Schedule Duration

Confidence in Cost or Schedule

The cumulative probability functions shows in Figure 5-5 and Figure 5-6 provide the same information shown in Figure 5-3 and Figure 5-4, but in a cumulative manner. The cumulative functions provide a quick reference for the mean (P50) and a confidence level in the estimate or schedule.



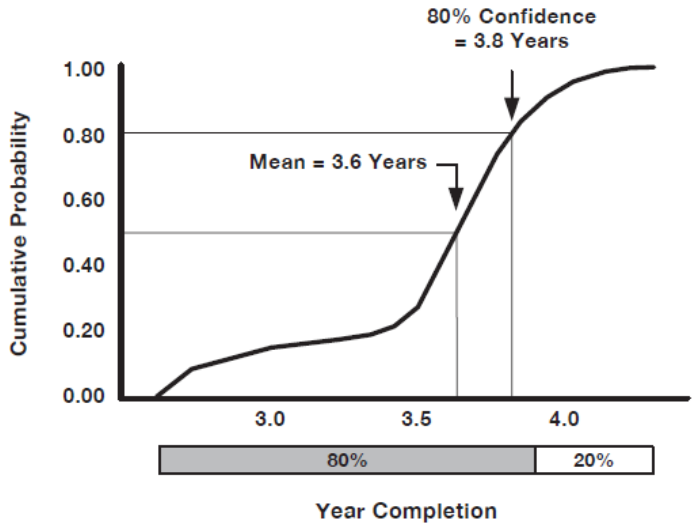


Figure 5-5 Sample Cumulative Probability Function on Project Costs; Figure 5-6 Sample Cumulative Probability Function on Schedule Duration

Identification of Risks with the Greatest Impact

Sensitivity analysis is a primary modelling output that can be used in the valuation of the impacts of individual risks. Figure 5-7 Sample Senstivity Analysis on Project Risks provides a sensitivity analysis in the form of a “tornado diagram”. Tornado diagrams depict the influence of individual risks and highlight the greater contributors to the overall risk. Using this information, project managers or function managers can spend more effort on mitigating the risks that has the higher impact on the success of the project/function.

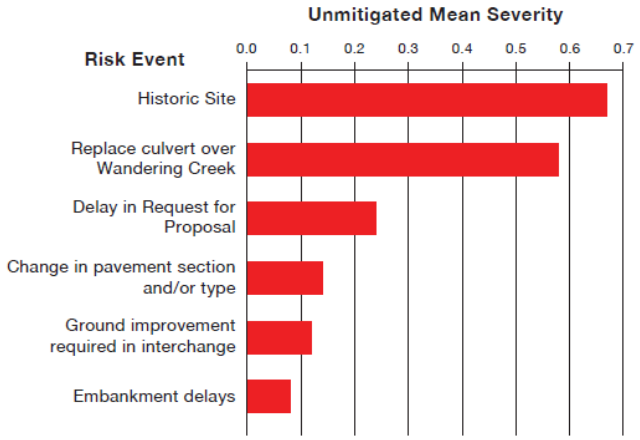


Figure 5-7 Sample Sensitivity Analysis on Project Risks

DRAFT

6.0 RISK

6.1 Purpose

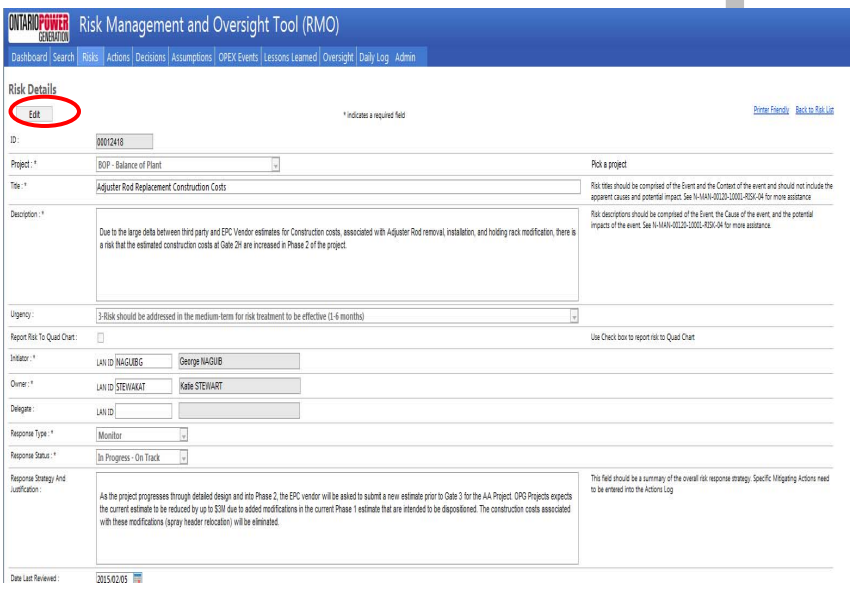
This Program and Project Risk Tab provides an accessible and centralized location to capture, manage and resolve NR Risks. This section of the RMO guide is designed to be read by the users who will be documenting Program and Project Risks**. N-MAN-00120-10001-RISK, Nuclear Projects Risk Management** manual provides direction for Risk.

Risk identification is the process of determining which risks may affect the NR project and documenting their characteristics and actions to mitigate. It is an iterative process since new risks may evolve or become known as the project/program progresses.

A Risk Register starts off as a list of identified risks. As the NR project/program progresses, the risk register becomes the repository of the outcomes of other risk management processes as they are conducted, i.e. risk responses, resulting in an increase in the level and type of information. The Risk Tab is updated as new information on the risks becomes available.

6.2 Editing a Risk Record

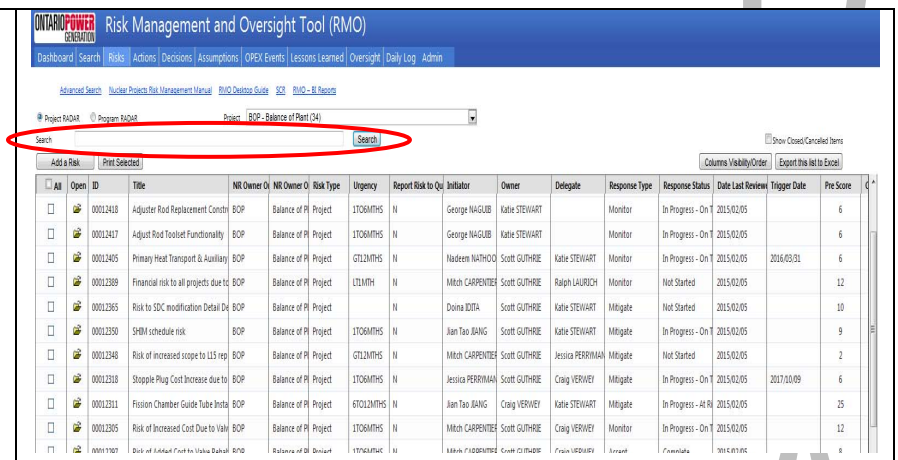
To open the fields to edit the record. Click **Edit** located at the top of the selected record.



6.3 Searching For a Record

To narrow the search, use the available "search" feature and input key words or names

The viewer will then display the requested information



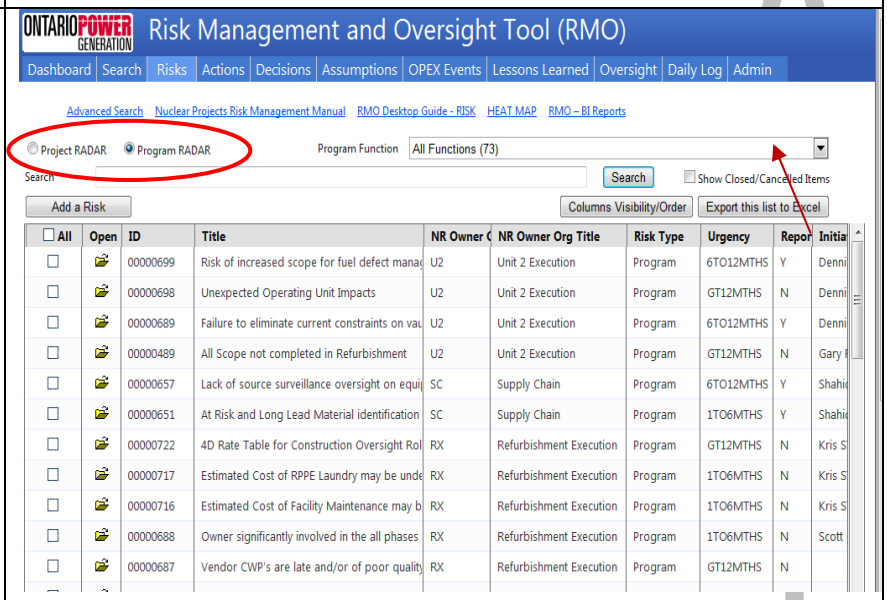
6.4 Selecting a Project

If you chose in the viewer "project for example" this feature will only show you the projects of NR.

When choosing function this feature will only show you the functional teams of NR.

Use the drop down menu to choose the project or function you are interested in.

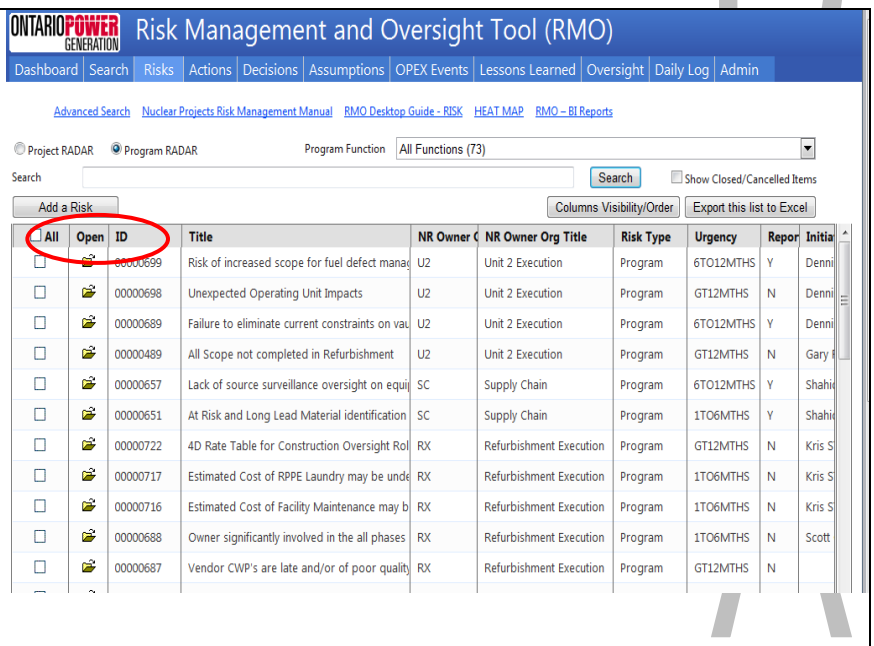
Open the record by clicking the file icon.



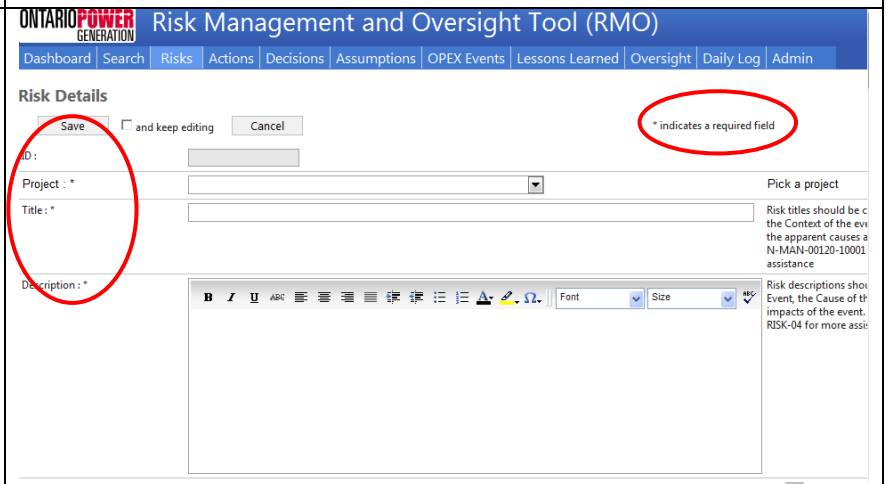
6.5 Add a New Risk Record

Click **Add a Risk**, located at the top left of the view screen

Input the required information before selecting **Save** (located at the top of the page) to **Save** the newly created record.

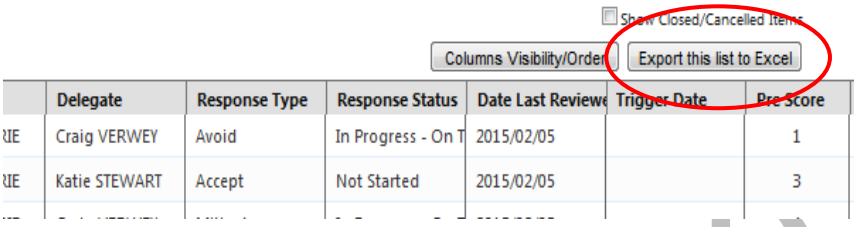


Each record will have unique “mandatory” entries filled out by the user before saving. These fields will have an asterisk * next to the fields name.



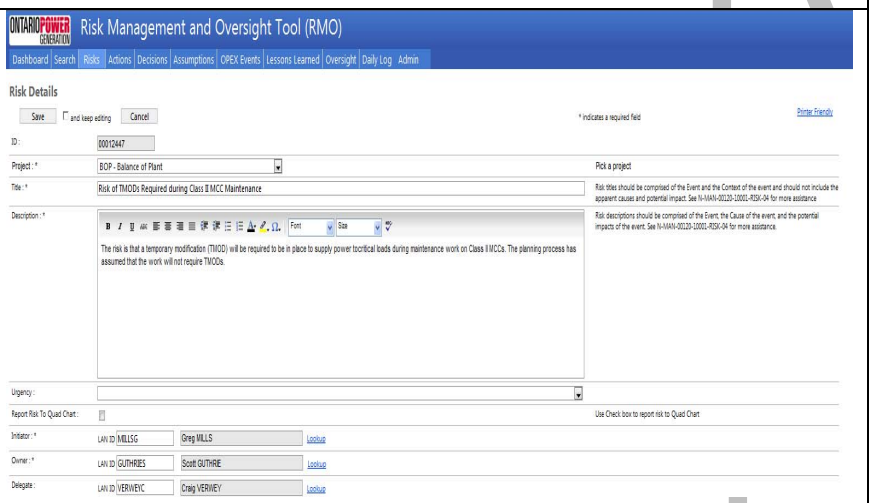
6.6 Export to Excel

Click **Export this list to Excel** to export lists to an excel table for formatting, located on the top right of the page.



6.7 Save

Always remember to scroll to the top of the screen and click **Save**.

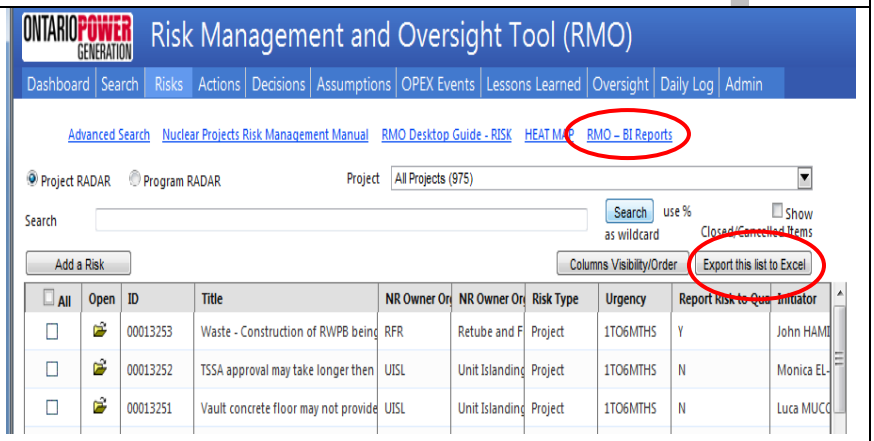


6.8 Print

The RMO tool will be the new workspace for SharePoint logs and such has enhanced printer friendly features for printing logs and BI reports. Click **RMO-BI Reports**

or

To print a list of records. Click **Export** this list to Excel.



RQE Contingency Development

N. Ryan Smith, Manager
Risk Management, Nuclear Refurbishment
June 24, 2015

BEHAVIOURS

- Integrate & Collaborate
- Think Top & Bottom Line
- Simplify It
- Say It. Do It
- Tell It As It Is

▪ SAFETY ▪ INTEGRITY ▪ EXCELLENCE ▪ PEOPLE & CITIZENSHIP ▪

PEOPLE POWERING THE FUTURE
OPG NUCLEAR

ONTARIO POWER GENERATION

Sources of Contingency for RQE

Cost Estimating Uncertainty

The possibility that the actual costs of the projects are more or less than the point estimates (***excluding discrete risk events***).

Schedule Estimating Uncertainty

The possibility that the actual schedule duration for the program is more or less than the point duration (***excluding discrete risk events***).

Discrete Risks

The incremental cost and schedule impacts to the project baselines if risk events were to occur. This includes risks specific risks identified for individual project bundles, as well as global program risks that could impact NR in an overarching manner.

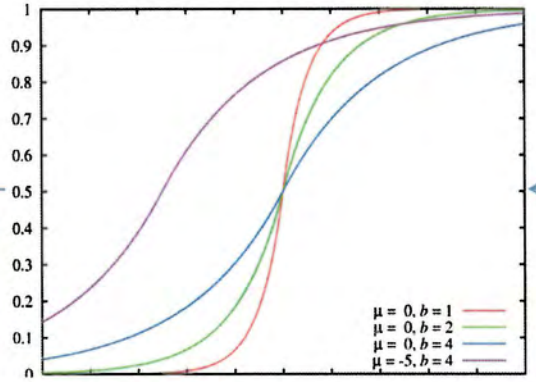
The Integrated Model

1 INDIVIDUAL PROJECT AND FUNCTIONAL INPUTS OBTAINED FROM WORKSHOPS

2
- ESTIMATE UNCERTAINTY
- SCHEDULE UNCERTAINTY
- DISCRETE RISKS

3 INTEGRATED MONTE CARLO SIMULATION

Integrated RQE S-Curves to Obtain P50, P90, etc.



4 Assignment of Contingencies to Individual Inputs ($/input to model)

@ MDK

Confidence Levels and Authority for Use

	Up to P50	ΔP50→P70	ΔP70→P90
Cost Estimate Uncertainty (Project)	Project Contingency	Program Contingency	Management reserve
Cost Estimate Uncertainty (Functions)	Program Contingency	Program Contingency	Management Reserve
Schedule Estimate Uncertainty (Program Only)	Management reserve	Management Reserve	Management Reserve
Discrete Risks (Project)	Project Contingency	Program Contingency	Management Reserve
Discrete Risks (Program/Functions)	Program Contingency	Program Contingency	Management Reserve

Authority Levels: All contingency shall be accessed via the change control process. Project Contingency shall be authorized for use by the Project Directors. Program Contingency shall be authorized for use at the VP Level. Management Reserve shall be authorized for use by the SVP. No delegates shall have authorization rights.

Cost Estimating Uncertainty

The following outlines an illustrative example of the general approach to cost estimating uncertainty for each estimate supplied for RQE:

	What	Who
Step 1:	Estimate is Approved and Classified	Estimating and PM
Step 2:	Estimate is split by PEPCCC elements and provided to Risk Department	PM, P&C Lead
Step 3:	Each element is assigned a 3 point estimate in a workshop led by Risk Department	Risk, PM, Estimating, SMEs as required
Step 4:	Input 3 point Estimates to Master RQE Monte Carlo File to run as part of the integrated simulation	Risk

Example: ***Class 3 Estimate for Project XXXXX***

	Point Estimate ($M)	Most Likely Cost ($M)	Optimistic Cost ($M)	Pessimistic Cost ($M)
Estimate Total	**100**			
Project Management	7	7	6	10
Engineering	15	15	14	17
Procurement	20	20	18	25
Construction	50	50	45	65
Commissioning	5	5	4.5	6
Closeout	3	3	2	3
SUM	**100**	**100**	**89.5**	**126**

Schedule Estimating Uncertainty

The following outlines an illustrative example for the general approach to determining schedule estimate uncertainty for RQE. For the Program overall, we use the Rev A logic:

	What	Who
Step 1:	Rev A logic, defining the planned execution windows, is approved.	Scheduling and Outage Manager
Step 2:	Each window is assigned a 3 point uncertainty estimate for duration by the outage department in consultation with project managers and SMEs	Outage, Scheduling, PMs, SMEs as required
Step 4:	Input 3 point Estimates to Master RQE Monte Carlo File to run as part of the integrated simulation	Risk

Example: ***NR Rev A Outage Logic - Revision XXXXX***

		U2		
	Point Estimate (Days)	Most Likely Duration (Days)	Optimistic Duration (Days)	Pessimistic Duration (Days)
Total Outage Duration (P6)	XXXX			
S/D to GSS	3	3	2	4
Defuel Reactor	113	113	90	123
Crane Maintenance	4	4	3	5
RFR Prereq. Prior to Containment Isolation	48	48	33	51
Containment Test Process	2	2	8	13
....	....	.....	....	....
SUM				

Units 3, 1, and 4 would be similarly analyzed or a rule based approach for the 3 point estimates would be performed assuming better performance and less uncertainty in future unit performance.

Discrete Risks

The following outlines an illustrative example for the general approach to how discrete risks from the RMO tool are extracted and translated to contingency funding for RQE. This process is common for project and functional (including program) risk registers:

	What	Who
Step 1:	Extract project or functional risk register from RMO. Assess post mitigated risks and determine which risks should be included for contingency consideration. This should exclude items with a post mitigated score of 4 or less ("green")	Risk, PMs, P&C Leads
Step 2:	In a workshop, each risk is assigned a 3 point uncertainty range for including Probability, Recurrence, Cost impact, ***Critical Path*** Schedule Impact, and Burn Rate (to allow monetization of schedule delays).	Risk, PMs, P&C Leads, Estimating, other SMEs as required
Step 4:	Input 3 point Estimates to Master RQE Monte Carlo File to run as part of the integrated simulation	Risk

Risk Register for Project Bundle XXXXX

		RES. RISK PROBABILITY			RISK RECURRENCE			COST IMPACT PER OCCURRENCE			CRIT. PATH SCHED. DELAY PER OCCURRENCE			BURN RATE COST PER DAY		
Risk ID	Risk Decription	ML (%)	Opt (%)	Pes (%)	ML	Opt	Pes	ML ($M)	Opt ($M)	Pes ($M)	ML (Days)	Opt (Days)	Pes (Days)	ML ($K)	Opt ($K)	Pess ($K)
712	The risk is that....	50	20	60	2	0	5	1	0.5	3	7	6	10	10	8	20
800	The risk is that....	20	10	25	0	0	0	6	1	15	15	14	17	10	5	17
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

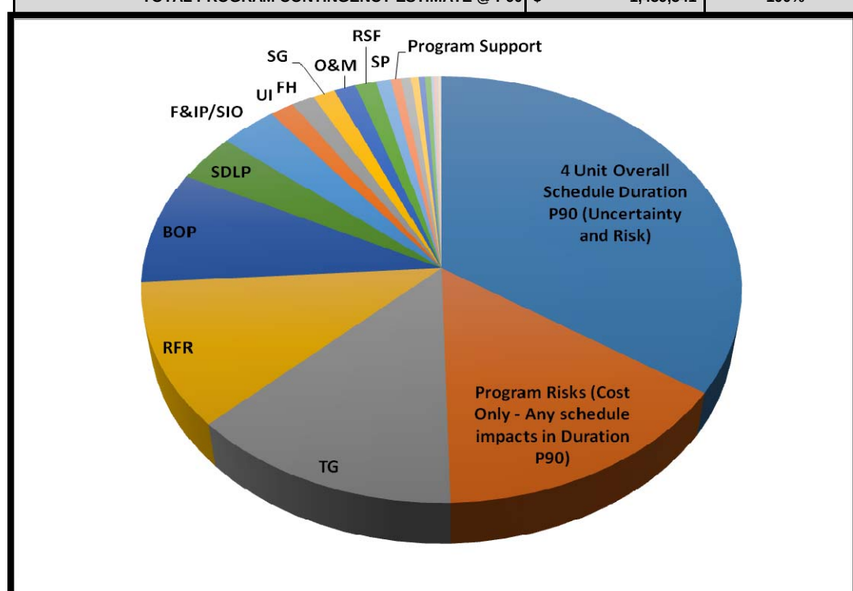
DARLINGTON REFURBISHMENT
Repowering Ontario

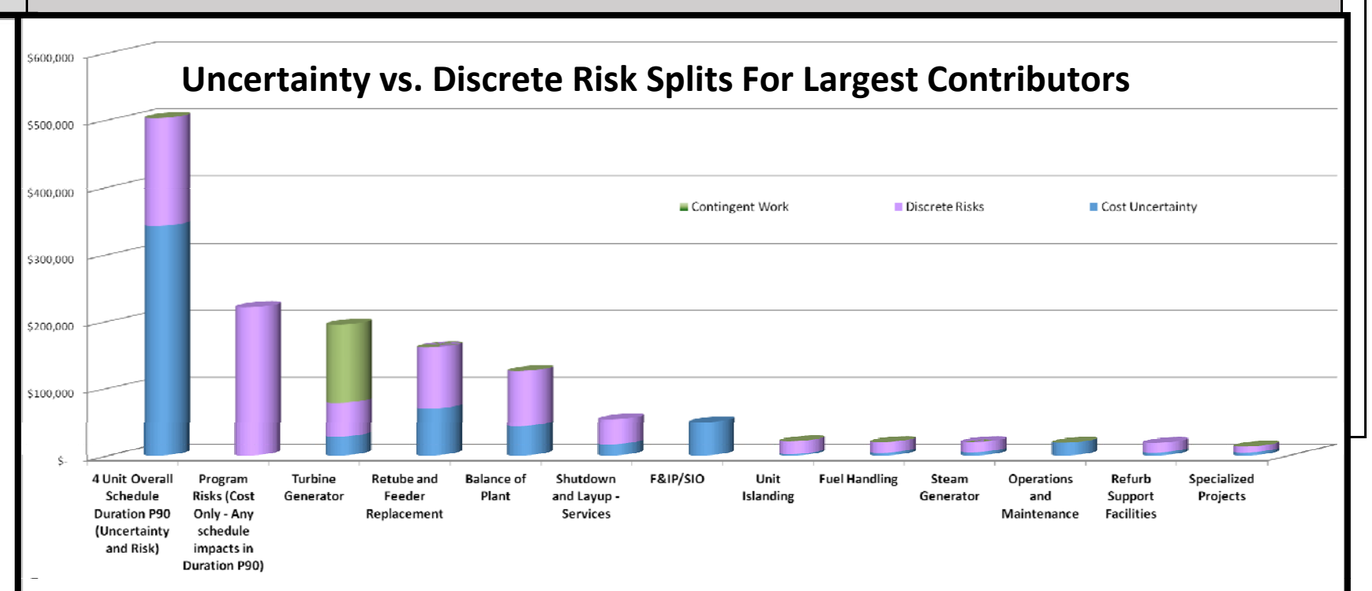
Darlington Nuclear Refurbishment Program

Integrated Contingency Estimate - SNAPSHOT 3 (FINAL)

Sep 30, 2015

Snapshot 3 Prime Contingency Summary $	$1,459,541 (2015$ Non-esc)			Key Notes and Considerations
Rank #	Project Bundle/Function/Element	Contingency	% Total Contingency	THE FIGURES SHOWN ARE NOT FINAL AND DO NOT REFLECT FINAL NPET REVIEW AND COMMENTS
01	4 Unit Overall Schedule Duration (Uncertainty and Risk)	$ 502,568	34.4%	This is detailed 4 unit analysis, and includes owners assessment of Project, Program, and JV owned risks that could impact critical path. It uses the uncertainty ranges for optimistic, most likely, and pessimistic outage durations agreed upon by RFR/JV in the R1 submission and rechallenged with all window owners on September 11, 2015. Detailed basis and rationale for the three point estimates have been documented. The basis for a program level burn rate has been documented by finance and is incorporated in the analysis. This figure reflects a range (optimistic/ML/pessimistic) of (631.6, 952.2, and 1285.5 k/day) for the cost of a day lost on critical path. This figure reflects strong correlation (or interdependence) of schedule risks and their impact on schedule activities and critical path duration.
02	Program Risks (Cost Only - Any schedule impacts in Duration P90)	$ 220,793	15.1%	Program risks in RMO that are being managed in Functional risk registers. Overarching program risks (alpha event, injury, project fire, vendor performance, discovery work, station interface, etc). Risks for vendor (ESMSA) poor performance and vendor default carries about $85M contingency. (There is no critical path schedule impact (burn rate type) costs in the contingency figure shown here. Schedule cost impacts for program risks were assessed and integrated in item 1 if applicable.
03	Turbine Generator	$ 194,855	13.4%	Includes 117M for contingent work. This bundle is the only bundle that has contingent work DSRs.
04	Retube and Feeder Replacement	$ 160,820	11.0%	This figure reflects the project contingency for RFR, including their estimate uncertainty and discrete risks. The total "RFR Contingency Picture" includes this figure, ~75% of the Schedule Duration contingency in line 1 is attributable to RFR work, as well as number of dollars built into the base estimate for JV target cost and schedule estabishment. **All told, there is approximately 700M dollars of contingency in various buckets across the program.**
05	Balance of Plant	$ 125,318	8.6%	
07	Shutdown and Layup - Services	$ 52,980	3.6%	
08	F&IP/SIO	$ 48,822	3.3%	Deterministic value provided by P&M Management. Note that an additional $69M program risk exists in in line Item 3 specifically for F&IP/SIO cost and schedule overrun risks.
09	Unit Islanding	$ 20,859	1.4%	
10	Fuel Handling	$ 19,625	1.3%	
11	Steam Generator	$ 19,592	1.3%	
12	Operations and Maintenance	$ 18,574	1.3%	Uncertainty only. Any risks that are monetized are included in line item 3
13	Refurb Support Facilities	$ 18,156	1.2%	
15	Specialized Projects	$ 12,819	0.9%	
16	Program Support	$ 8,950	0.6%	Uncertainty only. Any risks that are monetized are included in line item 3
17	Refurbishment Execution	$ 8,506	0.6%	Uncertainty only. Any risks that are monetized are included in line item 3
18	Engineering	$ 6,467	0.4%	Uncertainty only. Any risks that are monetized are included in line item 3
19	Defuelling	$ 5,398	0.4%	
20	Insurance Uncertainty	$ 5,393	0.4%	Derived from a three point estimate provided by Treasury.
21	Unit 2 Execution	$ 2,336	0.2%	Uncertainty only. Any risks that are monetized are included in line item 3
22	Supply Chain	$ 2,222	0.2%	Uncertainty only. Any risks that are monetized are included in line item 3
23	Planning and Control	$ 1,950	0.1%	Uncertainty only. Any risks that are monetized are included in line item 3
24	Contract Management	$ 1,503	0.1%	Uncertainty only. Any risks that are monetized are included in line item 3
25	Managed Systems Oversight	$ 1,035	0.1%	Uncertainty only. Any risks that are monetized are included in line item 3
27	EA and Licensing	$ -	0.0%	
28	Human Resources	$ -	0.0%	
	TOTAL PROGRAM CONTINGENCY ESTIMATE @ P90	$ 1,459,541	100%	





DARLINGTON REFURBISHMENT
Repowering Ontario

Darlington Nuclear Refurbishment Program

Integrated Contingency Estimate

Sep 30, 2015

4 Unit Schedule Contingency

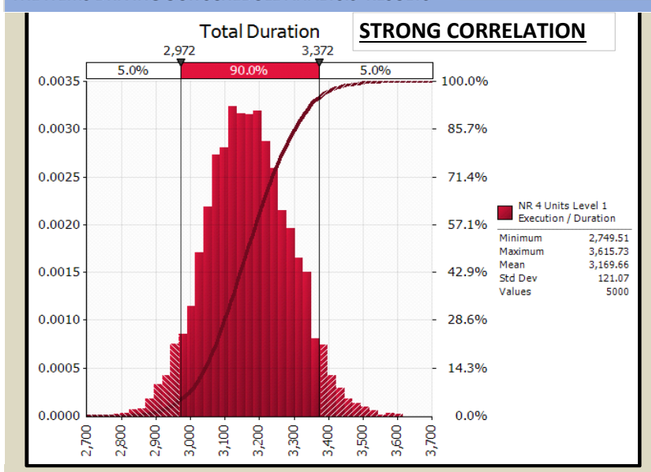
Strong Correlation to support Conservative Risk Management	U2			U3			U1			U4		
Probability of Achieving Planned Base Duration	23%			26%			26%			28%		
Base Duration	1,029	P(x)- Base	% Delay	1,009	P(x)- Base	% Delay	996	P(x)- Base	% Delay	998	P(x)- Base	% Delay
50%	1,092	63	6%	1,060	51	5%	1,041	45	4%	1,041	43	4%
70%	1,143	114	11%	1,103	94	9%	1,083	87	9%	1,080	82	8%
90%	1,209	180	18%	1,166	157	16%	1,141	145	15%	1,139	141	13%

SCHEDULE ANALYSIS SUMMARY

The table to the left shows schedule analysis, where a strong correlation between schedule risk and its impact on activities (interdependence) and critical path duration for 4 units. ***This is not to be confused with logic ties which are in place in both scenarios***.

With strong correlation in schedule risk and uncertainty, the positive (optimistic) outcomes as well as the negative (pessimistic) outcomes are more pronounced, resulting in longer tails (more very optimistic outcomes and more very pessimistic outcomes). Criteria for strong correlation reflected that RFR JV as major contractor to execute NR critical path activities, the company culture, management approach, crews training program, shall be consistent amongst units. So the effect of positive and negative momentum across schedule activities will be consistent among units. Thus with strong correlation representing a conservative risk management approach for NR.

THE LARGEST Risk AND UNCERTAINTY CONTRIBUTORS TO THE OVERALL UNIT OUTAGE FOR TOTAL CORRELATION SCHEDULE. IN THE UNCORRELATED, THE ITEMS ARE THE SAME HOWEVER THE MAGNITUDE OF THE IMPACT OF THE ITEM ON P90 IS LESS. **THESE ARE THE ITEMS DRIVING OUR SCHEDULE ANALYSIS RESULTS**



Mean	3,170	
Std. Dev.	121	**Outage Delay [ds]**
5%	2,972	(35.6)
10%	3,018	10.4
15%	3,046	38.3
20%	3,068	60.1
25%	3,085	77.7
30%	3,103	95.8
35%	3,120	112.4
40%	3,135	127.4
45%	3,151	143.3
50%	3,166	158.2
55%	3,183	175.0
60%	3,198	190.5
65%	3,214	206.6
70%	3,232	224.4
75%	3,252	244.0
80%	3,274	266.2
85%	3,298	289.9
90%	3,328	320.9
95%	3,372	364.2

Reference Duration	3007.59
Probability of achieving reference duration	8.30%
Probability of surpassing reference duration	91.70%

Assume Unit over Unit start to finish logic, without considering the focus period between units.

Opportunity ITEM	Opportunity Description	Rev A Logic Window Impacted	Saving on CP Duration @P90			
			U2	U3	U1	U4
Opportunity 4	OPG Islanding - Shielding not required due to fuelling configurations	RFR Prereq. Post Containment Isolation	-5.1	-5.1	0	0
Opportunity 3	OPG Islanding - Improve efficiency of work in the bulkhead installation window	RFR Prereq. Prior to Containment Isolation	-0.6	-2.8	-2.8	-2.8
Opportunity 5	OPG Islanding - improve the efficiency of work in the bulkhead removal window	Bulkhead Removal	-2.2	-2.2	-2.2	-2.2
Opportunity 2	OPG Islanding - "Remove Shielding" activity taken off critical path	Fuel Load, RTP Removals, Bridge Replacement	-1.6	-1.6	-1.6	-1.6
Opportunity 1	OPG Defuel - Perform Defuelling Single Ended and Reduce Dummy Bundles	Defuel Reactor	-0.7	-0.7	-0.7	-0.7
			Total Opportunity Saving on CP Duration			-37

UNCERTAINTY ITEM	Schedule Activity Duration Uncertainty	REV A LOGIC WINDOW IMPACTED	Days Critical Path Delay @P90
UNC	Low Power Testing & Heat-up	LEAD OUT	41.3
UNC	CT Install Series	FC INSPECT AND INSTALL	31.1
UNC	Fuel Channel Install Series	FC INSPECT AND INSTALL	29.4
UNC	Lower Feeder Install Series	FEEDER INSTALL	25.0
UNC	Defuel Reactor	DEFUELLING REACTOR	24.3
UNC	RFR Prereq. Prior to Containment Isolation	VAULT PREPARATION	19.5
UNC	Fuel Load, RTP Removals, Bridge Replacement	LEAD OUT	19.3
UNC	RFR Prereq. Post Containment Isolation	VAULT PREPARATION	19.1
UNC	End Fitting Removal	FC REMOVAL	18.4
UNC	Feeder Removal	FEEDER REMOVAL	15.8
UNC	Run-up & Sync	LEAD OUT	12.5
UNC	Inspection Series	FC INSPECT AND INSTALL	11.3
RISK ITEM	**RISK Description**	**REV A LOGIC WINDOW IMPACTED**	**Days Critical Path Delay @P90**
OPG Program 699	Risk of increased scope for fuel defect management	Low Power Testing & Heat-up	7.7
OPG Program 699	Risk of increased scope for fuel defect management	Low Power Testing & Heat-up	7.7
OPG Program 699	Risk of increased scope for fuel defect management	Low Power Testing & Heat-up	7.7
OPG Program 699	Risk of increased scope for fuel defect management	Low Power Testing & Heat-up	7.7
OPG Program 781	OPG TG - Turbine excitation/voltage regulation testing going sideways .	Run-up & Sync	6.8
OPG RFR 12322	OPG RFR - End Fitting Waste Processing - First of a kind risks	End Fitting Removal	5.1
JV RFR 16.9.	JV RFR - Interference with RFR activities due to unexpected OPG RFR related activities	Lower Feeder Install Series	3.6
JV RFR 16.9.	JV RFR - Interference with RFR activities due to unexpected OPG RFR related activities	Lower Feeder Install Series	3.5
JV RFR 16.9.	JV RFR - Interference with RFR activities due to unexpected OPG RFR related	Lower Feeder Install Series	3.4
JV RFR 16.9.	JV RFR - Interference with RFR activities due to unexpected OPG RFR related	Lower Feeder Install Series	3.2
OPG RFR 13332	OPG RFR- Ineffective Practices in Maintaining the Tools	Fuel Channel Install Series	3.0
OPG RFR 13332	OPG RFR- Ineffective Practices in Maintaining the Tools	Fuel Channel Install Series	2.8
OPG RFR 13332	OPG RFR- Ineffective Practices in Maintaining the Tools	Fuel Channel Install Series	2.6
		TOTAL DAYS ATTRIBUTED TO RISK & OPPORTUNITY	**102**
		TOTAL DAYS ATTRIBUTED TO UNCERTAINTY	**219**

AMPCO Interrogatory #77

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-7 Page 9
Ref: H1-1-1 Page 13

Preamble: OPG proposes that the variance between actual costs and firm financial commitments and those forecast costs and firm financial commitments underpinning the 2017-2021 annual nuclear revenue requirement approved by the OEB in this proceeding be recorded in the Capacity Refurbishment Variance Account ("CRVA"). The nuclear revenue requirement includes DRP in-service additions. In the event of any unallocated contingency at the point of in-service, the favourable revenue requirement amount will be recorded in the CRVA and returned to ratepayers in a future test period.

a) Please confirm that the CRVA balance will be zero in the event the DRP is on budget and on time at the end of the test period. If this is not so, please describe the other factors that will apply.

b) Please report the amounts that would be recorded in the CRVA that would reflect the revenue requirement impact over the test period if the DRP in-service additions were 10% and 25% over budget. Please show your calculations.

c) Please report the amounts that would be recorded in the CRVA that would reflect the revenue requirement impact over the test period if the DRP in-service additions were 10% and 25% delayed over schedule. Please show your calculations.

Response

OPG's response to this question is with reference to planned in-service additions of $4.8B associated with the return to service of refurbished Darlington Unit 2 in 2020.

a) Not confirmed.

The CRVA balance with respect to the $4.8 billion in-service additions associated with the return to service of refurbished Darlington Unit 2 in 2020 may not be zero at the end of 2020 if the in-service additions are on budget and on time. Other factors that could result in a credit or debit balance in the account include:

- Variances between actual and forecast depreciation expense associated with asset class categorization of actual in-service amounts (see Ex. L-06.9-1 Staff-180);
- Variances between actual and forecast capital cost allowance amounts deductible for tax purposes, including variances related to tax asset class categorization of actual expenditures; and
- Interest on the account balance at the OEB-prescribed rate.

b) For illustrative purposes, OPG has estimated CRVA additions related to the 2017-2021 revenue requirement impact of the DRP in-service additions associated with the return to service of Unit 2 in 2020 being 10% and 25% over planned amounts reflected in the pre-filed evidence. The estimated impacts are otherwise based on the same planning assumptions as reflected in the pre-filed evidence.

In the illustrative case of the 2020 service additions being 10% over budget, the total 2017-2021 revenue requirement that would be recorded in the CRVA is estimated at approximately $81M (debit), as detailed in Attachment 1, Table 1. In the illustrative case of the 2020 in service additions being 25% over budget, the total 2017-2021 revenue requirement that would be recorded in the CRVA is estimated at approximately $202M (debit) as detailed in Attachment 1, Table 2.

c) For illustrative purposes, OPG has estimated CRVA additions related to the 2017-2021 revenue requirement impacts of the DRP in-service additions associated with the return to service of Unit 2 in 2020 being 10% (i.e. 4 months to mid-June 2020) and 25% (i.e. 10 months to mid-December 2020) delayed over the schedule. Estimated incremental interest costs of approximately $80M and approximately $199M, respectively, have been added to the planned in-service amounts on account of the assumed delays. The estimated revenue requirement impacts are otherwise based on the same planning assumptions as reflected in the pre-filed evidence. Specifically, it is assumed there are no additional costs associated with the delay, other than interest.

In the illustrative case of the 2020 service additions being 10% delayed over schedule, the total 2017-2021 revenue requirement that would be recorded in the CRVA is estimated at approximately $177M (credit), as detailed in Attachment 1, Table 3. In the illustrative case of the 2020 in service additions being 25% delayed over schedule, the total 2017-2021 revenue requirement that would be recorded in the CRVA is estimated at approximately $456M (credit) as detailed in Attachment 1, Table 4.

Numbers may not add due to rounding.

Table 1

Darlington Refurbishment Program Unit 2 - Hypothetical 10% Over Budget In-Service Additions[1]

Summary of Estimated Capacity Refurbishment Variance Account Transactions - 2017 to 2021 ($M)

Line No.	Particulars	Note	2017	2018	2019	2020	2021
			(a)	(b)	(c)	(d)	(e)
	Capital Addition to Variance Account - Darlington Refurbishment Unit 2:						
1	**EB-2016-0152 Forecast Cost of Capital Amount** (from Table 1a, line 3b)	2	0.0	0.0	0.0	281.0	312.7
2	**Hypothetical Net Plant Rate Base Amount** (from Note 3, line 9a)	3	0.0	0.0	0.0	4,539.8	5,057.2
3	**EB-2016-0152 Weighted Average Cost of Capital** (from Table 1a, line 2b)	2	7.01%	6.86%	6.83%	6.81%	6.80%
4	**Hypothetical Cost of Capital Amount** (line 2 x line 3)		0.0	0.0	0.0	309.1	343.9
5	**Cost of Capital Variance** (line 4 - line 1)		0.0	0.0	0.0	28.1	31.3
6	**EB-2016-0152 Forecast Depreciation** (from Table 1a, line 5b)	2	0.0	0.0	0.0	128.9	147.3
7	**Hypothetical Depreciation** (from Note 3, line 5a)	3	0.0	0.0	0.0	141.8	162.0
8	**Depreciation Variance** (line 7 - line 6)		0.0	0.0	0.0	12.9	14.7
	Income Tax Impact:						
9	**EB-2016-0152 Total DRP Forecast Capital Cost Allowance Deduction** (from Table 1a, line 6b)	2	183.1	283.7	354.4	380.8	383.2
10	**Hypothetical Estimated Total DRP Capital Cost Allowance Deduction**	4	183.1	283.8	377.8	412.9	413.4
11	**Difference** (line 10 - line 9)		0.0	(0.1)	(23.4)	(32.2)	(30.2)
12	**Net Increase (Decrease) in Regulatory Taxable Income**	5	0.0	(0.1)	(23.4)	(0.7)	5.2
13	**Income Tax Rate**	6	25.00%	25.00%	25.00%	25.00%	25.00%
14	**Income Tax Impact** (line 12 x line 13 / (1 - line 13))		0.0	(0.0)	(7.8)	(0.2)	1.7
15	**Total Capital Addition to Variance Account** (line 5 + line 8 + line 14)		0.0	(0.0)	(7.8)	40.8	47.7

Notes:

1 For illustrative purposes, this analysis shows the hypothetical impact of 10% over budget Darlington Refurbishment in-service additions associated with the return to service of Unit 2 in 2020, relative to amounts reflected in the pre-filed evidence (Ex. D2-2-10, page 1, line 19).

2 See Table 1a for details on Note 2.

3 The hypothetical annual amounts are determined as follows:

Table to Note 3 - Darlington Refurbishment Unit 2 Hypothetical Net Plant Rate Base Amount ($M)

Line No.		2017	2018	2019	2020	2021
		(a)	(b)	(c)	(d)	(e)
1a	Gross Plant - Opening Balance	0.0	0.0	0.0	0.0	5,279.8
2a	Hypothetical In Service Additions[a]	0.0	0.0	0.0	5,279.8	0.4
3a	Gross Plant - Closing Balance (line 1a + 2a)	0.0	0.0	0.0	5,279.8	5,280.2
4a	Accumulated Depreciation - Opening Balance	0.0	0.0	0.0	0.0	141.8
5a	Hypothetical Depreciation[b]	0.0	0.0	0.0	141.8	162.0
6a	Accumulated Depreciation - Closing Balance (line 4a + 5a)	0.0	0.0	0.0	141.8	303.8
7a	Net Plant - Opening Balance (line 1a - 4a)	0.0	0.0	0.0	0.0	5,138.0
8a	Net Plant - Closing Balance (line 3a - 6a)	0.0	0.0	0.0	5,138.0	4,976.4
9a	Hypothetical Net Plant Rate Base Amount[c]	0.0	0.0	0.0	4,539.8	5,057.2

a For 2020, calculated as 110% x $4,799.8M (Ex. D2-2-10, Table 2, line 1, col. (o)). For 2021, from Ex. D2-2-10, Table 2, line 1, col. (p).

b Approximated as 110% x Table 1a, line 5b.

c As noted in Ex. D2-2-10, page 1, lines 19-24, the 2020 in-service amount of $4,799.8M in the pre-filed evidence consists of $4,777.7M placed in service in February 2020 upon return to service of Unit 2 and $22.1M placed in service in August 2020 for close-out activities. As also noted at that reference and at Ex. B3-3-1, Table 2, Note 3, the $4,777.7M value is assigned a 10.5/12 month weighting in the calculation of the 2020 net plant rate base amount. The same treatment is applied in the calculation of the 2020 Hypothetical Net Plant Rate Base Amount, as follows: $4,777.7M x 110% x 10.5/12 + $22.1M x 110% x 1/2 - line 5a x 1/2.
The 2021 Hypothetical Net Plant Rate Base Amount is calculated as (line 7a + line 8a)/2.

4 Calculated in the same manner as amounts in the pre-filed evidence (see Ex. L-6.10-1 Staff-194).

5 Calculated as the sum of lines 8 and 11, plus the ROE component of the cost of capital variance at line 5.
The ROE component of the variance is the difference between: (i) line 2 multiplied by the proposed equity portion (49%) of the capital structure, multiplied by the proposed ROE rate of 9.19%, and (ii) Table 1a, line 4b.

6 From Ex. F4-2-1,Table 3a, line 29.

Numbers may not add due to rounding.

Table 1a

Note 2 to Tables 1-4

The annual forecast amounts are determined as follows per the pre-filed evidence:

Table to Note 2 - Darlington Refurbishment Unit 2 Forecast Amounts - EB-2016-0152 ($M)						
Line No.		2017	2018	2019	2020	2021
		(a)	(b)	(c)	(d)	(e)
1b	Forecast Net Plant Rate Base Amount [a]	0.0	0.0	0.0	4,127.1	4,597.5
2b	Weighted Average Cost of Capital [b]	7.01%	6.86%	6.83%	6.81%	6.80%
3b	Cost of Capital Amount (line 1b x line 2b)	0.0	0.0	0.0	281.0	312.7
4b	ROE Component of Cost of Capital Amount [c]	0.0	0.0	0.0	185.8	207.0
5b	Depreciation [a]	0.0	0.0	0.0	128.9	147.3
6b	Total DRP Capital Cost Allowance[d]	183.1	283.7	354.4	380.8	383.2

a As shown in Ex. L-2.2-1 Staff 9, Attachment 1 for Darlington Refurbishment - Unit 2.
b EB-2016-0152, Ex. C1-1-1, Tables 1 to 5, col. (c), line 6.
c Calculated as line 1b x equity portion (49%) of the EB-2016-0152 proposed capital structure x ROE rate of 9.19% from Ex. C1-1-1, Tables 1 to 5, col. (c), line 5.
d Total Darlington Refurbishment Program capital cost allowance as shown in Ex. F4-2-1, Table 3b, Note 3.

Numbers may not add due to rounding.

Table 2

Darlington Refurbishment Program Unit 2 - Hypothetical 25% Over Budget In-Service Additions[1]

Summary of Estimated Capacity Refurbishment Variance Account Transactions - 2017 to 2021 ($M)

Line No.	Particulars	Note	2017	2018	2019	2020	2021
			(a)	(b)	(c)	(d)	(e)
	Capital Addition to Variance Account - Darlington Refurbishment Unit 2:						
1	**EB-2016-0152 Forecast Cost of Capital Amount** (from Table 1a, line 3b)	2	0.0	0.0	0.0	281.0	312.7
2	**Hypothetical Net Plant Rate Base Amount** (from Note 3, line 9a)	3	0.0	0.0	0.0	5,158.9	5,746.8
3	**EB-2016-0152 Weighted Average Cost of Capital** (from Table 1a, line 2b)	2	7.01%	6.86%	6.83%	6.81%	6.80%
4	**Hypothetical Cost of Capital Amount** (line 2 x line 3)		0.0	0.0	0.0	351.2	390.8
5	**Cost of Capital Variance** (line 4 - line 1)		0.0	0.0	0.0	70.2	78.2
6	**EB-2016-0152 Forecast Depreciation** (from Table 1a, line 5b)	2	0.0	0.0	0.0	128.9	147.3
7	**Hypothetical Depreciation** (from Note 3, line 5a)	3	0.0	0.0	0.0	161.1	184.1
8	**Depreciation Variance** (line 7 - line 6)		0.0	0.0	0.0	32.2	36.8
	Income Tax Impact:						
9	**EB-2016-0152 Total DRP Forecast Capital Cost Allowance Deduction** (from Table 1a, line 6b)	2	183.1	283.7	354.4	380.8	383.2
10	**Hypothetical Estimated Total DRP Capital Cost Allowance Deduction**	4	183.1	284.0	412.9	461.2	458.8
11	**Difference** (line 10 - line 9)		0.0	(0.2)	(58.5)	(80.4)	(75.6)
12	**Net Increase (Decrease) in Regulatory Taxable Income**	5	0.0	(0.2)	(58.5)	(1.7)	13.0
13	**Income Tax Rate**	6	25.00%	25.00%	25.00%	25.00%	25.00%
14	**Income Tax Impact** (line 12 x line 13 / (1 - line 13))		0.0	(0.1)	(19.5)	(0.6)	4.3
15	**Total Capital Addition to Variance Account** (line 5 + line 8 + line 14)		0.0	(0.1)	(19.5)	101.9	119.3

Notes:

1 For illustrative purposes, this analysis shows the hypothetical impact of 25% over budget Darlington Refurbishment in-service additions associated with the return to service of Unit 2 in 2020, relative to amounts reflected in the pre-filed evidence (Ex. D2-2-10, page 1, line 19).

2 See Table 1a for details on Note 2.

3 The hypothetical annual amounts are determined as follows:

Table to Note 3 - Darlington Refurbishment Unit 2 Hypothetical Net Plant Rate Base Amount ($M)

Line No.		2017	2018	2019	2020	2021
		(a)	(b)	(c)	(d)	(e)
1a	Gross Plant - Opening Balance	0.0	0.0	0.0	0.0	5,999.8
2a	Hypothetical In Service Additions[a]	0.0	0.0	0.0	5,999.8	0.4
3a	Gross Plant - Closing Balance (line 1a + 2a)	0.0	0.0	0.0	5,999.8	6,000.2
4a	Accumulated Depreciation - Opening Balance	0.0	0.0	0.0	0.0	161.1
5a	Hypothetical Depreciation[b]	0.0	0.0	0.0	161.1	184.1
6a	Accumulated Depreciation - Closing Balance (line 4a + 5a)	0.0	0.0	0.0	161.1	345.3
7a	Net Plant - Opening Balance (line 1a - 4a)	0.0	0.0	0.0	0.0	5,838.7
8a	Net Plant - Closing Balance (line 3a - 6a)	0.0	0.0	0.0	5,838.7	5,654.9
9a	Hypothetical Net Plant Rate Base Amount[c]	0.0	0.0	0.0	5,158.9	5,746.8

a For 2020, calculated as 125% x $4,799.8M (Ex. D2-2-10, Table 2, line 1, col. (o)). For 2021, from Ex. D2-2-10, Table 2, line 1, col. (p).

b Estimated as 125% x Table 1a, line 5b.

c As noted in Ex. D2-2-10, page 1, lines 19-24, the 2020 in-service amount of $4,799.8M in the pre-filed evidence consists of $4,777.7M placed in service in February 2020 upon return to service of Unit 2 and $22.1M placed in service in August 2020 for close-out activities. As also noted at that reference and at Ex. B3-3-1, Table 2, Note 3, the $4,777.7M value is assigned a 10.5/12 month weighting in the calculation of the 2020 net plant rate base amount. The same treatment is applied in the calculation of the 2020 Hypothetical Net Plant Rate Base Amount, as follows: $4,777.7M x 125% x 10.5/12 + $22.1M x 125% x 1/2 - line 5a x 1/2.
The 2021 Hypothetical Net Plant Rate Base Amount is calculated as (line 7a + line 8a)/2.

4 Calculated in the same manner as amounts in the pre-filed evidence (see Ex. L-6.10-1 Staff-194)

5 Calculated as the sum of lines 8 and 11, plus the ROE component of the cost of capital variance at line 5.
The ROE component of the variance is the difference between: (i) line 2 multiplied by the proposed equity portion (49%) of the capital structure, multiplied by the proposed ROE rate of 9.19%, and (ii) Table 1a, line 4b.

6 From Ex. F4-2-1, Table 3a, line 29.

Numbers may not add due to rounding.

Table 3

Darlington Refurbishment Program Unit 2 - Hypothetical 10% Delay In-Service Additions[1]

Summary of Estimated Capacity Refurbishment Variance Account Transactions - 2017 to 2021 ($M)

Line No.	Particulars	Note	2017	2018	2019	2020	2021
			(a)	(b)	(c)	(d)	(e)
	Capital Addition to Variance Account - Darlington Refurbishment Unit 2:						
1	**EB-2016-0152 Forecast Cost of Capital Amount** (from Table 1a, line 3b)	2	0.0	0.0	0.0	281.0	312.7
2	**Hypothetical Net Plant Rate Base Amount** (from Note 3, line 9a)	3	0.0	0.0	0.0	2,601.6	4,723.7
3	**EB-2016-0152 Weighted Average Cost of Capital** (from Table 1a, line 2b)	2	7.01%	6.86%	6.83%	6.81%	6.80%
4	**Hypothetical Cost of Capital Amount** (line 2 x line 3)		0.0	0.0	0.0	177.1	321.3
5	**Cost of Capital Variance** (line 4 - line 1)		0.0	0.0	0.0	(103.9)	8.6
6	**EB-2016-0152 Forecast Depreciation** (from Table 1a, line 5b)	2	0.0	0.0	0.0	128.9	147.3
7	**Hypothetical Depreciation** (from Note 3, line 5a)	3	0.0	0.0	0.0	81.1	149.8
8	**Depreciation Variance** (line 7 - line 6)		0.0	0.0	0.0	(47.8)	2.4
	Income Tax Impact:						
9	**EB-2016-0152 Total DRP Forecast Capital Cost Allowance Deduction** (from Table 1a, line 6b)	2	183.1	283.7	354.4	380.8	383.2
10	**Hypothetical Estimated Total DRP Capital Cost Allowance Deduction**	4	183.1	283.7	354.4	380.8	383.2
11	**Difference** (line 10 - line 9)		0.0	0.0	0.0	0.0	0.0
12	**Net Increase (Decrease) in Regulatory Taxable Income**	5	0.0	0.0	0.0	(116.5)	8.1
13	**Income Tax Rate**	6	25.00%	25.00%	25.00%	25.00%	25.00%
14	**Income Tax Impact** (line 12 x line 13 / (1 - line 13))		0.0	0.0	0.0	(38.8)	2.7
15	**Total Capital Addition to Variance Account** (line 5 + line 8 + line 14)		0.0	0.0	0.0	(190.5)	13.7

Notes:

1 For illustrative purposes, this analysis shows the hypothetical impact of a 10%, or 4 month (40 months x 10%), delay of the 2020 in-service additions associated with the return to service of refurbished Unit 2, relative to the pre-filed evidence (Ex. D2-2-10, page 1, line 19).

2 See Table 1a for details on Note 2.

3 The hypothetical annual amounts are determined as follows:

Table to Note 3 - Darlington Refurbishment Unit 2 Hypothetical Net Plant Rate Base Amount ($M)

Line No.		2017	2018	2019	2020	2021
		(a)	(b)	(c)	(d)	(e)
1a	Gross Plant - Opening Balance	0.0	0.0	0.0	0.0	4,879.4
2a	Hypothetical In Service Additions[a]	0.0	0.0	0.0	4,879.4	0.4
3a	Gross Plant - Closing Balance (line 1a + 2a)	0.0	0.0	0.0	4,879.4	4,879.9
4a	Accumulated Depreciation - Opening Balance	0.0	0.0	0.0	0.0	81.1
5a	Hypothetical Depreciation[b]	0.0	0.0	0.0	81.1	149.8
6a	Accumulated Depreciation - Closing Balance (line 4a + 5a)	0.0	0.0	0.0	81.1	230.9
7a	Net Plant - Opening Balance (line 1a - 4a)	0.0	0.0	0.0	0.0	4,798.3
8a	Net Plant - Closing Balance (line 3a - 6a)	0.0	0.0	0.0	4,798.3	4,649.0
9a	Hypothetical Net Plant Rate Base Amount[c]	0.0	0.0	0.0	2,601.6	4,723.7

a For 2020, calculated as $4,799.8M (Ex. D2-2-10, Table 2, line 1, col. (o)), plus estimated incremental interest costs of approximately $80M during the four-month delay period (40 months schedule x 10%). The 2021 in-service addition is from Ex. D2-2-10, Table 2, line 1, col. (p).

b Approximated for 2020 as Table 1a, line 5b, col. (d) x 6.5 months/10.5 months, plus
$80M in incremental interest costs x (Table 1a, line 5b, col. (d) / $4,799.8M from Note a)/12 x 6.5 months/10.5 months
Approximated for 2021 as Table 1a, line 5b, col. (e) + $80M in incremental interest costs x (Table 1a, line 5b, col. (e) / $4,799.8M from Note a).

c As noted in Ex. D2-2-10, page 1, lines 19-24, the 2020 in-service amount of $4,799.8M in the pre-filed evidence consists of $4,777.7M placed in service in February 2020 upon return to service of Unit 2 and $22.1M placed in service in August 2020 for close-out activities. As also noted at that reference and at Ex. B3-3-1, Table 2, Note 3, the $4,777.7M value is assigned a 10.5/12 month weighting in the calculation of the 2020 net plant rate base amount. The same treatment is applied in the calculation of the 2020 Hypothetical Net Plant Rate Base Amount subject to a four-month delay, as follows:
($4,777.7M plus incremental interest costs of approximately $80M) x 6.5/12 + $22.1M x 1/2 - line 5a x 1/2.
The 2021 Hypothetical Net Plant Rate Base Amount is calculated as (line 7a + line 8a)/2.

4 Estimate is calculated in the same manner as amounts in the pre-filed evidence (see Ex. L-6.10-1 Staff-194).

5 The increase/(decrease) in regulatory taxable income in col. (a) is calculated as the sum of lines 8 and 11, plus the ROE component of the cost of capital variance at line 5. The ROE component of the variance is the difference between: (i) line 2 multiplied by the proposed equity portion (49%) of the capital structure, multiplied by the proposed ROE rate of 9.19% and (ii) Note 2, line 4a.

6 From Ex. F4-2-1, Table 3a, line 29.

Numbers may not add due to rounding.

Table 4

Darlington Refurbishment Program Unit 2 - Hypothetical 25% Delay In-Service Additions[1]

Summary of Estimated Capacity Refurbishment Variance Account Transactions - 2017 to 2021 ($M)

Line No.	Particulars	Note	2017	2018	2019	2020	2021
			(a)	(b)	(c)	(d)	(e)
	Capital Addition to Variance Account - Darlington Refurbishment Unit 2:						
1	**EB-2016-0152 Forecast Cost of Capital Amount** (from Table 1a, line 3b)	2	0.0	0.0	0.0	281.0	312.7
2	**Hypothetical Net Plant Rate Base Amount** (from Note 3, line 9a)	3	0.0	0.0	0.0	204.2	4904.9
3	**EB-2016-0152 Weighted Average Cost of Capital** (from Table 1a, line 2b)	2	7.01%	6.86%	6.83%	6.81%	6.80%
4	**Hypothetical Cost of Capital Amount** (line 2 x line 3)		0.0	0.0	0.0	13.9	333.6
5	**Cost of Capital Variance** (line 4 - line 1)		0.0	0.0	0.0	(267.1)	20.9
6	**EB-2016-0152 Forecast Depreciation** (from Table 1a, line 5b)	2	0.0	0.0	0.0	128.9	147.3
7	**Hypothetical Depreciation** (from Note 3, line 5a)	3	0.0	0.0	0.0	6.4	153.4
8	**Depreciation Variance** (line 7 - line 6)		0.0	0.0	0.0	(122.5)	6.1
	Income Tax Impact:						
9	**EB-2016-0152 Total DRP Forecast Capital Cost Allowance Deduction** (from Table 1a, line 6b)	2	183.1	283.7	354.4	380.8	383.2
10	**Hypothetical Estimated Total DRP Capital Cost Allowance Deduction**	4	183.1	283.7	354.4	380.8	384.0
11	**Difference** (line 10 - line 9)		0.0	0.0	0.0	0.0	(0.9)
12	**Net Increase (Decrease) in Regulatory Taxable Income**	5	0.0	0.0	0.0	(299.2)	19.1
13	**Income Tax Rate**	6	25.00%	25.00%	25.00%	25.00%	25.00%
14	**Income Tax Impact** (line 12 x line 13 / (1 - line 13))		0.0	0.0	0.0	(99.7)	6.4
15	**Total Capital Addition to Variance Account** (line 5 + line 8 + line 14)		0.0	0.0	0.0	(489.3)	33.4

Notes:

1 For illustrative purposes, this analysis shows the hypothetical impact of 25% delay of the Darlington Refurbishment Program in-service additions associated with the return to service of Unit 2, relative to amounts reflected in the pre-filed evidence (Ex. D2-2-10, page 1, line 19).

2 See Table 1a for details on Note 2.

3 The hypothetical annual amounts are determined as follows:

Table to Note 3 - Darlington Refurbishment Unit 2 Hypothetical Net Plant Rate Base Amount ($M)

Line No.		2017	2018	2019	2020	2021
		(a)	(b)	(c)	(d)	(e)
1a	Gross Plant - Opening Balance	0.0	0.0	0.0	0.0	4,976.8
2a	Hypothetical In Service Additions[a]	0.0	0.0	0.0	4,976.8	22.5
3a	Gross Plant - Closing Balance (line 1a + 2a)	0.0	0.0	0.0	4,976.8	4,999.3
4a	Accumulated Depreciation - Opening Balance	0.0	0.0	0.0	0.0	6.4
5a	Hypothetical Depreciation[b]	0.0	0.0	0.0	6.4	153.4
6a	Accumulated Depreciation - Closing Balance (line 4a + 5a)	0.0	0.0	0.0	6.4	159.8
7a	Net Plant - Opening Balance (line 1a - 4a)				0.0	4,970.4
8a	Net Plant - Closing Balance (line 3a - 6a)				4,970.4	4,839.5
9a	Hypothetical Net Plant Rate Base Amount[c]	0.0	0.0	0.0	204.2	4,904.9

a For 2020, calculated as $4,777.7M (Ex. D2-2-10, Table 2, line 1, col. (o)), plus estimated incremental interest costs of approximately $200M during the 10-month delay period (40 months schedule x 25%).
For 2021, reflects the 10-month delay of the $22.1M addition from August 2020 and the $0.4M addition per Ex. D2-2-10, Table 2, line 1, col. (p).

b Approximated for 2020 as Table 1a, line 5b, col. (d) x 0.5 months/10.5 months, plus
$200M in incremental interest costs x (Table 1a, line 5b, col. (d) / $4,777.7M from Note a)/12 x 0.5 months/10.5 months
Approximated for 2021 as Table 1a, line 5b, col. (e) + $200M in incremental interest costs x (Table 1a, line 5b, col. (e) / $4,799.8M from Note a).

c As noted in Ex. D2-2-10, page 1, lines 19-24, the 2020 in-service amount of $4,799.8M in the pre-filed evidence consists of $4,777.7M placed in service in February 2020 upon return to service of Unit 2 and $22.1M placed in service in August 2020 for close-out activities.
As also noted at that reference and at Ex. B3-3-1, Table 2, Note 3, the $4,777.7M value is assigned a 10.5/12 month weighting in the calculation of the 2020 net plant rate base amount. The same treatment is applied in the calculation of the 2020 Hypothetical Net Plant Rate Base Amount subject to a 10-month delay, as follows:
($4,777.7M plus incremental interest costs of approximately $200M) x 0.5/12 - line 5a x 1/2.
The 2021 Hypothetical Net Plant Rate Base Amount is calculated as (line 7a + line 8a)/2.

4 The increase/(decrease) in regulatory taxable income in col. (a) is calculated as the sum of lines 8 and 11, plus the ROE component of the cost of capital variance at line 5. The ROE component of the variance is the difference between: (i) line 2 multiplied by the proposed equity portion (49%) of the capital structure, multiplied by the proposed ROE rate of 9.19% and (ii) Note 2, line 4a.

5 From Ex. F4-2-1, Table 3a, line 29.

AMPCO Interrogatory #78

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Ref: Exhibit D2-2-8 Cost

a) Page 1: Please provide the document provided to OPG's Board of Director's in 2009 that details the $14 billion cost estimate for refurbishing all four units at Darlington.

b) Page 2: Please provide a copy of AACE's Recommended Practice Nos. 17R-97 and 18R-97.

Response

a) None of the documents provided to OPG's Board of Directors in 2009 detailed the $14B cost estimate for refurbishing all four units at Darlington. This was not appropriately worded in OPG's evidence in Ex. D2-2-8, p.1.

   The $14B, which includes interest and escalation, was based on the public announcement at the February 10, 2010 joint press conference by OPG and the Government of Ontario. At that press conference, OPG's Management announced that the refurbishment of Darlington would be $6-10B. These numbers were in 2009$. $10B in 2009$ with interest and escalation added, translates to $14B. Please see also OPG's response to Undertaking J15.2 in EB-2013-0321.

b) With regard to AACE's Recommended Practice documents, please refer to L-4.3-15 SEC-028a.

AMPCO Interrogatory #79

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Ref: Exhibit D2-2-8 Page 6 Chart 3

a) Please provide the DRP RQE Breakdown in Chart 3 by Year.

b) Please provide the total contractor costs included in Chart 3.

c) Please provide a breakdown of Chart 3 categories based on total labour and non-labour costs.

d) For each of the major work bundles please provide a breakdown of contractor costs compared to OPG costs.

Response

a) Please refer to Attachment 1.

b) The total contractor costs in Chart 3 is $5,888 M.

c) The chart below breaks out OPG labour from non-labour:

Chart 1 ($M)

Bundle/Category	Total	OPG Labour	Other Costs
Retube & Feeder Replacement	3,598	46	3,552
Turbine Generators	658	21	636
Balance of Plant	967	75	892
Fuel Handing/ Defueling	198	33	165
Steam Generators	123	10	112
Subtotal Major Work Bundles	**5,543**	**186**	**5,357**
Facility and Infrastructure Projects	640	36	604
Safety Improvement Opportunities	205	11	194
Subtotal F&IP/SIO	**845**	**47**	**797**
Project Execution	322	166	156
Contract Management	52	34	18
Engineering	283	228	54
Managed Systems Oversight	41	30	11
Planning & Controls	136	70	66
Nuclear Safety	83	48	36
Program Fees & Other Support	341	51	290
Supply Chain	86	40	46
Work Control	80	45	34
Operations and Maintenance	805	643	162
Early Release 3	102	50	51
Early Release 4	7	0	7
Subtotal OPG Functions	**2,336**	**1,405**	**931**
Contingency	1,706	-	1,706
Subtotal Before Interest & Escalation	**10,429**	**1,638**	**8,791**
Interest	1,473	-	1,473
Escalation	898	-	898
Subtotal Interest & Escalation	**2,371**	**-**	**2,371**
Grand Total	**12,800**	**1,638**	**11,162**

d) Please refer to L-4.3-2 AMPCO-35 part b).

AMPCO Part a ($M)

Bundle/Category	Total	LTD '15	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Retube Feeder Replacement	3,598	652	427	316	273	192	211	361	392	362	261	142	10
Turbine Generators	658	107	59	76	41	43	109	79	51	68	15	8	2
Balance of Plant	967	168	131	80	68	88	96	99	82	77	41	26	10
Fuel Handing/ Defueling	198	43	17	38	30	10	33	8	8	11	2	0	-
Steam Generators	123	14	5	15	14	1	14	23	11	14	11	1	0
Subtotal Major Work Bundles	**5,543**	**983**	**637**	**525**	**426**	**335**	**462**	**570**	**543**	**532**	**330**	**177**	**23**
Facility and Infrastructure Projects	640	484	140	16	-	-	-	-	-	-	-	-	-
Safety Improvement Opportunities	205	144	56	5	-	-	-	-	-	-	-	-	-
Subtotal F&IP/SIO	**845**	**628**	**196**	**20**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Project Execution	322	10	37	38	38	36	33	31	30	27	27	13	1
Contract Management	52	10	5	5	4	4	4	4	4	4	4	4	2
Engineering	283	76	21	22	22	22	20	20	20	19	19	18	4
Managed Systems Oversight	41	14	3	3	3	3	3	3	3	3	2	1	-
Planning & Controls	136	62	20	8	7	7	6	5	5	5	5	4	2
Nuclear Safety	83	35	9	7	6	6	3	4	4	3	3	3	-
Program Fees & Other Support	341	21	39	27	27	27	27	38	41	41	29	21	3
Supply Chain	86	14	10	10	7	7	6	6	6	6	5	5	2
Work Control	80	9	6	7	8	8	8	8	8	7	5	4	0
Operations and Maintenance	805	52	68	70	70	73	73	87	93	88	67	51	13
Early Release 3	102	102	-	-	-	-	-	-	-	-	-	-	-
Early Release 4	7	7	-	-	-	-	-	-	-	-	-	-	-
Subtotal OPG Functions	**2,336**	**412**	**219**	**198**	**192**	**193**	**182**	**207**	**214**	**202**	**165**	**124**	**27**
Contingency	1,706	26	53	208	266	191	125	207	282	173	95	56	23
Subtotal Before Interest & Escalation	**10,429**	**2,049**	**1,105**	**952**	**885**	**720**	**769**	**984**	**1,039**	**907**	**590**	**356**	**73**
Interest	1,473	159	102	143	196	203	58	108	179	135	103	87	0
Escalation	898	-	24	41	55	59	80	123	153	154	114	78	17
Subtotal Interest & Escalation	**2,371**	**159**	**126**	**184**	**250**	**263**	**137**	**231**	**333**	**289**	**217**	**165**	**17**
Grand Total	**12,800**	**2,208**	**1,231**	**1,136**	**1,135**	**983**	**907**	**1,215**	**1,372**	**1,196**	**807**	**521**	**90**

AMPCO Interrogatory #80

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-8 Page 6 Chart 3

Preamble: Under OPG Functions, Operations and Maintenance has a budget of $805 million, the largest component (34%) of the OPG Functions budget of $2,336 million.

a) Please provide a detailed breakdown of the Operations and Maintenance budget.

Response

a) The Operations & Maintenance Functions budget is broken down into further detail on Ex. D2-2-8, Attachment 1, p. 29. A further breakdown is included below:

Chart 1 – Breakdown of Operations and Maintenance Function

	$M
L&ILW Variable Expense (OM&A)	38.1
Trainee Program(OM&A)	11.0
Definition Phase Costs	46.5
VP Office and Department Expenses	13.0
Chemistry Department	17.5
Return to Service Department	49.8
Maintenance Department	176.7
Operations Department	108.9
Radiation Support Department	272.0
Programs Department	71.7
Total	805.1

AMPCO Interrogatory #81

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-8 Page 6 Chart 4

a) Please provide Chart 4 for Units 1, 3 and 4.

Response

Note: The reference above should be to Ex. D2-2-8, page 9, Chart 4.

a) OPG declines to provide the requested information on the basis that the in-service additions for Units 1, 3 and 4 are outside of the test period for this Application.

AMPCO Interrogatory #82

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-8 Pages 11, 14 to 15, Charts 5 to 9

a) Please explain why the % of OPG Project Management Costs is not similar between the work bundles in Charts 6 to 8.

b) Please provide the OPG Project Management Costs included in the Balance of Plant Bundles Costs (Chart 9).

Response

a) Each Major Project Bundle has established its own dedicated project management team that is responsible for the management, oversight and delivery of specific scopes of work. Team size and make up is based on a number of factors including complexity, contract structure, and required level of oversight. Project Management costs were reviewed during the development of the RQE estimate.

b) The total OPG Project Management Costs included in the $480.9M Unit 2 Balance of Plant Bundle costs noted in Ex. D2-2-8, Chart 9 is $85M. It represents 18% of the total Unit 2 Balance of Plant Bundle costs.

AMPCO Interrogatory #83

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Ref: Exhibit D2-2-8 Page 17 Figure 2

a) Please provide Figure 2 for Units 1, 3 and 4.

Response

OPG declines to provide the requested information for Units 1, 3 and 4 on the basis of relevance. The return-to-service of these units is beyond the test period and, therefore, forms no part of OPG's request in this application.

AMPCO Interrogatory #84

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-8

a) Please provide the average daily rate for the DRP for Unit 2 and show the calculation.

b) Please define overnight rate.

c) Please provide a description of the types of crews that will work on each of the major work bundles including size, composition, shift lengths, hours per week, days off per week, and how OPG optimizes its crew schedules.

d) Please estimate the amount of time each crew will actually be on the reactor face during their shift.

e) Please provide the estimated average cost per crew shift.

Response

a) The average daily cost for the Darlington Refurbishment Program (DRP) will vary depending on the stage of the project. Simple average cost per day can be calculated by using the planned capital costs in 2018 of $1,121M set out in Ex. D2-2-10, Table 1, and dividing by 365 days. The daily cost would be $3.07M.

b) The term overnight rate is not located in the referenced material. OPG has used overnight costs to refer to dollars of the year, i.e. including escalation.

c) Each part of the refurbishment project schedule has a variety of different crews and schedules to meet the work requirements, including critical path work and balance of plant work. The base schedule for all non-critical path work crews is five 8-hour days per week (40 hour work week). Each major vendor on the project sets the hours and shifts for the work around this base schedule to meet schedule and cost requirements throughout the project. Crews are made up of traditional unionized trades (millwrights, electricians, carpenters, etc.) and vary in size depending on the work being executed in the field. OPG crews also work on the project and the crew size and schedule is also five 8-hour days per week in order to support the field work and the regulatory commitments in the schedule.

d) The Joint Venture construction crews are working 24 hours a day, and will be on the reactor face continuously, when planned work requires them to be, at all hours of their shift. Crews are working split-shift hours to accomplish this. There will be times when operations on the reactor face are performed remotely, and again this operation is 24 hours a day. All critical path work is executed on a 24-hours schedule.

e) Under the multi prime model, the DRP will not deploy 'crews' in the normal manner; rather each of OPG's contract partners will deploy the necessary staff to complete their tasks in the agreed upon work windows; please see part c). Because the size of the shift crews will vary with the level of activity and the nature of the work, OPG is unable to answer the question.

AMPCO Interrogatory #85

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-8 Attachment 1

a) Please provide the original Darlington Refurbishment Business Case from 2013 (before Revision 1)

b) Please explain the significant changes in the Business Case approved in 2015 compared to the Business case approved 2013.

Response

a) There was only one Darlington Business Case approved by OPG's Board of Directors in 2013. The 2013 Business Case was marked Revision 1 because it was a revision to the November 2009 Darlington Refurbishment Business Case (filed in EB-2010-0008 as Ex. D2-2-1, Attachment 4). The 2013 Business Case Summary is provided in Attachment 1 to this response. It was approved by OPG's Board of Directors on November 14, 2013 and filed in EB-2013-0321 as Ex. D2-2-1, Attachment 5.

b) Significant changes in the 2015 Business Case as compared to the 2013 Business Case are:
   - The 2013 Business Case was prepared while the project was still in the Definition Phase. The cost and schedule estimates were not as well developed with several estimates still at the conceptual levels (Class 5 or 4).
   - For the 2015 RQE Business Case, OPG had an overall Class 3 estimate with the majority of projects at Class 3 or 2, and had developed an initial integrated schedule including all contractors and scopes of work and was able to determine the critical path through the Unit 2 schedule. By this time, OPG had also completed contract negotiations with the joint venture for the Retube and Feeder Replacement Project and had established a target price and schedule for that key contract.
   - A detailed review of project risks and contingencies was completed for the 2015 Business Case based on the critical path schedule and a full assessment of the project risks. OPG was able to reduce the amount of contingency in the Darlington Refurbishment Program estimate used in 2015 RQE Business Case compared to the 2013 Business Case because of the higher level of definition of the 2015 Darlington Refurbishment Program estimate.

- The 4-unit schedule in 2013 was based on 36 months per unit with a total refurbishment window of 108 months. The 2015 Business Case has unit outage durations ranging from 37-40 months, including schedule contingency, with a total refurbishment window of 112 months.

ONTARIO POWER GENERATION

File No: N-REP-00120.3-10000-R001

Project ID - 16-27959

Darlington Refurbishment Business Case Summary

November 14, 2013, Revision 1

OPG Confidential & Commercially Sensitive

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY

1.0 RECOMMENDATION:

In 2009, OPG's Board of Directors approved the Economic Feasibility Assessment and the Business Case Summary related to the refurbishment of the Darlington Nuclear Generating Station. The Board approved the project and released funds to commence preliminary planning within the Definition Phase in accordance with the Program's release strategy. Management also approved the release of funds in November 2011 and November 2012 to complete detailed planning activities within the Definition Phase. The purpose of this Business Case Summary is to provide an update on the status and economics of the Darlington Refurbishment Program ("DRP") and to request funding to continue to complete planned 2014 detailed planning activities within the Definition Phase.

In 2010, Management communicated that the project cost would be less than $10 Billion in 2009$ which is equivalent to $10.8 Billion in 2013$, excluding capitalized interest and escalation. Taking into account the current level of cost and schedule development, Management continues to communicate, with high confidence, that the cost of the DRP will be less than $10 Billion in 2013$, excluding capitalized interest and escalation. By asserting high confidence that the DRP will be less than $10 Billion in 2013$, Management is indicating increasing confidence regarding the maximum amount likely to be expended. The $10 Billion cost estimate in 2013$ is $12.9 Billion including capitalized interest and future escalation.

The current point estimate being used for the calculation of the Levelized Unit Energy Cost ("LUEC") is $9.2 Billion (2013$), including $2.1 Billion of project and program contingency and $820 Million life-to-date costs to the end of 2013. This point estimate also includes approximately $220 Million in provision funds related to Re-tube Waste Containers as well as $150 Million related to facility improvements required at Darlington due to an additional 30 years of post-refurbishment operations. This project estimate, including capitalized interest and future escalation translates into a completion cost of $11.4 Billion.

At a cost of $9.2 Billion (2013$), the Levelized Unit Energy Cost ("LUEC") of refurbishing and continuing to operate the Darlington units for a further 30 years is estimated to be 7.9 ¢/kWh (2013$), based on a high-confidence estimate of the Darlington Refurbishment Program. Excluding costs for fixed Corporate Overheads for Pension and Other Post-Employment benefits which are independent of the decision to refurbish Darlington, the LUEC is estimated at 7.5 ¢/kWh (2013$). In 2010, Management had communicated that the project LUEC would be less than 8 ¢/kWh in 2009$, which is equivalent to 8.7 ¢/kWh in 2013$.

The economics of refurbishing the Darlington Station are comparable with Combined Cycle Gas Turbines (CCGT) at a median long-term forecast of gas prices of approximately $6/mm BTU and assuming carbon prices of $15 - $30/tonne. At median gas prices and $15/tonne carbon prices, the LUEC for CCGT is estimated at 7.5¢/kWh (2013$), with the carbon pricing accounting for 0.6 ¢/kWh of that LUEC. At low long-term gas prices of about $4/mmBTU and zero carbon prices, the price of CCGT would be more favourable than the price for refurbishing the Darlington Station. It should be noted that the costs to make gas-fired generation carbon-free (i.e. carbon sequestration), is estimated to be the equivalent of a $100/tonne carbon price, which would add 4 ¢/kWh to the LUEC of a CCGT.

While CCGTs have shorter execution lead times, lower up-front investment and lower ongoing operations, maintenance and administrative costs, there are significant uncertainties with regards to future gas prices and the potential implementation of carbon prices. There are other considerations which contribute to and support the favourable economic assessment for refurbishing the Darlington Station. These include:

- The use of an existing generation site with a proven environmental record and a supportive host community avoids the additional costs to OPG (and ratepayers) of site selection, securing environmental approvals and development of host community support at an unproven green or brown field site. It also avoids the additional costs to ratepayers of establishing a new transmission infrastructure.

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- The economic benefits of refurbishing the Darlington Station, in terms of direct, indirect and induced job creation, are anticipated to be greater than for CCGT. It is estimated that approximately 2,000 direct jobs are created during the Program Definition and Execution Phases. Continued Operation of the Darlington Station (post-refurbishment) will maintain the same level of employment as is currently associated with the Darlington Station for an additional 30 years. Economic impact studies indicate that post-refurbishment operations of the Darlington Station will result in approximately 5,700 resident jobs in Durham Region (direct, indirect and induced).

Management's assessment is that the refurbishment of the Darlington Station would also be competitive with the recently completed refurbishment of Bruce Units 1 and 2. Based on the Auditor General's 2007 assessment of the price being received by Bruce Power for the output of Bruce Units 1 and 2, management has estimated the LUEC for those units at approximately 8.5 ¢/kWh (2013$).

Since the 2009 Feasibility Assessment, and as communicated in November 2011 and November 2012 as part of the Detailed Planning release of funds (Release 4b), Management has revised the overall timeline and release strategy for Darlington Refurbishment, including the submission of the Release Quality Estimate (RQE) in October 2015 and a first unit refurbishment start date of October 2016.

As a result of OPG's improving confidence in the life of critical components at Darlington and the resulting opportunity this creates to maximize the value of the asset and to smooth overall rate impact while mitigating execution risk of the DRP, Management recommended the removal of the overlap of the first and second refurbishment units in June, 2013, effectively delaying the beginning of the refurbishment outages on the 2nd, 3rd and 4th units by nominally 18 months each. This schedule change was approved by the CEO and forms the base schedule planning assumption for this November 2013 updated Business Case.

Management is seeking a partial release of Detailed Planning funds (Release #4c) to complete 2014 planned deliverables in the amount of $680 Million. The total cumulative funds released to the project, including this release, will total $1,608 Million including capitalized interest, escalation, and contingencies.

$ Millions (including contingency)	Cash Flows			
	LTD 2012	2013 Forecast	2014	Total
Currently Released (Releases #1 - 4b)	380	548	0	928
Requested Now (Release #4C)	-15	-94	788	680
Cumulative Release	365	454	788	1,608

Management, in planning for the DRP, has negotiated contracts that limit OPG's exposure should a decision be made not to continue the DRP. Based on the amount of work currently in progress, should a decision be made not to continue the DRP, the currently committed cost to close the project, including demobilization of project staff and cancellation of existing contracts, material orders, etc., is estimated to be $200 Million. Management is not requesting a release of funding for demobilization costs with this release.

Key 2014 Deliverables, as defined in Appendix D, to be completed in the Detailed Planning Phase include:

- Integrated Improvement Plan (IIP) and Global Assessment Report (GAR) to support the 10 year license application for Darlington in 2014.
- Progression of refurbishment pre-requisite work including construction of facilities and infrastructure projects, safety improvement projects (e.g. Third Emergency Power Generator,

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Containment Filtered Venting System), as well as scope defining inspections and unit islanding modifications.

- Negotiation and award of remaining major contracts by Q1 2014 including Steam Generators and Turbine Generator Engineering and Construction contracts.
- Progression of detailed engineering.
- Reconstruction of the Holt Road Bridge to improve traffic flow to the project and in order to not impact traffic flows in the adjoining communities.
- Progression of design, fabrication, and testing of R&FR tooling and mock-ups to determine project durations for re-tube and feeder replacement activities.
- Scope finalization and further development of the project RQE to be issued by October 2015.
- Development of project agreements with the Building Trades Union ("BTU") through EPSCA; and continued discussions with the Power Workers Union ("PWU") to establish labour certainty throughout the DRP.

2.0 SIGNATURES

Submitted By:

Bill Robinson
Senior Vice President, Nuclear Projects

Finance Approval:

Donn Hanbidge
Chief Financial Officer

Approval per OAR Element 1.3.

Tom Mitchell
President and Chief Executive Officer

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BACKGROUND AND ISSUES:

In June 2006, the Ontario Government directed OPG to begin feasibility studies on refurbishing its existing nuclear plants. The need for refurbishment of nuclear plants was also addressed in the Ontario Power Authority's Integrated Power System Plan I (IPSP I) issued in 2007 and the Ontario Government's Long-term Energy Plan issued in November 2010 and in the Government's Supply Mix Directive issued to the OPA in February 2011. At the time of writing, the Ontario Government was in the process of revising the Long-term Energy Plan (known as LTEP II) for potential issuance in late 2013, and it is expected to include a recommendation that the refurbishment of Darlington be pursued.

OPG commenced the Initiation Phase of the Darlington Refurbishment project, including an economic feasibility assessment, in late 2007. The objective of the Darlington Refurbishment Program is to extend the operating life of the station by approximately 30 years. The refurbishment would involve an outage for replacement of life-limiting components, as well as maintenance or replacement of other components which are most effectively done during the refurbishment outage period.

The initiation Phase concluded on December 21, 2009 with OPG Board approval of management's recommendation to proceed to refurbish the Darlington units. In November 2009, concurrent with approval to proceed with the project, the Board of Directors released $240.7 Million for Preliminary Planning within the Definition Phase of the project. Funding included $102.5 Million for Preliminary Planning, as well as $138.2 Million for the design and construction of facility and infrastructure projects required prior to refurbishment of the units and/or to support the post-refurbishment operations period.

On November 17, 2011, OPG's Board of Directors approved the revised overall project timeline, the updated Program Release Strategy incorporating an October 2015 Release Quality Estimate (revised from October 2014 in order to incorporate tool testing results from the Re-tube and Feeder Replacement project), and Management's recommendation to move to the Detailed Planning Phase including a partial release of $436 Million.

In November 2012, OPG updated the DRP economics including cost and schedule updates, post-refurbishment operational assumptions, and the resulting Levelized Unit Energy Costs (LUEC). OPG's Board of Directors approved a further partial release of funds, for 2013 deliverables, in the amount of $492 Million for a cumulative project release of $928 Million.

Total releases to date are $928 Million for the Preliminary Planning and Detailed Planning Phases of the Definition Phase. OPG is requesting an additional $680 Million to complete 2014 deliverables within the Definition Phase of the project for a cumulative release of $1,608 Million. The total Definition Phase cost estimate is projected to be $2,365 Million. Releases to date and projected are shown in Figure 1 – Darlington Refurbishment Program – Release Summary.

A detailed cost and schedule and release quality estimate is planned to be completed by October 2015 and the execution of the first unit's refurbishment outage is planned to start in October 2016.

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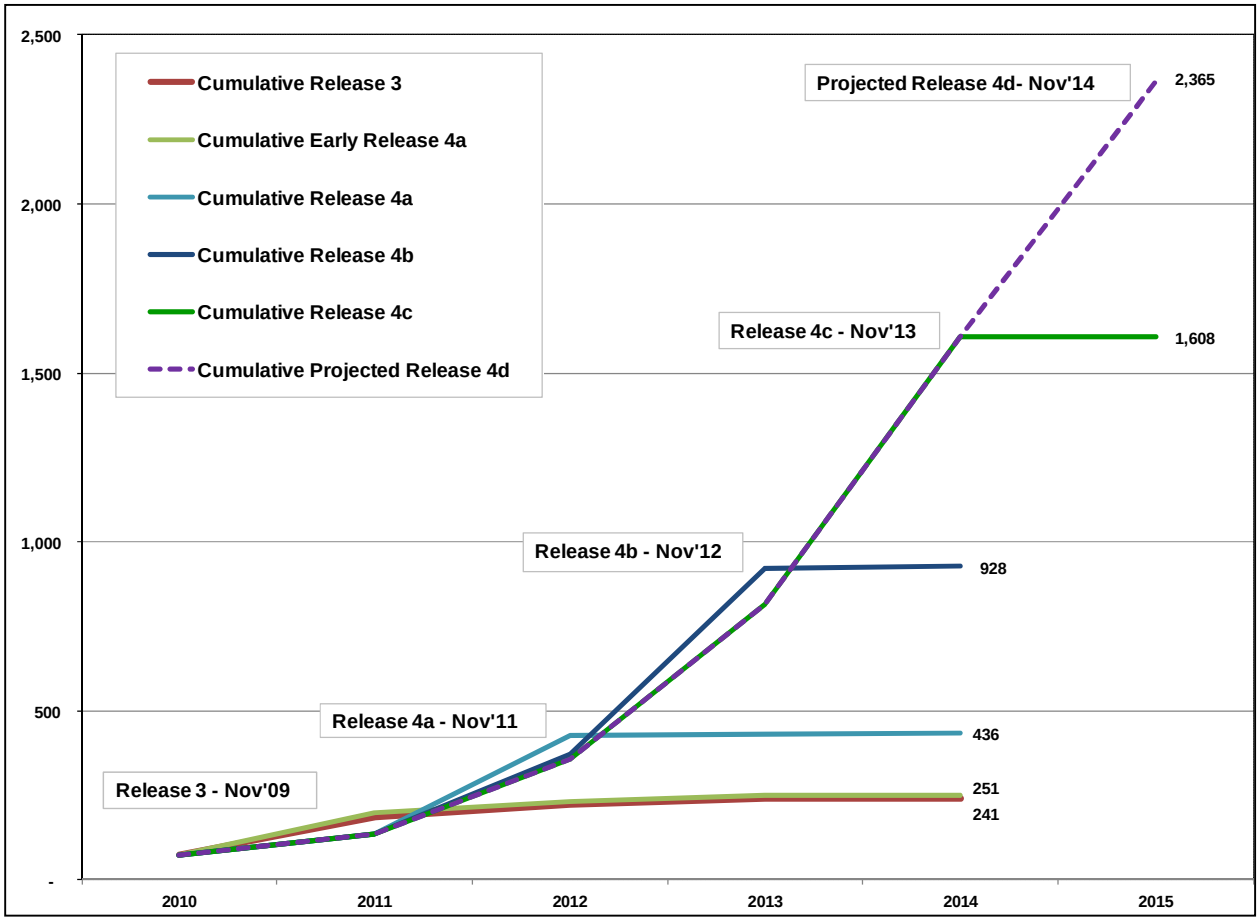
DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY

Figure 1: Darlington Refurbishment Program – Release Summary



Status of Work in the Definition Phase:

The status of Detailed Planning is reported to the Nuclear Oversight Committee on a quarterly basis; the latest report, as of September 30, 2013, provides a status of the Detailed Planning Phase.

The following is a summary of the major planning activities.

a. **Project Planning**

Project Management

The Project Management organization, using a "strong project matrix" model, for the Definition Phase of the project has been put in place. The key roles on the project team include Engineering, Execution, Supply Chain, Contract Management, Managed Systems Oversight, and Project Planning and Controls. All positions report to the Senior Vice President of Nuclear Refurbishment who has the overall accountability to deliver the project.

The project is currently developing the organization model and supporting strategies, including professional staffing and labour strategies, for the execution phase of the project.

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Project Governance

Project controls governance and supporting information technologies, including scope management, cost management, scheduling, estimating, risk management, change management, and document and records management have been implemented.

Project Planning

At the time of the initial economic feasibility assessment in 2007, the Darlington Nuclear units were predicted to reach their nominal end-of-service lives in 2019 to 2020, based on a nominal fuel channel life expectancy of 210,000 Effective Full Power Hours. End-of-service life predictions are continually reviewed as new inspection information and knowledge of possible degradation mechanisms becomes available and forecast productions levels are updated. Based on the expectation of nominal end-of-service lives in 2019 to 2020 for the Darlington units, on June 12, 2008 the CEO approved the initial planning assumptions for Darlington Refurbishment, including the reference schedule. At that time, the planning assumptions were based on a first unit refurbishment start date of October, 2016. Each unit's refurbishment was to last 25 months, and, with a 4 month overlap of unit outages, the overall duration (elapsed time) of the refurbishment outage window would be 88 months for the 4 units with 100 actual outage months.

In 2009, based on information received from the Re-tube and Feeder contractor, and operating experience (OPEX) from Bruce Power and Pt. Lepreau, the planning assumptions were modified. The most likely critical path duration of each unit refurbishment was determined to be 36 months. Management subsequently endorsed a schedule of nominal 36 month outages, with the first unit beginning its outage in October 2016, and with a 16 or 19 month overlap to ensure that only two units are in a refurbishment state at any point in time, resulting a total refurbishment outage window of 88 months for the 4 units with 144 actual outage months.

OPG has pursued increased fuel channel life for both Pickering and Darlington through the Fuel Channel Life Management Project with the aim of developing high confidence in the fuel channel service lives. Recent developments indicate that there may be an opportunity to extend the lives of the fuel channels at Darlington beyond the nominal life of 210,000 EFPH. This opportunity is being explored through a Fuel Channel Life Extension project, which builds on the work accomplished in the Fuel Channel Life Management project. The Fuel Channel Life Extension (FCLE) project is scheduled to be launched in early 2014 and has, as one of its objectives, the achievement of high confidence in 235,000 EFPH on the fuel channels at Darlington.

In June 2013, based on improving confidence in the life of critical components at Darlington and the expectation of positive results from the FCLE project and the resulting opportunity this creates to maximize the value of the asset and to smooth overall rate impact while mitigating execution risk of the DRP, Management recommended the removal of the overlap of the first and second refurbishment units. This was approved by the CEO and forms the base planning assumption for this Business Case.

This schedule will **continue to be developed** in the Detailed Planning phase in consultation with planning work to be performed in conjunction with the Re-tube and Feeder Replacement (R&FR) vendor. A release quality performance baseline schedule will be issued as part of the RQE in October of 2015.

The following table provides a summary of the current refurbishment start dates and overall durations currently in use for planning purposes.

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Table 1: Current Darlington Schedule Planning Assumptions

Unit	Start of Refurbishment Outage	Finish of Refurbishment Outage	Duration (months)	Overlap on Previous Unit
D2	**October 2016**	September 2019	36	
D1	October 2019	September 2022	36	0
D3	March 2021	February 2024	36	19
D4	October 2022	**September 2025**	36	17
		Total Unit Outage Months (4 units)	144	
		Refurbishment Window	108	

Scoping

A Scope Review Board ("SRB") with supporting governance was put in place to approve the scope of the DRP. The technical scope for the refurbishment project was initially confirmed in May 2012. Since that time, as a result of engineering studies and analysis, results of planned inspections, and completion of regulatory submittals including the Integrated Safety Review ("ISR") and the Environmental Assessment ("EA"), scope continues to be developed and finalized.

Contracting

The DRP is a multi-phase project made up of individual projects of various sizes. As part of the Definition Phase, OPG developed an overall Commercial Strategy and separate Contracting Strategies for all major project work packages.

The "Commercial Strategy" sets out an overall commercial framework with guiding principles for establishing and maintaining commercial relationships with third parties to support the DRP.

The Commercial strategy selected by OPG is a multi-prime contractor model in which there is more than one prime contractor working on the project. The owner has a separate contract with each prime contractor. Each prime contractor is responsible for the completion of the work under its particular contract, but not for the entire project. The owner is the integrator between the prime contractors and is responsible for the entire project. Under this model OPG retains project management responsibility and design authority for the DRP.

To execute the work OPG retains a number of contractors who are responsible for major project work packages. To guide OPG in project oversight and contracting activities, OPG has engaged external technical and project management experts to assist with the overall project management.

The benefits of this model are that OPG retains control over the entire DRP, including the deliverables, costs and schedule. Retaining control by OPG is important given the scale, technical complexity and integrated nature of the DRP. OPG will also be able to assign risks to the party best able to manage the risk and mitigate is impact on the DRP. This will provide OPG with a better balance between the transfer of risk and the costs of the contractor services.

OPG considered a number of alternative commercial strategies, including multi-prime contractors, partnering, lump-sum turnkey agreement and a project management organization arrangement.

Partnering typically contemplates a single agreement with a number of service providers (organized in the forming of a joint venture). However, OPG found it not viable because of issues of alignment between service providers, a loss of control related to the service providers and service providers typically unwilling to engage in this structure.

OPG found that although there was price certainty in a lump sum turnkey strategy, it came at a cost including loss of control of design, schedule and management of key aspects. Additionally the risk premium was out of proportion to the corresponding transfer of risk since various exclusions or force majeure provisions diminished the transfer of risk.

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Under the project management model, one firm would be responsible for planning the project, negotiating requirements and managing the work packages. Although this provides the owner with project management experience, there can be lack of alignment between the project manager, owner and contractors, especially if the project manager was also participating in the completion of an aspect of the project. There would also be a risk premium factored into the arrangement.

In examining the alternatives, OPG took into consideration lessons learned from other nuclear refurbishment projects such as the consequences of schedule slippage and replacement power where a lump sum turnkey agreement was used; and in another instance, a mid-project commercial strategy change (i.e. the abandonment of the project management model and the adoption of the multi-prime model).

A "Contracting Strategy" is the means for successful implementation of the project delivery approach for the major project work packages making up the DRP. Each Contracting Strategy is free standing and takes into account factors such as the nature and scope of the work, the vendor marketplace, and any potential long term commercial arrangements. Each Contracting Strategy results in a recommendation on the most suitable sourcing approach, contract structure and pricing mechanism for that specific work package.

Engineering

In 2008 to 2011, Engineering completed a detailed set of component condition assessments (CCA) in order to determine preliminary scope for the project. Since that time, some CCA's have been further developed in order to finalize DRP scope.

As of September 30, 2013, over 140 owner specified modification design packages (MDP) have been prepared. These MDP packages define the scope requirements and are provided to the major project contractors in order to perform detailed engineering. Engineering is on track to complete all MDP's, approximately 180, by mid 2014.

In parallel, Engineering, as the Design Authority, is providing oversight of all engineering deliverables being prepared by each contractor working on the DRP.

In 2013, Engineering also completed 57 engineering studies in order to further define scope.

An update of the OPG construction and engineering design standard manuals which will be provided to all contractors working on the DRP was also completed in 2013.

Cost Recovery and Financing

Cost Recovery and Financing confirmation is underway, however, currently not in place. OPG will recover prudently incurred costs via the OEB rate approval process (O. Reg. 53/05) once the units are refurbished and returned to service. The risk is that there is no assurance that all costs are recoverable through this process.

OPG continues to discuss with the Province the need for greater assurance of cost recovery and has suggested regulatory changes to facilitate this. The Province continues to support the DRP and OPG expects that the Long Term Energy Plan to endorse the DRP

In the current OEB application, OPG is seeking recovery of OM&A costs associated with the project, and findings that OPG's commercial and contracting strategies for the DRP are reasonable and that the capital expenditures that we have proposed for 2014 – 2015 are reasonable.

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b. **Major Projects**

Re-tube and Feeder Replacements

The Re-tube & Feeder Replacement (R&FR) work package determines the DRP's critical path. This work package includes the removal and replacement of each reactor's 480 pressure tubes and calandria tubes, and the removal and replacement of the 960 feeder pipes in each reactor.

OPG initiated the R&FR contracting process in 2010. OPG initially issued a request for expressions of interest and received submissions from seven potential contractors. Based upon the responses received, pre-qualification of the potential contractors, and the subsequent partnering by potential contractors, OPG, in March 2011, issued a Request for Proposals (RFP); responses to the RFP were received on June 26, 2011. OPG continued negotiations with two proponents in an effort to reach acceptable commercial terms with each proponent. OPG then required each proponent to submit their final proposals based on the negotiated terms. The SNC/AECON consortium was selected and OPG executed a final agreement with the consortium on March 1, 2012.

The contracting strategy selected by OPG for the R&FR work package is to use an Engineering, Procurement and Construction (EPC) arrangement that combine fixed/firm pricing for known or highly definable tasks and a target price for the remaining scope of the R&FR work package where work is less definable. The work is phased with a project schedule comprised of a definition phase, an execution phase and a commissioning phase.

During the definition phase, OPG and its selected contractor will complete the detailed design of the project, procure long lead materials, fabricate long lead components and tools, test the specialized tooling and complete final planning activities. At the conclusion of the definition phase, the "execution phase target price" will be determined to estimate the total cost to complete the execution phase work with upper and lower cost sharing bands. Financial incentives also exist for early completion of each unit outage, and financial penalties exist for failure to complete unit outages within the agreed upon schedule.

Since the contract award, R&FR work program has progressed in three main areas:

a. R&FR Mock-ups

Re-tube and Feeder full-scale Calandria mock-up construction is in progress; reactor components have been ordered, installation of East and West Vault structural steel is complete, fueling machine bridge installation is complete, fabrication of the fuel channel components are in progress, and reactor face machining has commenced.

b. R&FR Tooling

On July 31, 2013, R&FR tooling preliminary engineering was completed ahead of schedule. Assignment of purchase orders to subs to fabricate the tools is currently in progress.

c. Execution Phase Planning

Detailed Engineering for station modifications required to execute the Re-tube and Feeder replacement work program are now in progress. Long lead material orders, including end-fittings, pressure tubes, feeder tubes etc. are in progress of being awarded. A Class 4 cost and schedule estimate has been completed; the project is now developing comprehensive work packages (CWPs) in preparation for development of a Class 3 estimate by Q2, 2014.

Turbine Generator

The Turbine Generator Project consists of (i) inspections, repairs and replacement of specific components of the four Turbine Generator sets and their auxiliaries; and (ii) upgrades to the steam

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turbine control and generator excitation systems from analog to a digital platform. The turbine generator sets are highly specialized machines designed and manufactured to order specifically for Darlington by BBC Brown Boveri Canada Inc. A series of corporate mergers and acquisitions resulted in Alstom Power & Transport Canada Inc. (Alstom) becoming the Original Equipment Manufacturer (OEM).

This work package was divided into two contracts. The first contract for Engineering Services and Equipment Supply was awarded as a single source contract to Alstom on March 27, 2013. Since the original design was specifically for Darlington and given the technical complexity of the work, the single source strategy was selected to ensure that no technical or operational risks were introduced as a result of component replacements and converting from analog to digital turbine and excitation control systems. Operating experience across other major refurbishments has shown that the OEM is the only provider capable of ensuring the compatibility of the new systems to existing equipment. A complete steam path retrofit is not being undertaken since the Turbine Generator sets are in excellent condition and have performed extremely well over the years, and replacement is not required. As a result, the OEM provides the consistency needed to ensure compatibility.

The scope of the work for the second contract includes the field work required for installations, repairs and replacements of equipment and components, and engineering integration of the OEM equipment with the OPG Engineering Change Control process. The contract is following the competitive procurement process and is expected to be awarded early in 2014.

Fuel Handling

The Fuel Handling work package has two distinct areas of work: (i) defueling of the reactor core; and (ii) refurbishment of the fuel handling equipment.

Defueling is a critical path element for each unit's refurbishment since it involves the removal of all irradiated fuel from each reactor prior to each refurbishment outage. No other refurbishment work can occur until the unit is defueled. The defueling work will include field and non-field work. All defueling field work will be done by OPG. Defueling non-field work involving engineering, manufacturing and technical support will be done by a third party.

The non-field related work will be performed under an Engineering Services and Equipment Supply contract issued to GE-Hitachi Nuclear Energy Canada Inc. (GHNEC) on May 17, 2013. The contract is made up of firm/fixed price for components and equipment and a cost reimbursable element for technical support during the defueling operation.

The Darlington fuel handling system was designed and manufactured by GHNEC. GHNEC, as the OEM, has provided OPG with fuel handling related equipment, components and services including test facilities, systems engineering, and materials and troubleshooting support for over 30 years. Engaging a supplier other than the OEM would introduce integration, compatibility, operational and nuclear safety risks. The contract strategy selected to mitigate these risks was to single source the supply component and equipment related to defueling, along with the technical experts required to support OPG during the defueling operations, to the OEM.

The second work area of Fuel Handling is refurbishment of the Fuel Handling systems. The work for the Fuel Handling System has been divided into 6 work packages. As part of the 2013 Darlington Scope Review, a portion of the scope has been transferred to the Darlington Station to be performed as part of the stations Fuel Handling Reliability project. The balance of the scope will be awarded in late 2013 and early 2014.

Steam Generators

The Steam Generator work package consists of major inspections and maintenance work to extend the life of the Steam Generators for an additional 30 years. There are a number of aspects including chemical cleaning of the inside of the Steam Generator tubes, augmented inspection and repairs, leakage measurements, and water lancing each steam generator.

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After evaluating the work and other contracting considerations, OPG has decided to bundle all of the Steam Generator Work into one work package to be competitively bid. OPG considered various contracting models and determined that the Steam Generator work package fits well into a model where an EPC contract is negotiated.

A Request for Proposal (RFP) for Steam Generator primary side clean was issued on February 28, 2013. Bids have been subsequently received and evaluated and contract negotiations are complete. The contract is expected to be awarded before the end of November 2013.

Balance of Plant

Balance of Plant work represents the remaining work to be performed by the DRP that is not included in one of the above major packages.

As a result of the Darlington Scope Review the balance of plant project scope has been reduced. The remaining scope has been evaluated and divided into 4 bundles based on system and/or location.

A team has been established to review procurement options to expedite contract award for this work. Options include the direct allocation of work to the existing Extended Services Master Service Agreement contractors and procurement with additional vendors issued for specialized work; i.e. Shut Down System (SDS) computer replacement.

c. **Facility and Infrastructure Projects**

Darlington Energy Complex

Lessons learned in previous refurbishments and other nuclear projects have shown that the use of equipment mock-ups, replicas and models for training is effective for the successful execution of complex projects. Accordingly, a decision was made to design and build multiple mock-up models in preparation for the refurbishment of the Darlington reactors. The Darlington Energy Complex (DEC) will house a full-scale reactor mock-up, other key mock-ups, and a training center for both the DRP and the Nuclear Operations organization. Workers will be trained on the mock-ups and tested on new tooling in the DEC prior to working on the reactor face. Additionally, the DEC includes a warehouse for the storage of tooling and materials to be used in the training center. The project was placed in-service in June 2013.

Water and Sewer

The Water and Sewer project will ensure adequate and reliable domestic and fire water supply and sanitary sewer system capacity in support of the new Refurbishment support facilities, as well as continued operation of the station for an additional 25 to 30 years.

The project is currently in the execution phase. The Water/Sewer main will go into service in 2013. The execution of the west pumping station and related water/sewer distribution lines to support Refurbishment facilities will be installed in mid 2014. The demolition of the existing Sewage Treatment Plant will also commence in 2014.

Heavy Water Storage and Drum Handling Facility

The Heavy Water (D2O) Storage and Drum Handling Facility project will provide heavy water storage capacity during refurbishment and support ongoing station operations. This storage capacity is needed for the heavy water removed from the reactors being refurbished (approximately 1,500 m3, per unit) and to facilitate flushing and other support operations associated with the preparation of the Darlington units for refurbishment work. The project will also implement improvements for heavy water management at the Tritium Removal Facility (TRF) including increasing operational storage; adding D2O drum handling, cleaning, testing, and storage capability; and consolidating offices for TRF staff.

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The project commenced start of installation on October 1, 2013 with a planned 2015 in-service date.

Darlington Operations Support Building Refurbishment

The purpose of this project is to extend the life of the Operations Support Building (OSB) to support the continued operations of the Darlington station. The OSB houses technical services that are essential to the operations of Darlington including security systems, site IT and telephone network hubs, quality assurance vault, station domestic water piping and safe access to the powerhouse via the bridge. This facility also provides office and conference room space for 375 station employees and various specialty groups inside the Darlington protected area.

The project is currently in the definition phase; detailed design will be complete in early 2014 at which time the project will commence the refurbishment of the OSB facility. Preliminary Supply and Install contracts will be awarded in late 2013 for cladding/windows, elevator, HVAC, and Cladding. The targeted in-service date for the facility is October 2015.

Auxiliary Heating System

This project will provide a source of reliable back-up steam to the Darlington main heating steam header. Back-up steam is needed to support irregular operating conditions such as an event where all four turbine units are shut down in the winter, to mitigate potential major equipment damage due to freezing. This will be achieved by replacing the existing original Construction Boiler House with a new facility that can, in the event of a four unit shutdown, provide reliable back-up steam at a sufficient capacity to meet the station's needs. This back-up steam will contribute to maintaining the temperature inside the Powerhouse and Tritium Removal Facility/Heavy Water Management Building at levels needed to prevent impairment of essential systems due to freezing.

The project is currently in the definition phase; detailed engineering is underway. The facility has a planned in-service date of April 2015.

Electrical Power Distribution System

Electrical power from the grid is supplied to Darlington site facilities and buildings located outside the protected area by a feeder line from Hydro One's Wilson Transformer Station. This system was designed and installed 25 to 30 years ago, and has reached the end of its operational life. Capacity in the existing system has diminished due to growth in electricity demand resulting from the addition of several new buildings on site. The performance and reliability of the existing system has gradually degraded over time. The existing system is not capable of supplying power to the new buildings needed to support Darlington Refurbishment and operations.

This project will upgrade the existing site power distribution system to meet the incremental demands of the new building/facilities, as well as to facilitate the supply of reliable electrical power to the existing and new buildings at the Darlington station. The upgrades include refurbishment / overhaul of the two existing power distribution substations and construction of a new power distribution substation and associated distribution system.

Holt Road Interchange Upgrade

Refurbishment of the Darlington units requires a significant increase in personnel and material deliveries to the station and the area immediately to the west of the station. The current road infrastructure cannot handle the anticipated increase in vehicular traffic, which would result in delays and increased cost. Additionally, backups onto Highway 401 and the South Service Road would impact commuters going to and from the Greater Toronto Area from Bowmanville and points east as well as impacting other businesses adjacent to the Darlington site.

Improvements to the Highway 401/Holt Road interchange are required to minimize traffic delays that could impact on the cost and schedule of the Refurbishment project and minimize the impact of the project on the surrounding community and the environment.

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Road access was identified as a key risk to the Darlington New Nuclear Project (DNNP) due to the volume of traffic from the simultaneous execution of new station construction and refurbishment of the existing Darlington units. In 2008, the DNNP agreed to fund preliminary design work for the upgrade of the Holt Road interchange, which was supported by the DNNP Environmental Assessment. However, with the delay in the New Nuclear Project, design work was stopped in the summer of 2011.

The Environmental Assessment for Darlington Refurbishment and Continued Operations confirmed the need for the upgrade. A follow-up assessment was completed in January 2012 to determine the impact of DN Refurbishment only. This assessment recommended improvements, albeit at a lesser scope.

In November 2011, the Darlington Refurbishment project opened discussions to resume design work based on refurbishment staffing and material delivery volumes only. This design work resumed in February 2012 with a Memorandum of Understanding (MOU) between OPG and the MTO regarding funding signed in August 2012.

OPG is currently finalizing its business case recommending that the Holt Road Interchange upgrade project proceed.

d. Regulatory Projects

Environmental Assessment

The EA Screening Report for the project was submitted to the CNSC on December 1, 2011. The CNSC released its decision on the EA on March 14, 2013. The overall finding of the CNSC is that the project will not result in any significant adverse environmental effects given the proposed mitigations.

Integrated Safety Review

The Integrated Safety Review (ISR), which assesses and documents key safety factors against modern codes and standards, was submitted to the CNSC on October 27, 2011. The CNSC issued their assessment of the ISR on July 5, 2013. The assessment concluded that the ISR meets applicable regulatory requirements.

Integrated Implementation Plan and Global Assessment Report

OPG is currently in the process of preparing the Integrated Implementation Plan (IIP) and Global Assessment Report (GAR), as well as a licensing application for the DRP; all will be submitted to the CNSC by December 2013, with approvals expected by early 2015. The new licence will allow OPG to execute the refurbishment and continue to operate DNGS for an additional 30 years assuming all licence conditions and regulatory obligations are met.

e. Safety Improvement Projects

Powerhouse Steam Venting System

This safety improvement project is a DRP EA commitment to the CNSC and is to be in-service prior to the first unit refurbishment. The project will improve the reliability of powerhouse venting and preclude vulnerability to common mode failures. Secondary side piping failures (e.g., steam, feed water, condensate and heating system piping breaks) may result in harsh environmental conditions that may impact safety-related systems, structures and components.

The project is projected to be in-service in the fourth quarter of 2015.

Containment Filtered Venting System (CFVS)

The Containment Filtered Venting System detailed design contract was awarded ahead of schedule to E.S. Fox / HSL / Westinghouse on August 27, 2013.

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Darlington Fire Water System

The purpose of this portfolio project is to separate the Emergency Service Water system, required for reactor safety, from the fire water systems. The project is currently in the conceptual phase.

Emergency Power Generator

This safety improvement project is a DRP EA commitment to the CNSC and is required to improve availability and reliability of the Emergency Power System.

The project involves installation of a third Emergency Power Generator (EPG) that can withstand a higher level seismic event than the Design Basis Earthquake to which the existing two EPGs are designed, and that can operate following a severe site flood. It will also address availability in cases where either both current EPGs fail or where one of the two EPGs is undergoing maintenance and the second EPG fails.

In addition, the third EPG is one of a suite of modifications required to support safe plant operation during Darlington Refurbishment. These modifications will allow for the removal of support services as needed to perform refurbishment activities.

The Emergency Power Generator 3 project is forecast to be placed in service in the fourth quarter of 2015.

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3.0 ALTERNATIVES AND ECONOMIC ANALYSIS

Alternatives

Alternative 1: Approve the strategic schedule to refurbish Darlington units starting in October 2016, with the first and second unit execution overlaps removed – RECOMMENDED.

This alternative positions OPG to be ready to execute a successful refurbishment of the first Darlington unit in October 2016, by ensuring that the Definition Phase of the Project is focussed primarily on readiness of the first unit, applying operating experience/lessons learned of other refurbishments, and lowering overall execution phase risk on the first unit. This will also provide OPG with a better opportunity to apply lessons learned on the first unit against subsequent units.

The execution schedule for this alternative is described in Section 3.0 of this Business Case Summary. To enable this alternative, the Fuel Channel Life Extension Project, which is being submitted for Board approval concurrently with this Refurbishment Business Case and which has, as its goal, achievement of high confidence in fitness-for-service of the fuel channels to 235,000 Effective Full Power Hours (EFPH) would need to be successful.

Economic assessment shows that this recommended alternative is more economical to the Ontario system than the previous overlapped alternative provided that the units can be operated to 235,000 EFPH, particularly on the last unit to be refurbished, Unit 4. Should the Fuel Channel Life Extension Project indicate, with sufficient lead time, that the Darlington Units cannot be safely operated to as high as 235,000 EFPH, Management has the option of modifying the schedule to mitigate the risk of idle time and significant cost impacts.

This alternative mitigates risk to the execution of the refurbishment of the first two units; as there would be no overlapping execution periods. This alternative also provides additional time for lessons learned on the first unit to be applied to subsequent units. However, by extending the overall outage window, this alternative does result in increased costs of OPG Program Management and Support, by approximately $130 Million, and there are greater challenges with this alternative than with Alternative 2 (overlap of the first two units) in retention and continuity of the trades' staff and potentially some key project staff.

Alternative 2: Retain the original schedule of refurbishing the Darlington units starting in October 2016, with all 4 units overlapped as before – NOT RECOMMENDED.

This alternative also positions OPG to be ready to execute a successful refurbishment of the first unit at Darlington in October 2016. However, this alternative carries increased risk relative to Alternative 1 in the Definition phase of the first two units, by dividing the attention of resources preparing for the first unit's refurbishment between the first two units. The overlapping execution phases would also result in greater risk to the execution of the first two units, and provides reduced time, compared to alternative 1, to incorporate lessons learned from the first unit into the execution phases of the remaining units.

Economic assessment shows that this Alternative is less economical to the Ontario system, if 235,000 EFPH are achievable on the fuel channel life. Thus, provided that the units can operated to 235,000 EFPH or beyond, particularly on the last unit to be refurbished, Unit 4, Alternative 1 is preferred. Should the Fuel Channel Life Extension Project conclude that the Darlington Units cannot be safely operated to 235,000 EFPH; Management has the option of reverting modifying the schedule to fully or partially mitigate idle time risks.

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Alternative 3: Delay the Approval of continued work in the Definition Phase of the DRP by 1 or more years – NOT RECOMMENDED.

This alternative would result in a suspension of the Definition Phase work, including work on the required infrastructure to execute the program, and would likely result in increased costs to demobilize and remobilize the significant planning, engineering, project management and oversight organization which OPG has built up over the past several years. There is a risk of a loss of key resources to other projects, in particular, competing refurbishment projects on the Bruce units. The risk of "idle time" on all of the units increases relative to Alternative 2, but is decreased on Units 1, 3, and 4 relative to Alternative 1.

Economic analysis shows that this alternative is more costly to the Ontario system than the recommended alternative (Alt 1).

Alternative 4: Abandon the DRP and do not Plan to Refurbish Darlington – NOT RECOMMENDED

Refurbishment of the Darlington units is supported by the Ontario Power Authority's (OPA) IPSP I and is included in the Ontario Government's Long-Term Energy Plan (LTEP) (2010) and in the Supply Mix Directive (2011) issued by the Government to the OPA, and is expected to be included in the LTEP II plan to be released in the fall of 2013. Compared to CCGT options, which require a lower capital investment, the refurbishment of Darlington exposes OPG to significant risk exposure because of the high capital cost. However, CCGT options are more expensive on a life cycle basis than the Darlington Refurbishment Project at median gas price forecasts and assumed carbon taxes and have significantly higher exposure to the risk of fuel costs increases, during their operating lives.

Economic Assessment

An assessment has been done of the relative economics of Alternatives 1, 2 and 3 at different assumed lives of the fuel channels. This assessment is summarized in the comparative Net Present Value Table below. Positive numbers mean that the Alternative is more economical; negative numbers mean that the Alternative is worse. It should be noted that, should the targeted number of EFPH not be achieved, there are mitigating actions that could be taken to avoid idling the units prior to refurbishment, including adjusting the refurbishment schedule and/or performing selective maintenance or replacements of fuel channels to enable the units to continue to operate until their refurbishment outages.

Table 1: Relative Present Values of Schedule Alternatives for Darlington Refurbishment

Alternatives Compared	Operating Life Achieved (EFPH)			
	210,000	**217,000**	**225,000**	**235,000**
2016 Start with No Overlap of 1st and 2nd Units (Alt 1) vs. **2016** Start with 1st and 2nd Units Overlapped (Alt 2)	-755	-385	-155	+30
2016 Start with No Overlap of 1st and 2nd Units (Alt 1) vs. **2017** Start with 1st and 2nd Units Overlapped (Alt 3)	-15	145	160	345
2017 Start with 1st and 2nd Units Overlapped (Alt 3) vs. 2016 Start with 1st and 2nd Units Overlapped (Alt 2)	-715	-510	-295	-295

Conclusions:

1. Provided beyond 235,000 EFPH can be achieved, it is forecast to be slightly more beneficial to the Ontario system to remove the overlap of the first two units, than to retain the original over-lapped schedule.
2. In all except the 210,000 EFPH case, it is more beneficial to the Ontario system to start in 2016 with the overlap removed on the first two units, than to delay the entire refurbishment program by 1 year (and retain the overlap). At 210,000 EFPH, the two cases are virtually breakeven.

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3. In all cases, if the overlapped schedule were maintained, it is more beneficial to the Ontario system to start in 2016 than to delay the entire refurbishment program by 1 year.

The recommended alternative for the Darlington Refurbishment Program has been assessed against other feasible generation projects including new Combined Cycle Gas.

In November 2009, based on the economics of the project as documented in the Economic Feasibility Assessment Business Case, the OPG Board of Directors approved the overall timeline and release strategy for the refurbishment. The Board released funds for the project to complete preliminary planning within the Definition Phase of the Darlington Refurbishment Project. OPG's Board of Directors also released funding to commence detailed planning within the Definition Phase in November 2011, and to continue detailed planning in November 2012.

Since the 2009 Feasibility Assessment, and as communicated in November 2011 and November 2012 as part of the Detailed Planning release of funds (Release 4b), Management has revised the overall timeline and release strategy for Darlington Refurbishment, including the submission of the Release Quality Estimate (RQE) in October 2015 and a first unit refurbishment start date of October 2016.

The economic assessment has been updated to reflect current knowledge and understanding of the Darlington refurbishment project and to reflect additional experience from other refurbishment projects. In 2010, Management had communicated that the project would be less than $10 Billion in 2009$ which is equivalent to $10.8 Billion in 2013$. Taking into account the current level of cost and schedule development, Management can now state with high confidence that the cost of the DRP will be less than $10 Billion in 2013$. By asserting high confidence that the DRP will be less than $10 Billion in 2013$, Management is indicating increasing confidence about the maximum amount likely to be expended. All of these figures exclude capitalized interest and future escalation. The $10 Billion in 2013$ translates into a completion cost $12.9 Billion, including capitalized interest and contingency, by the end of the project.

The current point estimate being used for the calculation of the Levelized Unit Energy Cost ("LUEC") project is $9.2 Billion (2013$), including $2.1 Billion of project and program contingency. This project estimate, including capitalized interest and future escalation translates into a completion cost of $11.4 Billion.

At a cost of $9.2 Billion (2013$), the Levelized Unit Energy Cost ("LUEC") of refurbishing and continuing to operate the Darlington units for a further 30 years is estimated to be 7.9 ¢/kWh (2013$), based on a high-confidence estimate of the Darlington Refurbishment Program. Excluding fixed Corporate Overheads for Pension and Other Post-Employment benefits which are independent of the decision to refurbish Darlington, the LUEC is estimated at 7.5 ¢/kWh (2013$). In 2010, Management had communicated that LUEC for the Darlington Refurbishment Program would be less than 8 ¢/kWh in 2009$, which is equivalent to 8.7 ¢/kWh in 2013$.

The economics of refurbishing the Darlington Station are comparable with Combined Cycle Gas Turbines (CCGT) at a median long-term forecast of gas prices of approximately $6/mm BTU and assuming carbon prices of $15 - $30/tonne. At median gas prices and $15/tonne carbon prices, the LUEC for CCGT is estimated at 7.5¢/kWh (2013$), with the carbon pricing accounting for 0.6 ¢/kWh of that LUEC. At low long-term gas prices of about $4/mm BTU and zero carbon prices, the price of CCGT would be more favourable than the price for refurbishing the Darlington Station. It should be noted that the costs to make gas-fired generation carbon-free (i.e. carbon sequestration), is estimated to be the equivalent of a $100/tonne carbon price, which would add 4 ¢/kWh to the LUEC of a CCGT.

While CCGTs have shorter execution lead times, lower up-front investment, lower ongoing operations, maintenance and administrative costs, there are significant uncertainties with regards to future gas prices and the potential implementation of carbon prices. There are other considerations which contribute to and support the favourable economic assessment for refurbishing the Darlington Station. These include:

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- The use of an existing generation site with a proven environmental record and a supportive host community avoids the additional costs to OPG (and ratepayers) of site selection, securing environmental approvals and development of host community support at an unproven green or brown field site. It also avoids the additional costs to ratepayers of establishing a new transmission infrastructure.
- The economic benefits of refurbishing the Darlington Station, in terms of direct, indirect and induced job creation, are anticipated to be greater than for CCGT. It is estimated that approximately 2,000 direct jobs are created during the Program Definition and Execution Phases. Continued Operation of the Darlington Station (post-refurbishment) will maintain the same level of employment as is currently associated with the Darlington Station for an additional 30 years. Economic impact studies indicate that post-refurbishment operations of the Darlington Station will result in approximately 5,700 resident jobs in Durham Region (direct, indirect and induced).

Management's assessment is that the refurbishment of the Darlington Station would also be competitive with the recently completed refurbishment of Bruce Units 1 and 2. Based on the Auditor General's 2007 assessment of the price being received by Bruce Power for the output of Bruce Units 1 and 2, management has estimated the LUEC for those units at approximately 8.5 ¢/kWh (2013$).

The future operating costs and performance of Darlington are a significant aspect of the economic assessment. An updated analysis has been completed of past performance in order to forecast the expected capability factor for the Darlington units in the post-refurbishment period. A capability factor of 88% has been used in this economic assessment with a range of 83% to 93%. Given the historical performance and the bottom-up analysis carried out by Darlington Operations, there is medium to high confidence in achieving this capability factor over the post-refurbishment life of the station.

Table 2 below summarizes the key post-refurbishment costs and performance assumptions used in the economic assessment.

Table 2: Darlington Post-Refurbishment Costs and Performance Forecasts

Post-Refurbishment Operations Estimates	Average Cost / Unit (Overnight 2013 $M)	Comments
Annual Direct Station Costs Post-Refurbishment	130	Consistent with Current Business Plan levels and previous BCS, adjusting for Business Transformation.
Annual Support Costs Post-Refurbishment (1)	110	Estimate based on Current Business Plan forecast adjusted for Business Transformation. Updated since last BCS to reflect planned shutdown of Pickering A and B.
Plant Performance Post Refurbishment (Gross Capability Factor)	88%	Range is 83%-93%. Darlington performance for the past 10 years is 89% and the station has achieved 90.7 %over the past 5 years. The station's performance since in-service has been 84.5%.

(1) The Annual Support Costs shown exclude past-service Pension and OPEB costs.

As shown in Figure 1, Management's current best estimates, based on further definition work done during the Detailed Planning phase, indicate a high confidence (70% - 90%) that the Levelized Unit Energy Cost (LUEC) for refurbishment and continued operation of Darlington will be in the range of 7.6 ¢/kWh (2013$)

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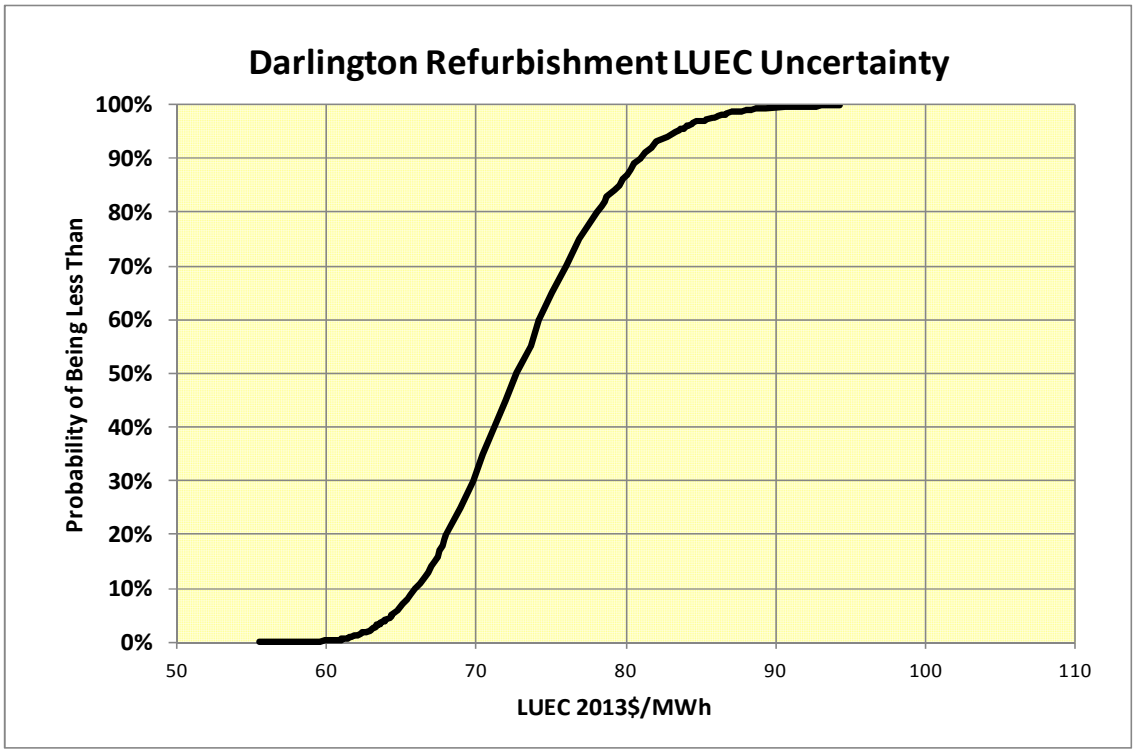
to 8.1 ¢/kWh (2013$). OPG continues to maintain a very high confidence that the refurbishment of the Darlington units will result in a LUEC of less than 8.7¢/kWh (2013$), which is equivalent to the very high confidence of less than 8 ¢/kWh (2009$) as stated in 2010.

Figure 1: Darlington Refurbishment Levelized Unit Energy Cost Confidence Ranges



On the basis of the updated economic analysis which continues to show the refurbishment of Darlington is economic relative to the other generation options, Management recommends proceeding with the expenditures in the Detailed Planning phase of the Definition phase of the Darlington Refurbishment Project.

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4.0 THE PROPOSAL

Approve the continuation of the Definition Phase of the Darlington Refurbishment Project by approving a release of funds to complete 2012 Detailed Planning deliverables within the Definition Phase, which includes the following Detailed Planning work program:

Key 2014 Deliverables to be completed in the Detailed Planning Phase include:

- Integrated Improvement Plan (IIP) and Global Assessment Report (GAR) to support the 10 year license application for Darlington in 2014.
- Progression of refurbishment pre-requisite work including construction of facilities and infrastructure projects, safety improvement projects (e.g. Third Emergency Power Generator, Containment Filtered Venting System), as well as scope defining inspections and unit islanding modifications.
- Negotiation and award of remaining major contracts by Q1 2014 including Steam Generators and Turbine Generator Engineering and Construction contracts.
- Progression of detailed engineering.
- Reconstruction of the Holt Road Bridge to improve traffic flow to the project and in order to not impact traffic flows in the adjoining communities.
- Design, fabrication, and testing of R&FR tooling and mock-ups to determine project durations for re-tube and feeder replacement activities.
- Scope finalization and further development of the project RQE to be issued by October 2015.
- Development of project agreements with the Building Trades Union (“BTU”) through EPSCA; and continued discussions with the Power Workers Union (“PWU”) to establish labour certainty throughout the DRP.

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Table 3 below, provides a summary of the key milestones for the Definition Phase.

Table 3: Overview of the Darlington Refurbishment Detailed Planning Phase Key Milestones

REGULATORY KEY DATES	Milestone Date
CNSC Staff Issue Final ISR Sufficiency Report	06-Feb-2012
CNSC Decision on EA	15-Mar-2013
CNSC Certification of RWC Transportation Package Design	22-Jan-2014
CNSC Staff Acceptance of Final ISR Report	5-Jul-2013
IIP Approval by CNSC	31-Dec-2014
CAMPUS PLAN KEY DATES	
All Campus Plan Building & Facilities Ready for Service	15-Apr-2016
REFURBISHMENT KEY DATES	
1st Priority Projects Contracts All Awarded	01-Mar-2012
R&FR Mock-up Available for Service	15-Jul-2014
Program Health Review Finished	15-Oct-2014
R&FR Tooling Available for Service	15-Aug-2015
All Projects Detailed Engineering Finished	15-Aug-2015
Unit 2 Refurbishment Readiness Assessment Finished	15-Oct-2015
All Projects Release Quality Estimate Complete	15-Oct-2015
Unit 2 Initial Stage Materials and Tools On Site	15-Jul-2016
Unit 2 Breaker Open (BO)	15-Oct-2016

Legend: Green = Complete

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5.0 QUALITATIVE FACTORS OR FACTORS NOT FULLY QUANTIFIED

CO2 Reduction:

The refurbishment of Darlington retains 3500 MW of nuclear base load generation on the Ontario Electricity system for another 30 years which contributes to Provincial and Federal goals of the reducing CO2 emissions from electricity generation. Based on approximately 0.4 Tg of CO2 emissions avoided for each Terawatt-hour of generation (assuming efficient gas-fired plant would replace Darlington, the refurbishment of Darlington would result in approximately 800 Tg of CO2 emissions avoided over the post-refurbishment life of the station.

Decommissioning Fund Impacts:

Proceeding with the refurbishment of Darlington, and extending its life by 30 years, results in a decrease in the present value of the liability related to the eventual decommissioning of Darlington. This reduction in the liability has already been incorporated into OPG's financial statements as of 2010 following Board approval to proceed to the Definition Phase in 2009. This has reduced the risk to the ratepayers around future cost increases for decommissioning. As of September 2013, the decommissioning fund for OPG's stations was fully funded, partly as a result of the reduction in the present value of the liability caused by the assumption of Darlington refurbishment. A decision not to proceed with the refurbishment would result in an increase in the liability on OPG's books, and could require additional contributions to the fund to make up any resultant shortfalls, with resultant impacts to the electricity rates.

Workforce Impacts:

Darlington Nuclear is a major employer within Durham Region. As of December 2010, approximately 2600 persons worked at the Darlington Nuclear site including 1800 station employees, and 800 employees who support the station and the Darlington Waste Management Facility. If Darlington were to be shutdown, there would be a gradual reduction of these staff as units are removed from service, prepared for safe storage, then placed in a safe store state over the late 2010s and early 2020s.

OPG is the second largest private sector employer in the Region of Durham, and the largest in the Municipality of Clarington, and is associated with approximately 2.4% and 12.3% of total employment (direct, indirect and induced) in the Region and Municipality, respectively.

Darlington Nuclear has attracted nuclear related businesses, helping to establish a Durham Energy Industry Sector Cluster (e.g. Eastern Power, Eco-tech, Black and MacDonald; AREVA, New Horizons Systems Solutions, etc.).

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6.0 RISKS

A Risk Management Plan has been developed and issued for the overall refurbishment project; risks at both the project and program level are identified and mitigating actions are prepared to ensure that the risk is appropriately managed. Key Business Case Risks and Opportunities are summarized below:

- **Station Performance Risks/Opportunities:** OPG is using an average station performance of 88% capability factor over the post-refurbishment life of the Darlington Station. Although this performance level is slightly below the station's demonstrated performance over the past 10 years of 89%, and a few percentage points below recent station performance (past 5 years) of 91%, it is imperative that preventative and corrective maintenance programs at the station be maintained at or above the current high standards, in order to assure performance of the station at these high levels for its entire post-refurbishment life.

- **Support Costs Risks:** OPG faces losses of economies of scale as the nuclear fleet shrinks. Thus, OPG must carefully manage the transition from operating a 10-unit nuclear fleet pre-2020 to a 4 unit nuclear station (i.e. Darlington Station only) post 2024, in order to ensure that the long-term operating and support costs for the Darlington Station remain at or below current levels. Initiatives have already begun as part of business transformation to effect this transition, and further initiatives need to be implemented to streamline organizations and support services delivery as the shutdown of the Pickering station approaches.

- **Program Costs and Schedule:** The DRP is still in Definition Phase and several estimates remain at the conceptual level. Several major contracts have not yet been awarded and there have been cost pushes, relative to the current conceptual estimates, in the R&FR contract and the Turbine Generator (TG) contract. This risk will be gradually reduced as major contracts are finalized and the Release Quality estimate is developed. Schedule development work has so far not revealed any significant risks to the refurbishment durations. Bearing in mind that previous refurbishment projects have encountered major schedule delays, management must remain vigilant during both the Definition Phase and Execution Phase to avoid schedule delays. Contracts are being structured to ensure that schedule adherence is a top priority.

- **Financing and Cost Recovery:** There is a risk that OPG may not be able to fully recover prudently incurred costs upon return to service of the units. OPG continues to discuss with the Province the need for greater assurance of cost recovery and has suggested regulatory changes to facilitate this. Given that the DRP will require significant funding during the Definition Phase leading up to the Release Quality Estimate, the capital at risk, and hence the need for cost recovery assurance is increasing.

- **Station Operating Life Risk:** Recent developments indicate that there may be an opportunity to extend the lives of the fuel channels at Darlington beyond the nominal life of 210,000 EFPH. This opportunity is being explored through a Fuel Channel Life Extension project, which builds on the work accomplished in the Fuel Channel Life Management project. The Fuel Channel Life Extension (FCLE) project is scheduled to be launched in early 2014 and has, as one of its objectives, the achievement of high confidence in 235,000 EFPH on the fuel channels at Darlington. In June 2013, based on improving confidence in the life of critical components at Darlington and the expectation of positive results from the FCLE project and the resulting opportunity this creates to maximize the value of the asset and to smooth overall rate impact while mitigating execution risk of the DRP, Management recommended the removal of the overlap of the first and second refurbishment units. This was approved by the CEO and forms the base planning assumption for this Business Case.

  The recommended refurbishment schedule, which removes the overlap of the first two unit refurbishment outages, requires the achievement of approximately 230,000 EFPH in order to eliminate the risk of idle time on the last unit to be refurbished, Unit 4. Mitigation of this risk includes the planned Fuel Channel Life Extension Project. Should high confidence in a station life of greater

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than 210,000 EFPH not be achieved, and provided this knowledge is obtained with sufficient lead time, there is an opportunity to adjust the schedule and re-align start dates of the subsequent units in order to reduce station operating life risks, thereby mitigating the significant cost of idle time if the units were to be shutdown prior to the project team being ready to commence the refurbishment.

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7.0 POST IMPLEMENTATION REVIEW (PIR) PLAN

A Comprehensive Post Implementation Review (PIR) shall be carried out by an independent team prior to the completion of the Definition Phase: The PIR will review and confirm the following:

1. Verify that the stated targets, milestones, deliverables, etc. were achieved and confirm readiness to proceed to the execution phase,
2. Make recommendations for the execution phases on the project, and,
3. Document the lessons learned for use in the subsequent stages of the project.

The Comprehensive PIR Independent Team will be appointed and will include the Independent Oversight Organizations as well as key OPG staff independent of the DRP.

The PIR should complete an independent and systematic evaluation of the work completed in the Definition Phase including the following:

- Review the completeness of the Program Management Plans and execution strategies for the Execution Phases of the project including:
  - i. Project Management organization with detailed role and accountability descriptions that are comparable to similar successful mega projects,
  - ii. Development of appropriate labour strategies for the project that is consistent with the corporate HR strategy and reflective of the projected skill requirements and availability during the project's life-span,
  - iii. Contractual relationships established for major components such as Re-tube, Fuel Handling, Turbines and Generators, which are comparable to similar successful projects, and,
  - iv. Review of project scope, the Release Quality Estimate, the overall project schedule, the integrated risk register, and the overall LUEC of the project, with detailed input from key stakeholders.
- Finalization of financing and cost recovery arrangements with required internal and external parties in a manner that is comparable to similar successful projects.
- Review of contracting strategies for balance of plant and execution phase work developed based on a process that is comparable to similar successful projects.
- Completion of initial Infrastructure (e.g. Training and Mock-up Building, Water and Sewer work), preliminary planning and design work and issuance of contracts.
- Review and confirmation of the regulatory strategy and an assessment of regulatory certainty for the DRP, and,
- Preparation of an updated BCS with up to date information.

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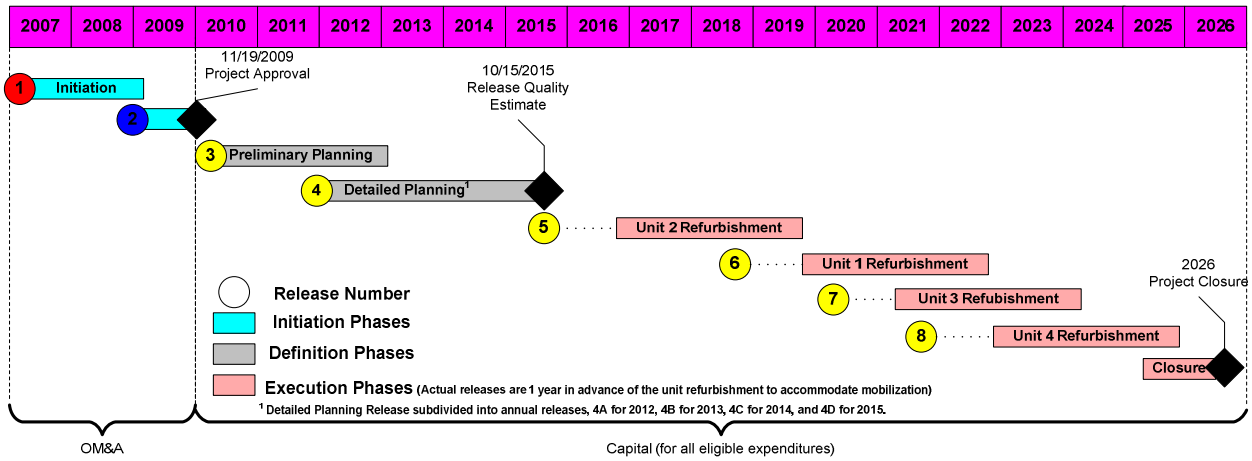
DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX A – RELEASE STRATEGY AND DESCRIPTION OF WORK PHASES

1. Overview of Release Strategy

Funding for the DRP will be released in phases using a gating methodology, i.e. the project cannot proceed from one phase to the next without completing certain deliverables.

The overall release strategy is described in Figure 1.

Figure 1: Overview of the Darlington Refurbishment Release Strategy



This release strategy is based on an October 2016 1st unit outage and incorporates an October 2015, 2015 Release Quality Estimate ("RQE") date in order to incorporate the results of Re-tube and Feeder Replacement tooling production test results into the overall baseline schedule in order to increase Management's confidence in the projects scope, cost, and schedule estimate at RQE.

For the Detailed Planning Phase of the project, the releases have been sub-divided into annual release amounts, i.e. Release 4a for 2012, Release 4b for 2013, Release 4c for 2014, and Release 4d for 2015.

For the Execution Phase of the project, funding will be requested and released one year in advance of each individual unit outage to provide funding for mobilization of staff and to perform unit specific preparation including development of comprehensive work packages, unit specific planning and engineering, unit isolation and barriers preparation, and procurement of unit specific materials.

The sections below document the key deliverables for each release of the project. As the project progresses through the Planning Phase, further definition on deliverables and risks, may result in changes to timing and/or deliverables within each release, however, the phase-based gating methodology will be adhered to throughout the Darlington Refurbishment Project.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX A – RELEASE STRATEGY AND DESCRIPTION OF WORK PHASES

2. Project Phases

As described in Figure 1 above, the project has been divided into phases. A description of the deliverables for each phase has been provided.

Initiation Phase – Releases 1 to 2

The initiation phase included the following activities:

- Determine preliminary project scope through the completion of a Plant Condition Assessment (PCA) with a special focus on the life-limiting components, such as feeders and fuel channels. Studies were also conducted to assess the condition of all major station components, and methods and timing for carrying out the required refurbishment scope would be proposed.
- Planning for the ISR, including a review of modern codes and standards, and an EA.
- Assessed the various execution options (e.g., contracting, project management, work management, governance) for the Definition and Execution Phases of the Refurbishment Project, and recommended an execution strategy.
- Identification of an initial project organization for the Definition and Execution Phases.
- Developed a communication plan to ensure stakeholders are informed of OPG's Refurbishment Project and obtain their support for the decision.
- Developed Project Management support such as Project Controls, performance measures, schedules, risk and contingency processes, project metrics and reports.
- Developed a preliminary schedule and cost estimate for the refurbishment outages, and a Refurbishment Outage Preparation Plan that included both key and supporting scope (organization, infrastructure, oversight, plant and programmatic work, risk contingencies and allowances). Construction Islanding is a key study to determine the supporting scope.
- Prepared a recommendation with respect to proceeding to refurbish the Darlington station to OPG Senior Management, OPG's Board of Directors and Shareholders. Supported this recommendation through the completion of a Business Case Summary (BCS).

Definition Phase - Preliminary Planning – Release 3

The following key deliverables in the Preliminary Planning Phase have been completed.

- The project Management organization for the Definition Phase of the project has been put in place. The key roles on the project team include Engineering, Execution, Supply Chain, Contract Management, Managed Systems Oversight, and Project Planning and Controls. All positions report to the Senior Vice President of Nuclear Refurbishment who has the overall accountability to deliver the project.

- An overall contract strategy document has been developed and approved for the project. Additionally, contract strategy documents for each major work component, i.e. Re-tube and Feeder Replacement, Fuel Handling, Turbine Generators, Steam Generators, and Balance of Plant has been developed.

- The ISR final report, a required regulatory document that assesses and documents key safety factors against modern codes and standards, was submitted to the CNSC in October 2011. The CNSC issued their assessment of the ISR on July 5, 2013. The assessment concluded that the ISR meets applicable regulatory requirements.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX A – RELEASE STRATEGY AND DESCRIPTION OF WORK PHASES

- The EA Screening Report was submitted to the CNSC December 1, 2011. The CNSC released its decision on the EA on March 14, 2013. The overall finding of the CNSC is that the project will not result in any significant adverse environmental effects given the proposed mitigations. Both the Integrated Safety Report and Environmental Assessment are precursors for the CNSC approval of the Integrated Improvement Plan which will allow the project to proceed and the Darlington Station to be operated for an additional 30 years post refurbishment.

- Project controls governance and supporting tools, including cost management, scheduling, estimating, risk management, and change management have been implemented. Governance has been put in place, establishing the review and approval process for all major program scope and funding through the Scope Review Board (SRB) and the Gate Review Board (GRB). The technical scope for the refurbishment project was finalized in 2011 and the SRB will continue to review and approve scope deletions and/or additions due to plant configuration, regulatory or code changes, on a reduced frequency for the duration of the project. Funds are released by the GRB, as projects proceed through each phase of the gate process.

- Labour strategies have been developed for the project with labour agreements in placed with Society. Additionally, in July 2011, OPG declared the Darlington Refurbishment Project a “Rehabilitation” project which invoked the Chestnut Park Accord Agreement. Subsequently, the committee has reviewed and assigned approximately 90% of the craft work to the Building Trades Union (BTU) with approximately 5% assigned to the Power Worker’s Union and another 5% to be determined.

- An organizational “strong project matrix” model has been deployed for the Refurbishment Project. The model is in the process of being implemented. Staffing guidelines recognizing the model and the fact that OPG will be performing oversight of Engineer, Procure, Construct (EPC) contractors have been established.

- Cost Recovery and Financing confirmation is underway. As cost recovery and/or financing certainty is currently not confirmed, the project will request a release of funds for 2014 portion of the Detailed Planning Phase only. Upon cost recovery and financing confirmation, the project will request a release of the remaining Detailed Planning funds.

- The project economics and the BCS have been updated based on the latest known information.

Definition Phase - Detailed Planning – Releases 4a to 4d

The Definition Phase - Detailed Planning work program includes the following activities:

- Completion of all Outage preparation plans and unit pre-requisite work, including infrastructure and facilities required to execute the Refurbishment as well as unit modifications to enable unit islanding and isolation.
- Finalization of all project scope and progression of engineering.
- Integrated Implementation Plan and Global Assessment report submitted to the CNSC and approvals obtained. OPG is currently in the process of preparing the Integrated Implementation Plan (IIP) and Global Assessment Report (GAR), as well as a licensing

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application for the DRP; all will be submitted to the CNSC by December 2013, with approvals expected by early 2015. The new licence will allow OPG to execute the refurbishment and continue to operate DNGS for an additional 30 years assuming all licence conditions and regulatory obligations are met.

- Orders for long lead items issued and delivery dates confirmed, where required.
- Contracts for Engineering, Detailed Planning and pre-execution outage work (i.e., development of mock-up and tooling for Re-tube, awarded or partially released to key vendors).
- Establishment of an independent oversight process and assurance model.
- Preparation of a Release Quality Estimate ("RQE") including detailed cost estimates and a detailed execution phase schedule based on approved scope.
- Update of the Program Business Case, with a full project cost estimate, and presented to Senior Management, the Board of Directors and Shareholder, with a project execution strategy recommendation, for approval.

Field Execution and Closeout Phase – Releases 5 to 8

The Field Execution and Closeout Phase will involve completion of all planned aspects of refurbishment and associated re-commissioning and re-licensing tasks.

Releases for subsequent units will be developed and approved throughout this phase.

A Full Release BCS will be prepared for each of the subsequent units (2nd, 3rd, and 4th Units), including any updates to cost and schedule estimates, for each of these subsequent releases. Release 8, for the 4th and final unit, will include project closure costs.

Operations Phase

The Operations phase is the return to service of the units, starting around 2019, when the first unit refurbishment is complete.

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For Internal Project Control

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX B – SUMMARY OF ESTIMATE

ONTARIO POWER GENERATION	**PROJECT** **Summary of Estimate**	Date	November 14, 2013
		Project #	27959 (OM&A) 73010 & 73011 (Capital)

Facility Name:	Darlington Nuclear Station
Project Title:	**Darlington Refurbishment Program (DRP)** Definition Phase

Estimated Cost in Million $

Year	LTD 2013	2014	2015	Total	%
Major Projects **Includes:** Retube and Feeder Replacement, Fuel Handling, Defueling, Steam Generators, Turbine Generators, and Balance of Plant projects	266	348	309	**923**	39
Facility and Infrastructure Projects	201	147	93	**441**	19
Holt Road Improvements	3	14	16	**33**	1
Operations/ Maintenance Support	13	16	29	**58**	2
OPG Oversight and Program Support	245	124	123	**492**	21
Regulatory, including CNSC Fees	54	8	2	**64**	3
Insurance	1	2	7	**10**	0
Interest	32	52	81	**165**	7
Contingency	5	63	72	**140**	6
Escalation	0	14	25	**39**	2
Totals	**820**	**788**	**756**	**2,365**	

Notes:	1.	LTD costs include all costs related to the Darlington Refurbishment project Definition Phase, including Preliminary Planning (2010 to 2011) and Detailed Planning (2012 and 2013, based on 2013 Year End forecast). 2014 and 2015 cash flows represent forecast expenditures for each year. The above table excludes initiation phase (2007 to 2009) costs incurred prior to approval of the project in 2010 totaling $34M. These costs are not eligible for capitalization within the DRP.
	2.	Interest and Escalation rates are based on current allocation rates provided by Corporate Finance

Prepared by:	**Approved by:**
G. Rose Director, Planning and Control Nuclear Refurbishment	**D. Reiner** SVP, Nuclear Refurbishment

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

1.0 Assessing the Economics of Refurbishment

In order to assess the economics of the refurbishment decision on Darlington, the following key factors must be considered:

- Refurbishment Scope, Cost, Duration and Timing
- Expected Life of each unit post-refurbishment
- Forecast annual operating costs post-refurbishment, including Operation, Maintenance and Administration costs, On-going Project (Capital & OM&A) costs, Outage costs, Fuel costs, Nuclear Waste Management and Decommissioning (Provisions) costs and Overhead (Nuclear and Corporate) costs.
- Forecast Performance post-refurbishment (annual capacity factor/capability factor).
- Economic Indices (e.g. labour and material escalation rates, appropriate discount rate)

The above factors can be used to determine the LUEC of the refurbishment option. There are other potential incremental costs or opportunities associated with a decision to go or not to go ahead, such as changes to the present value of the decommissioning liability or incremental transmission costs, which are applicable if one were to take a societal view of the costs and benefits of the project, which may also influence the ultimate decision.

The above items are discussed in more detail in the following sections.

1.1. Refurbishment Scope, Cost and Reference Schedule

1.1.1. Refurbishment Scope

The main scope of work during the refurbishment of each Darlington unit is the replacement of fuel channels (pressure tubes and calandria tubes) and feeder pipes (up to the feeder header). The refurbishment scope does not include replacement of the steam generators. The scope also includes provisions for outage support work (unit islanding, facilities, construction island barriers, heavy water management, and radioactive waste management).

Since 2009, significant progress has been made in defining the scope of the refurbishment work and the categorization of this scope has become more granular. Core scope and non-core scope has been clearly defined, with both core scope and non-core scope divided into several categories for ease of categorization, review and decision-making. Certain categories of non-core scope must successfully pass a cost-benefit analysis test before being considered for inclusion in the refurbishment scope. There are now formal on-going assessments of the technical merits, costs, and funding requirements of each proposed scope item and formal review and approval of proposed scope by the Scope Review Board. Required regulatory scope has been identified through CNSC approval of the Environmental Assessment and CNSC staff assessment of the Integrated Safety Review. Following initial approval, secondary reviews of non-core scope have also been executed as a result of a broad scope review and also triggered in part by a re-assessment of Component Condition Assessments and these reviews have led to further rationalization of the scope.

Non-core refurbishment scope includes advancement of future life-cycle work (i.e. work that would be necessary in the post-refurbishment life to ensure that the plant can continue to operate safely and reliably during its post-refurbishment life), where it makes business sense to advance this work into the refurbishment outage, e.g. because of the duration of the work or the state of the plant required to execute the work.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

1.1.2. Refurbishment Costs

In conjunction with the scope reviews and updates, cost estimates for the refurbishment scope of work have been updated as part of the Detailed Planning activities. As well, benchmarking has continued against publicly available costs of other on-going CANDU refurbishment projects at Pt. Lepreau and the Bruce 1 & 2 Units and lessons learned from these projects continue to be incorporated into the Darlington Refurbishment Program cost estimate.

A contract has been let for the main scope of the refurbishment outage, i.e. the re-tube and feeder replacement activities and definition phase work is well underway. The establishment of this contract has resulted in improving cost certainty on this major component of the scope. Other project bundles, such as Fuel Handling, Defueling, Turbine Generator and Steam Generator have either had contracts let or are in the final stages of evaluation and negotiation. Updated estimates of the OPG Program Management and Oversight function have also been completed.

Table C1 summarizes the Refurbishment Project costs which were utilized in the economic assessment. The overnight cost estimate for the known scope of work is $7.1 Billion. With $2.1 Billion of contingency added to bring the bottom line total to $9.2 Billion (2013$), this is considered a high confidence (90% confidence) estimate.

For the purposes of preparing sensitivity analyses, ranges were applied to the most likely estimates in each line item of the cost estimate.

Table C1: Refurbishment Project Costs Used in the Updated Economic Assessment

Category of Work			Nov-13	Nov-12	Nov-11	Nov-09	Plan/ Plan 09 - 13	Description of Work
Project Estimate ($2013)	Direct Work	Major Contracts (RFR, FH, Defueling, SG, TG)	3,207	3,321	3,016	2,753	454	Vendor EPC (Engineering, Procurement, Construction) costs for major component work programs, including retube and feeder replacement, turbine generator upgrades and digital control system, Steam Generator primary side clean, and fuel handling equipment refurbishment.
		Balance of Plant	275	340	511	374	(99)	Vendor EPC costs for refurbishment of balance of plant equipment including implementation of 3rd Emergency Power Generator and Containment Filtered Venting.
		Islanding	153	115	92	88	65	Includes containment isolations (bulkheads), D20 management modifications and negative pressure containment
		Holt Road Improvements	33	32	-	-	33	Estimate from MTO. Stand alone BCS to be provided to BoD
		System Shutdown	82	65	51	-	82	Includes In-Station Facilities
		Operations & Maintenance Support	871	860	729	518	353	Includes online, cyclical, project support, chemistry, radiation and return to service programs
		Waste Mgmt & Waste Containers	230	172	153	205	25	Tipping fee based on m3. Excludes storage buidling due to accounting determination
		New Fuel	132	132	132	132	-	Fuel replacement for each refurbished unit once returned to service.
		Facilities and Infrastructure Projects	459	475	501	676	(217)	Facilities and infrastructure improvements to support refurbishment activities (i.e. Darlington Energy Complex, D2O Storage Facility) and extended station operations (i.e. Water and Sewer, electrical upgrades, Operations Support Building renovation).
		Total Direct Work	5,442	5,512	5,186	4,747	695	
		OPG Project Management and Support	1,639	1,505	1,229	876	763	
		Total Direct plus Indirect Work	7,081	7,017	6,415	5,623	1,458	
		Contingency and Management Reserve	2,091	2,356	2,390	2,215	(123)	
		Total Project Estimate	9,172	9,373	8,805	7,837	1,335	
		Capitalized Interest	1,059	1,143	1,127	1,509	(450)	
		Tottal Project Estimate Incl. Interest ($2013)	10,231	10,516	9,932	9,346	885	
		Future Escalation	1,154	867	1,132	1,702	(548)	
		Total Project Estimate ($ of the year)	11,385	11,383	11,064	11,048	337	

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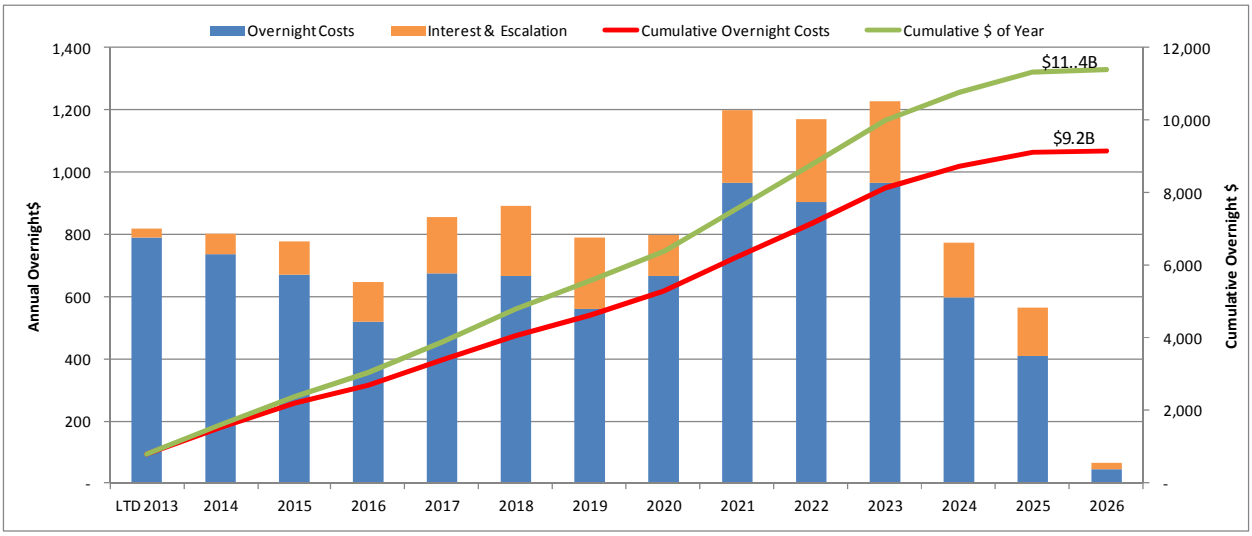
DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

Figure C1 provides the anticipated cash flows for the DRP, based on the current estimate.

Figure C1: Darlington Refurbishment Program Anticipated Cash Flow



OPG continues to benchmark its cost and schedule assumptions and plans against other CANDU refurbishments. OPG's refurbishment schedule is based on the Wolsong refurbishment actual duration, pro-rated to account for the Darlington Station's larger unit size (480 fuel channels in a Darlington or Bruce unit vs. 380 fuel channels in a CANDU 6 design).

Table C2 provides a comparative assessment, based on publicly available information, of the current cost and schedule of the Darlington Refurbishment as compared to other CANDU refurbishments.

Table C2: Darlington Refurbishment Comparison to Other Refurbishments

Station (Per Unit)	Start Date	Planned / Actual Duration (Months)	Planned / Actual Cost
Darlington Station	OCT 2016	36/TBD	~$3.0/TBD
Pt. Lepreau	MAR 2008	18/55 (1)	$1.0B/$1.4B (2)
Wolsong	APR 2009	22/28 (1)	Not Available
Bruce A Units 1 & 2 (3)	OCT 2005	25/84 for 2 units	$1.4B/$2.4B ($4.8B/2 units)

Notes:

(1) Pt. Lepreau and Wolsong are for CANDU 6 designs with 380 calandria/pressure tubes and a dedicated fuelling machine versus the Darlington and Bruce designs of 480 pressure tubes and a shared fuel handling system. Refurbishment assessed the Wolsong actual duration and pro-rated applicable series to conclude that the corresponding duration for the Darlington Station is approximately 34 months.

(2) An additional $1B in replacement energy costs, operations and maintenance costs, and incremental financing for non-project related costs was incurred by New Brunswick Power.

(3) Bruce scope includes replacement of Steam Generators as well as large Balance of Plant scope due to fact that units were in a laid-up state prior to refurbishment. Refurbishment of Units 1 and 2 commenced in October 2005 with Unit 1 complete in September 2012 and Unit 2 in October 2012, for a total of 7 years (84 months). The cost estimate publicly quoted is from November 2010; it is uncertain whether this cost estimate includes all of the applicable capitalized interest costs and/or operations and maintenance costs that can be directly attributable to the project.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

1.1.3. Contingency and Risks - Refurbishment

Included in the refurbishment estimate is an allowance for uncertainties in project scope, costs and schedule. In addition, allowances are added for known discrete risks.

At the 50%, 70% and 90% confidence levels the total amounts included for contingency and risks are approximately $1.1 Billion, $1.5 Billion and $2.1 Billion, respectively. The contributing factors to these contingency amount estimates are broken out as follows:

- Cost Estimate Uncertainty

  This contingency item represents the amount that has to be added to the most likely estimates of the project bundles and project support and oversight estimates to bring the confidence level in these estimates to a certain level of confidence, e.g. 50% probability or 90% probability. This is due to the cost estimate ranges developed for each scope item showing more of a potential to increase than to decrease. This results in the expected value being higher than the most likely estimate. Recent progress in developing contracts for the project bundles and in reviewing and refining the project support and oversight estimates has resulted in a reduction in the amount of contingency needed for this item.

- Contingent Work Risk

  This contingency item represents an amount that has been estimated for potential work that may be required following inspections of equipment prior to and during the refurbishment outages. This potential work was identified during scope development activities during both the Preliminary Planning and Detailed Planning Phases.

- Labour/Materials Price Risk

  This item deals with risks associated with the potential for labour and material prices to be higher than expected in tight markets and is in addition to the cost estimate uncertainty. High demand for qualified workers and the required materials may occur if concurrent infrastructure improvement projects in Canada and worldwide result in tightening markets for labour and materials. As contracts are finalized, the contingency required for Labour/Materials Price Uncertainty will decline.

- Discrete Risk Items

  This item reflects contingency to address discrete risks listed in the risk register that are not accounted for in the other risk categories shown above. It includes regulatory delays, materials delays, rework risks and discovery work.

- Schedule Uncertainty Risks

  This item reflects the schedule uncertainty risk; the complexity of the project poses a risk to meeting the schedule. Schedule uncertainty risk should improve as the Detailed Planning Phase of the Project progresses.

  The estimates for each of these contributors to contingencies and risks at the 50%, 70% and 90% confidence levels are shown in Table C3.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

Table C3: Contingency & Risk Amounts added to the Darlington Project Cost Estimate

#	Category	Examples	Contingency (2013$M)		
			50% Conf.	70% Conf.	90% Conf.
1	**Cost Estimate Uncertainty** – Risk that actual cost of project scope is higher than planned.	Uncertainty in costs of project Bundles such as R&FR, Fuel Handling, T/G set and Balance of Plant	**145**	**285**	**500**
2	**Contingent Work** –Work which may be required dependent on inspection results.	Repair and/or replace equipment that could not be visually assessed / tested during the condition assessments.	**240**	**250**	**260**
3	**Labour/Material Price Uncertainty** – Risk that labour & materials prices may escalate higher than forecast	Labour market pressures lead to higher than expected labour prices	**60**	**255**	**625**
4	**Discrete Risk Items** – Known risks that the project will manage	Regulatory delays, Material Delays, Rework, Discovery Work	**605**	**640**	**665**
5	**Schedule Estimate Uncertainty** – Risk that actual duration of the refurbishment is longer than planned	Longer duration results in continued overhead costs	**15**	**20**	**20**
		TOTAL:	**$1.1B**	**$1.5B**	**$2.1B**

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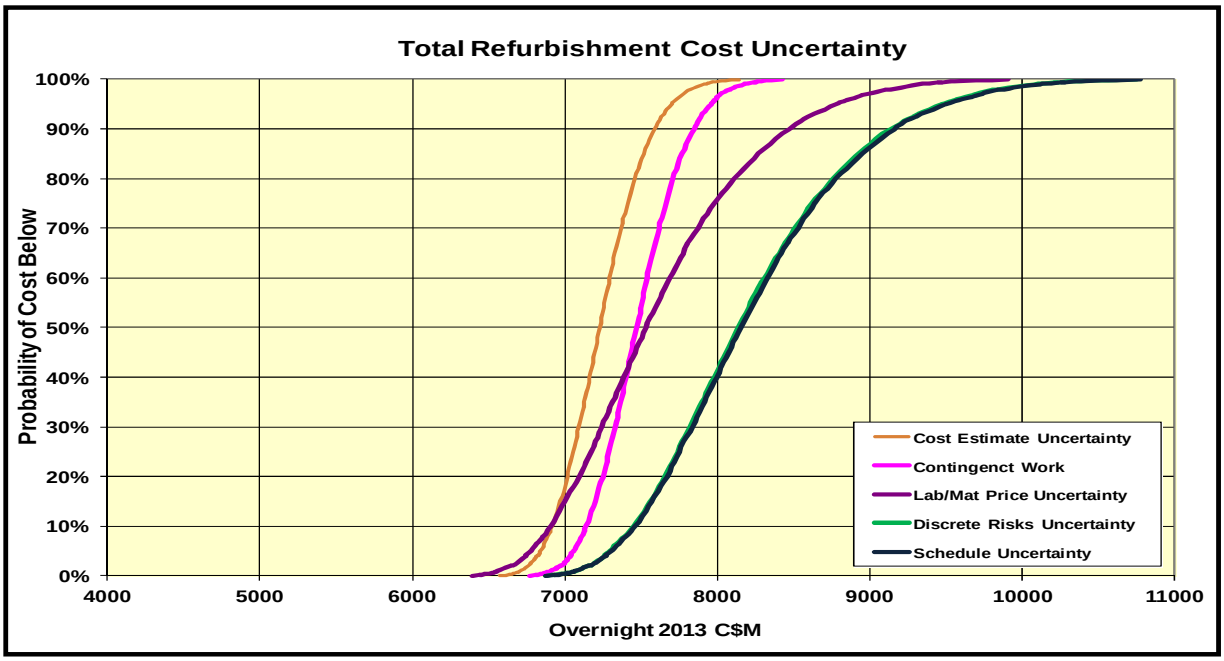
DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

The resulting distribution of Darlington refurbishment project costs is shown in Figure C2.

Figure C2: Darlington Refurbishment Project Costs Uncertainty



1.1.4. Refurbishment Reference Schedule

Unit Refurbishment Duration: The duration of the refurbishment outage of the Darlington units continues to be assessed at nominally 36 months per unit.

Timing of Unit Refurbishment Outages:

Several criteria are used to assess the optimum start dates for a Darlington refurbishment outage, including the life of major components (e.g. pressure tubes and feeders), lead times for key decisions (EA, ISR), lead times for critical path procurement activities (e.g. re-tube and re-feeder tooling), project preparation and planning efficiency and project execution efficiency. The overall assessment indicated that the optimum start date for the first Darlington refurbishment outage was 2016.

The refurbishment schedule considers a range of factors. Key considerations included minimizing refurbishment planning and execution risks while maximising the value of the asset to the Ontario electricity system prior to refurbishment, bearing in mind the expected operational lives of the units. If readiness to refurbish cannot be achieved (e.g. lead time constraints have prevented the acquisition of necessary materials or tooling) before a unit reaches its operational end-of-life, there is a risk of idle time being incurred on the unit. On the other hand, operational life is forsaken when units are shutdown for refurbishment before they reach the limiting component end-of-life. Because the end-of-life dates of the four Darlington units would occur within approximately a 1- 2 year span, it is necessary to stagger the start dates of the refurbishments, thereby incurring some forsaken life on the earlier units to be refurbished), in order to minimize the risk of idle time.

OPG has pursued increased fuel channel life for both Pickering and Darlington through the Fuel Channel Life Management Project with the aim of developing high confidence in the fuel channel

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service lives. Recent developments indicate that there may be an opportunity to extend the lives of the fuel channels at Darlington beyond the nominal life of 210,000 EFPH. This opportunity is being explored through a Fuel Channel Life Extension project, which builds on the work accomplished in the Fuel Channel Life Management project. The Fuel Channel Life Extension (FCLE) project is scheduled to be launched in early 2014 and has, as one of its objectives, the achievement of high confidence in 235,000 EFPH on the fuel channels at Darlington. In June 2013, based on improving confidence in the life of critical components at Darlington and the expectation of positive results from the FCLE project and the resulting opportunity this creates to maximize the value of the asset and to smooth overall rate impact while mitigating execution risk of the DRP, Management recommended the removal of the overlap of the first and second refurbishment units. This was approved by the CEO and forms the base planning assumption for this Business Case.

The current planning schedule for refurbishment is that the first unit's refurbishment will start in October 2016, with nominal refurbishment outage durations of 36 months/unit, and with 0, 19 and 17 month overlaps between the first-to-second, second-to-third and third-to fourth units respectively. The overall refurbishment window remains at 108 months, and the overall unit outage months remain at 144 months.

This schedule was compared to the previous refurbishment schedule which assumed a 2016 start, with the first two units overlapped, and also to a 2017 start with the first two units overlapped. Table C4 summarizes the results of that economic assessment.

Table C4: Relative Present Values of Schedule Alternatives for Darlington Refurbishment

Alternatives Compared	Operating Life Achieved (EFPH)			
	210,000	**217,000**	**225,000**	**235,000**
2016 Start with No Overlap of 1st and 2nd Units (Alt 1) vs. **2016** Start with 1st and 2nd Units Overlapped (Alt 2)	-755	-385	-155	+30
2016 Start with No Overlap of 1st and 2nd Units (Alt 1) vs. **2017** Start with 1st and 2nd Units Overlapped (Alt 3)	-15	145	160	345
2017 Start with 1st and 2nd Units Overlapped (Alt 3) vs. 2016 Start with 1st and 2nd Units Overlapped (Alt 2)	-715	-510	-295	-295

Conclusions:

1. As long as beyond 235,000 EFPH can be achieved, it is forecast to be slightly more beneficial to the Ontario system to remove the overlap of the first two units, than to retain the original overlapped schedule.
2. In all except the 210,000 EFPH case, it is more beneficial to the Ontario system to start in 2016 with the overlap removed on the first two units, than to delay the entire refurbishment program by 1 year (and retain the overlap). At 210,000 EFPH, the two cases are virtually breakeven.
3. In all cases, if the overlapped schedule were maintained, it is more beneficial to the Ontario system to start in 2016 than to delay the entire refurbishment program by 1 year.

1.2. Post-Refurbishment Assumptions

To fully assess the merits of the option to proceed with the refurbishment of the Darlington plant, all future expected costs of operating the facility over its post-refurbishment life, as well as the expected operating performance of the plant and expected unit life must be forecasted.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

1.2.1. Unit Life

Since the Darlington units would have been in service for nominally 60 years by the end of their post-refurbishment lives, it is considered prudent to utilize conservative assumptions for unit lives in the economic assessment, in order to mitigate the risk that an unforeseen equipment issue could emerge which could bring about an earlier than expected end of post-refurbishment life.

The post-refurbishment life of each unit was assumed to be nominally 30 calendar years. This post-refurbishment calendar life was derived from the current design life of pressure tubes of 24 effective full power years (210,000 EFPH) with recognition that, given the knowledge gained about pressure tube degradation mechanisms, future pressure tubes will likely be designed and operated to achieve longer service lives. Thirty calendar years, with an assumed 88% capability factor translates into a pressure tube life of approximately 26 effective full power years (approx. 231,000 EFPH).

Sensitivities on unit lives were run at +/- 2 calendar years.

1.2.2. Annual Station Operating, Maintenance & Projects Costs

Annual OM&A levels were derived based on levels in the current business plan forecast, factoring in OPG's Business Transformation targets, as well as forecast changes to work programs and approaches expected over the life of the units. OM&A levels were estimated to be nominally the same as the current 2016 Business Plan, with appropriate adjustments over the post-refurbishment period.

The post-refurbishment outage costs were developed based on expected work programs and outage templates. Outage durations and costs were adjusted during the last 10 years of post-refurbishment life to reflect potential equipment aging-related driven need longer outage windows. Outage costs and durations include allowances for periodic 4-unit shutdowns for Vacuum Building Inspections and Station Containment Testing.

Ongoing sustaining projects expenditures were estimated based on the current and projected nuclear project portfolio assumptions, as well as benchmarking against other utilities. This was modified by assuming that, in the first year post-refurbishment, 50% of the "typical' annual project costs would be incurred, ramping up to 100% by the 5th year.

Table C5 provides details on the assumptions used for these factors in the analysis.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
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Table C5: Annual OM&A, Outages & Projects Costs Used in the Economic Assessment

Going Forward Cost Item	Post-Refurbishment Forecast Avg. Median Confidence ($M/yr; 2013$)	2013 - 2016 Plan Avg. ($M/yr; 2013$)
Station Base OM&A (1)	270	280
Outages OM&A (1)	110	120
Projects (Cap & OM&A) (2,3)	130	127
Annual Direct Costs	510	527

Note: Costs are rounded to the nearest $5M.

1. Base and Outage post-refurbishment forecasts are based on the current 2016 business plan forecast, and includes all Station Containment/Vacuum Building Outages and cost and scope adjustments as the unit's age. The Vacuum Building Outage Costs in 2015 were normalized to reflect a planned VBO every 12 years.
2. Capital & OM&A project forecasts are based on current business plan forecasts adjusted for losses of economies of scale upon the shutdown of Pickering and also informed by benchmarking against other utilities. Periodic major projects (e.g. facilities, security) are factored into the long-term projects forecast.

1.2.3. Annual Support and Overhead Costs

Costs associated with direct and allocated support services are divided into Nuclear and Corporate Support. Examples of nuclear support include Nuclear Engineering, Nuclear Services, Fleet Operations and Maintenance and Inspection and Maintenance Services. Examples of Corporate Support costs include Finance, People and Culture, Business and Administrative Services, Legal Support and Commercial Operations and Environment, which includes Regulatory Affairs. In addition, there are centrally held costs, such as insurance premiums, pension adjustments and interest on Other Post-Employment Benefit obligations which are allocated to the Darlington station.

Based on the following premises: a) that there are economies of scale in the provision of Nuclear and Corporate Support to a large fleet of stations; b) that there are some "centrally held costs" allocated by Corporate to each station that are purely "fixed", i.e. are not affected by a decision to continue or not continue to operate a station, it has been postulated that, should the nuclear fleet shrink, losses of economies of scale will result in an effective increase in the cost of providing Nuclear & Corporate support services to the remaining stations. Also, the fixed overheads currently allocated to a larger fleet of stations will effectively need to be re-allocated to a smaller fleet, resulting in the allocation of fixed overheads to the remaining stations increasing.

Hence, the analysis of Darlington's economics is done including only the portion of those costs which are considered incremental to the operation of Darlington. Table C6 shows the incremental support and overhead costs which were assumed in the Updated Economic Assessment. Because it is assumed that the Pickering units will have already been shutdown at the time that the Darlington Station will be in its post-refurbishment period, Darlington's share of the Nuclear Support Costs and Corporate Support costs will come under upward pressure due to losses of economies of scale. Therefore, in this assessment, for conservative purposes, the incremental view of Darlington's costs of operation (for economic analysis purposes) is equal to or in select instances (e.g. insurance premiums), worse than the costs which are currently allocated to Darlington in the Business Plan.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
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Table C6: Nuclear & Corporate Support Costs Used in the Economic Assessment

Going Forward Cost Item	Incremental M$/Yr, 2013$
Nuclear Support	215 (1)
Corporate Support & Adjustments	235 (1)
Total	440

Note 1: Costs are rounded to the nearest $5M.

1.2.4. Station Performance Assumptions

In developing an estimate of the performance of the Darlington units in the post-refurbishment period, a number of factors were considered including historical performance. Recent (5-yr) capability factor performance has been excellent, in the 85%-94% range, with the low year of 85% in 2009 coinciding with the periodic planned station shutdown for the vacuum building outage. Recent planned outage performance and forced loss rates (FLR) have also been very good.

Factors considered in forecasting post-refurbishment performance include the following:

- Lifetime performance of the Darlington station has been 84.5% capability factor; last 10 years' performance has averaged 89% and last 5 years' performance has averaged 90.7%.
- As part of the assessment for refurbishment, detailed plant condition assessments (PCAs) were completed. These PCAs have been reviewed and plans put in place to address findings, either pre-refurbishment, during refurbishment or post-refurbishment.
- Technical knowledge of equipment reliability issues, including component degradation mechanisms in CANDU reactors and the balance of plant, has improved dramatically over the past 5 decades of the CANDU program, leading to some confidence that there will be fewer unexpected degradation mechanisms uncovered in the future.

These issues were discussed in meetings with senior station personnel and in discussions with the Refurbishment Project Team. The consensus was to assume a reference annual capacity factor of 88% but to analyze over a broad range as shown in Table C7:

Table C7: Performance Assumptions Used in the Updated Economic Assessment

Performance Factor	High Confidence	Medium Confidence	Low Confidence
Gross Capability Factor (%)	83%	**88%**	93%

The 88% capability factor (medium confidence) is slightly lower than Darlington's average performance for last 10 years, which was 89%. It is considered conservative given the station's performance of 90.7% over the last 5 years. The low end performance of 83% (which is 1.5% lower than the station's since-in-service performance of 84.5%) could result, for example, from a failure to effectively implement the Integrated Aging Management Program (IAMP) and/or an inability to maintain a 3-year outage cycle. It would also allow for large outages for major equipment maintenance during the post-refurbishment period, if necessary. The high end performance of 93% could be achieved if Darlington were to sustain 1st or 2nd quartile INPO performance, funding levels are maintained, the IAMP is effectively implemented, and Human Performance is maintained.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

2.0 Results

The LUEC was calculated using the above assumptions and alternative scenarios and sensitivity analyses were run on the low/high (pessimistic/optimistic) assumptions in order to assess the sensitivity of the results to the various input variables. These results are presented below.

2.1. Levelized Unit Energy Costs

The project's economics and the BCS have been updated based on the latest information. The updated analysis also indicates 70%- 90% confidence that the LUEC for Darlington Refurbishment will be in the range 7.6 ¢/kWh to 8.1 ¢/kWh (2013$) and very high confidence that the LUEC will be less than 8.7 ¢/kWh (2013$). Therefore, management continues to have high confidence that the LUEC of refurbishing and continuing to operate the Darlington units for a further 30 years, as shown in Figure C3, would be less than 8 ¢/kWh (2009$), as provided in November 2009, which is equivalent to 8.7¢/kWh (2013$)).

Figure C3: Levelized Unit Energy Cost Confidence Ranges

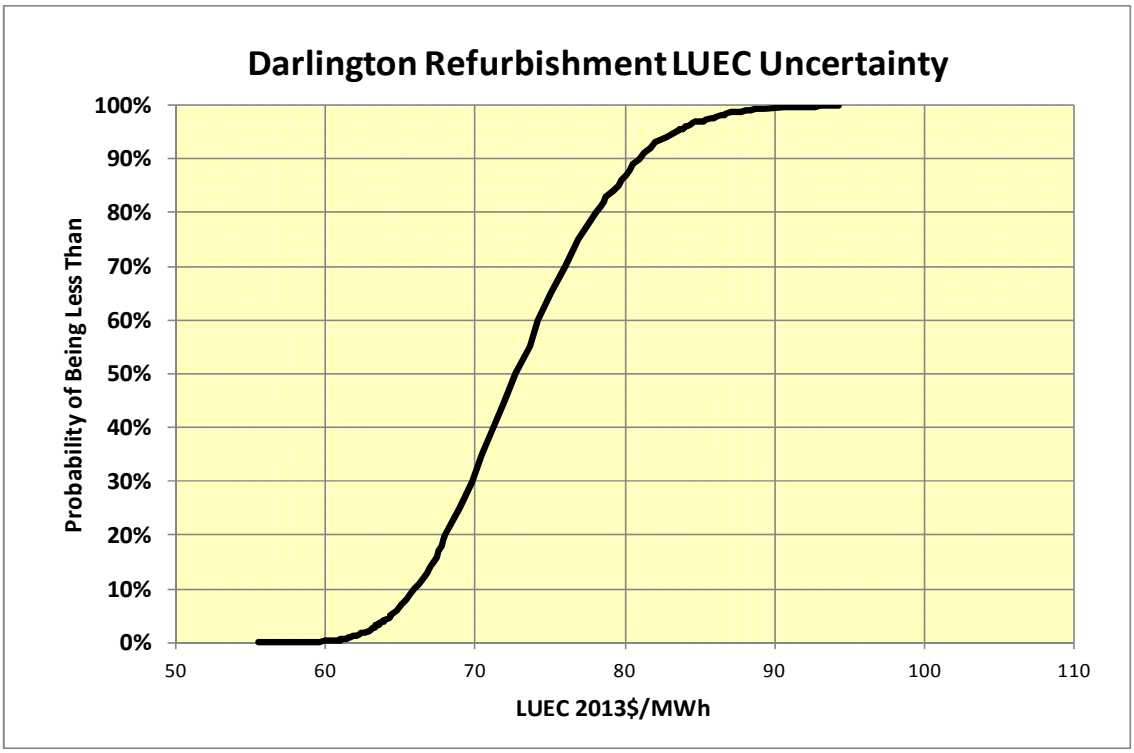

Figure C4 shows the percentage contribution of the major components which make up the DRP LUEC. These are: 1) Direct Station OM&A and Fuel costs; 2) Station Support provided by both Nuclear and Corporate Support groups; 3) the DRP itself, and; 4) fixed Corporate Overheads for pension and OPEB.

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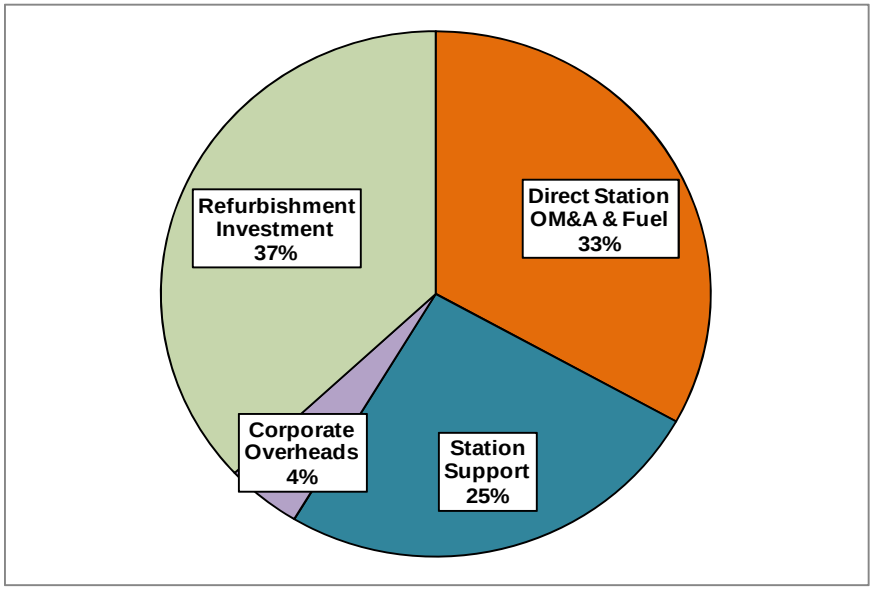
As shown in Figure C4, the DRP contributes approximately 40% to the total, while the post-refurbishment costs contribute approximately 60% to the LUEC.

Figure C4: Darlington Refurbishment Levelized Unit Energy Cost – Major Components



2.2. Sensitivity of Results to Changes in Input Assumptions

As documented in Section 1, this Updated Economic Assessment includes a large number of assumptions regarding refurbishment costs and durations, going forward operating and sustaining investment costs and operating performance. For each of these factors, ranges were developed and sensitivity analyses were performed at the low and high ends of these ranges for each of the key input factors. Figure C5 shows the results of the sensitivity analysis. The following helps to understand the impacts of specific changes in underlying assumptions on the magnitude of the Darlington Refurbishment LUEC.

- A $500 Million increase/decrease in DRP costs increases/reduces LUEC by 0.15 ¢/kWh
- An increase in DRP duration of 12 months would increase LUEC by approximately 0.5 ¢/kWh while a 6 month decrease would decrease LUEC by approximately 0.25 ¢/kWh.
- A 5% increase in capacity factor (from 88% to 93%) lowers LUEC by 0.35 ¢/kWh while a 5% decrease in capacity factor (from 88% to 83%) increases LUEC by 0.4 ¢/kWh
- Each $100 Million increase/decrease in post-refurbishment annual costs increases/reduces LUEC by 0.4 ¢/kWh

These impacts on LUEC highlight the importance of managing the DRP within its current high confidence cost and schedule and of addressing the key risks to costs and performance post-refurbishment.

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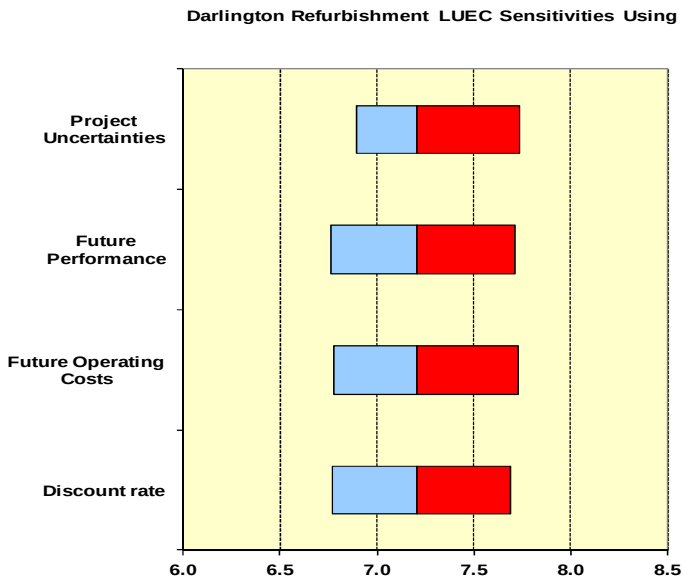
DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX C – SUMMARY OF ECONOMIC ASSESSMENT

Figure C5: Sensitivity Analysis – Darlington LUEC

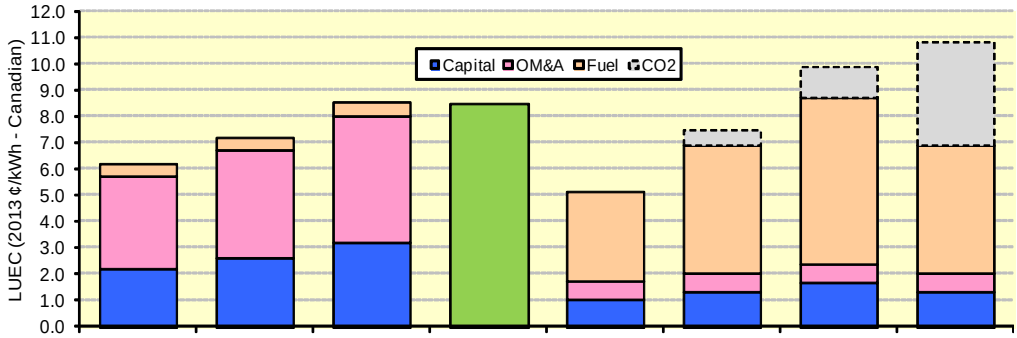


Assumptions	Lower	Median	Upper
Project Uncertainties			
Refurb Cost (2013$)	-10%	$8.2B	15%
Refurb Duration (months)	-2 mths	36 mths	+5 mths
Future Performance			
ACF (%)	-5%	88%	5%
Life of Refurb Units (yrs)	+2 yrs	30 yrs	-2 yrs
Future Operating Costs			
Base OM&A ($M)	-5%	270	10%
Outage OM&A ($M)	-10%	115	10%
Sustaining Projects ($M)	-10%	135	10%
Nuclear Support ($M)	-5%	215	15%
Corp Support Incr ($M)	-15%	235	10%
Fuel ($/MWh)	-15%	5	15%
Discount Rate	-1%	7%	+1%

2.3. Comparisons to Other Options

A significant input into the decision-making process on the economic viability of the Darlington Refurbishment is a comparison to the LUECs of other options competing with this project. Figure C6 presents such a comparison.

Figure C6: Levelized Unit Energy Costs for Darlington Refurbishment and Comparators



Assumptions:	Darlington Refurb			Bruce 1/2	New CCGT			
Scenarios	Low	Median	High	-	Low	Median	High	Carbon-free based on Median
Overnight capital (C$B)	7.5	8.2	9.2	4.8 (incl. IDC)	3.4	4.1	4.9	4.1
Overnight capital (C$/kW)	2,100	2,300	2,600	N/A	950	1,150	1,400	1,150
Annual Fixed Operating Cost (C$M)	885	965	1,075	N/A	15	15	15	15
Annual Capacity Factor (%)	93%	88%	83%	85% (est.)	93%	88%	83%	88%
Gas Price (C$/mmBtu @ Henry Hub)					4	6	8	6
CO2 Offset Cost (C$/tonne)					0	15	30	100

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The economics of refurbishing the Darlington Station are comparable with Combined Cycle Gas Turbines (CCGT) at a median long-term forecast of gas prices of approximately $6/mm BTU and assuming carbon prices of $15 - $30/tonne. At median gas prices and $15/tonne carbon prices, the LUEC for CCGT is estimated at 7.5¢/kWh (2013$), with the carbon pricing accounting for 0.6 ¢/kWh of that LUEC. At low long-term gas prices of about $4/mm BTU and zero carbon prices, the price of CCGT would be more favourable than the price for refurbishing the Darlington Station. It should be noted that the costs to make gas-fired generation carbon-free (i.e. carbon sequestration), is estimated to be the equivalent of a $100/tonne carbon price, which would add 4 ¢/kWh to the LUEC of a CCGT.

While CCGTs have shorter execution lead times, lower up-front investment, lower ongoing operations, maintenance and administrative costs, there are significant uncertainties with regards to future gas prices and the potential implementation of carbon prices. There are other considerations which contribute to and support the favourable economic assessment for refurbishing the Darlington Station. These include:

- The use of an existing generation site with a proven environmental record and a supportive host community avoids the additional costs to OPG (and ratepayers) of site selection, securing environmental approvals and development of host community support at an unproven green or brown field site. It also avoids the additional costs to ratepayers of establishing a new transmission infrastructure.
- The economic benefits of refurbishing the Darlington Station, in terms of direct, indirect and induced job creation, are anticipated to be greater than for CCGT. It is estimated that approximately 2,000 direct jobs are created during the Program Definition and Execution Phases. Continued Operation of the Darlington Station (post-refurbishment) will maintain the same level of employment as is currently associated with the Darlington Station for an additional 30 years. Economic impact studies indicate that post-refurbishment operations of the Darlington Station will result in approximately 5,700 resident jobs in Durham Region (direct, indirect and induced).

Management's assessment is that the refurbishment of the Darlington Station would also be competitive with the recently completed refurbishment of Bruce Units 1 and 2. Based on the Auditor General's 2007 assessment of the price being received by Bruce Power for the output of Bruce Units 1 and 2, management has estimated the LUEC for those units at approximately 8.5 ¢/kWh (2013$).

In summary, the Darlington Refurbishment Project's median confidence LUEC is approximately 7 – 7.5 ¢/kWh, which compares favourably with median confidence CCGT LUECs and with the estimated LUEC of Bruce Units 1 & 2.

3.0 Conclusions of Economic Assessment

The forecast LUEC for Darlington Refurbishment is competitive economically with other available generation options, including Combined Cycle Gas. There is merit to continuing the Definition Phase work and implementing the project based on current economic comparisons.

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DARLINGTON REFURBISHMENT BUSINESS CASE SUMMARY
APPENDIX D – SUMMARY OF RELEASE 4C EXPENDITURES

1.0 Summary of 2014 Expenditures

The expected spend of $788M in 2014 includes $680M of new Release 4c funding plus a carry forward of $108M from 2012 and 2013. The total cumulative funds released to the project, including this release, will total $1,608 Million including capitalized interest, escalation, and contingencies.

$M		LTD 2013	2014	2014 Deliverables/Activities
Major Project Work	Retube & Feeder Replacement	229	215	Design, fabrication, and testing of R&FR tooling and mock-ups to determine project durations for RFR activities, as well as procurement of long lead materials
	Fuel Handling		5	Contract award for Fuel Handling main trolley, power track and auxiliaries; commencement of engineering and procurement
	Defueling	4	4	Continued engineering and procurement activities
	Steam Generators		4	Commencement of engineering and procurement activities related to contract award in late 2013
	Turbine Generators	20	26	Negotiations and contract award to Engineering and Construction vendor, as well as continued progress on engineering and procurement of long lead materials
	Balance of Plant	10	65	Award contracts and execution of pre-requisite work and scope defining inspections, as well as continued execution of safety improvement projects (e.g. Third Emergency Power Generator, Containment Filtered Venting System). Also includes Shutdown Safety Computer Replacement and Vault Cooler projects
	Islanding	3	18	Unit islanding modifications including Heavy Water System modifications and Bulkhead
	System Shutdown	0	12	Continued engineering for system shutdown, as well as planning for in station infrastructure
	Holt Road Improvements	3	14	Reconstruction of the Holt Road interchange to improve traffic flow to the project and in order to not impact traffic flows in the adjoining communities
Operations & Maintenance Support		13	16	Pre-requisite field work and continued planning activities related to unit turnover
Facilities & Infrastructure Projects		201	147	Further progress on infrastructure required for project and second station life, including OSB Refurbishment, D2O Storage Facility, Water & Sewer, Electrical Upgrades, RFR Annex, Refurb Project Office and Contractor Facility.
OPG Oversight and Program Support		300	134	Engineering deliverables including completion of MDRs, progression of detailed engineering, Integrated Improvement Plan (IIP) and Global Assessment Report (GAR) to support the 10 year license application for Darlington. Planning deliverables including scope finalization and further development of the project RQE to be issued by October 2015. Also includes project oversight of major contracts/ project bundles and program overheads
Other	Contingency	5	63	Includes allowance for discrete items, cost estimate uncertainty, as well as released contingency for infrastructure projects
	Interest	32	52	As spending continues, interest carrying costs increase
	Escalation	0	14	Conversion to 2014$
Totals		**820**	**788**	

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AMPCO Interrogatory #86

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-8 Attachment 1 Page 31

Preamble: The evidence states "Resource Management/Bridging Between Units - Contingency is provided to retain critical trades and leadership resources between periods of specific resource demand. The risk is that due to the current un-lapped Unit 2 schedule, after the majority of the field work is complete on Unit 2, and prior to their requirement for Unit 3, key resources might leave OPG and not return to execute Unit 3. This could result in re-training of staff and reduced opportunity for performance improvement, as well as the potential loss of 'project momentum'. OPG will mitigate this by assigning certain critical resources to Nuclear Project portfolio work, Fleet Unit Outage work, or Darlington 'Life Extension' works during this period. In the unlikely event where this is not possible, OPG has included $50M in the contingency estimate to retain these resources. This risk is the focus of continual effort in order to minimize the impact on the project.

a) Please confirm the $50 million contingency is allocated to Unit 2. If not, please provide the allocation of the $50 million contingency.

b) Please explain how the $50 million was calculated.

c) Please provide the amount of idle time to date for the DRP project.

d) Please discuss the amount spent to date to "retain resources".

e) Please discuss if this is retention strategy is a typical practice in other nuclear refurbishment projects.

Response

a) This is not confirmed. The $50M contingency for resource management/bridging between units is not allocated to Unit 2. The decision was made to allocate this amount equally to the four units; i.e. $12.5 million has been allocated to each unit.

b) Please refer to Ex. L-4.3-1 Staff 067.

c) Other than normal project issues where trade labour has been directed to stand down or to standby because of, for example, construction schedule conflicts and/or emerging station priorities, there has been no idle time spent to date.

d) No amount has been spent to date to retain resources for future needs or as part of a risk mitigation strategy.

e) OPG is not aware of resource retention strategies employed on other nuclear projects. The DRP plan to refurbish multiple units in a serial manner (with partial overlaps of the last three units) is relatively unique. When only one unit is being refurbished (e.g. Pt. Lepreau) or two units are being done effectively in parallel (i.e. Bruce Units 1 and 2), the need for resource management/bridging between units would not arise.

AMPCO Interrogatory #87

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-8 Attachment 2 Page 29

Preamble: Modus/Burns McDonnell states "The DR Team nonetheless has high confidence in the extent of the estimates it has prepared for RQE and are all-inclusive of what could reasonably be identified for staffing at this time. We believe that there is some risk that OPG will not meet its proposed plan in this area as the job functions and specific roles within the functional groups are not as defined as they could be. Additionally, the pace of the proposed ramp-up of the DR Team's staff over the next several months is very aggressive and will be very difficult to meet. In order to meet the plan, the DR Team would have to increase from 770 to just over 900 (17%) staff in less than 3 months. Moreover, the DR Team's projections for 2016 show a planned functional expenditure of $120M, excluding Operations & Maintenance and Engineering, which would equate to nearly 70% of the cost of these functions for the last 5+ years. The DR Team has been chronically under-spent during the Definition Phase, and missing these major ramp-up dates will further impact the accuracy of the team's staffing forecasts and potentially the status of preparatory work for breaker open.

a) How has OPG addressed the above concerns expressed by Modus/Burns McDonnell?

b) Please explain whether OPG was able to meet this plan staffing target or if OPG has put in place another viable option/plan.

c) Does OPG have experience in meeting staff increases of this magnitude in a short timeframe? Please explain and provide details.

d) Please provide details of the proposed ramp-up and the make-up of the staff compliment.

e) Please explain why OPG has been chronically under-spent during the Definition Phase, and missing major ramp-up dates?

f) Please discuss the current impact on the accuracy of the team's staffing forecasts and potentially the status of preparatory work for breaker open.

g) Are all of the functional roles and responsibilities/accountabilities been assigned for this work? If not, why not?

h) How are these functional roles being integrated with other major work bundle contractors?

Response

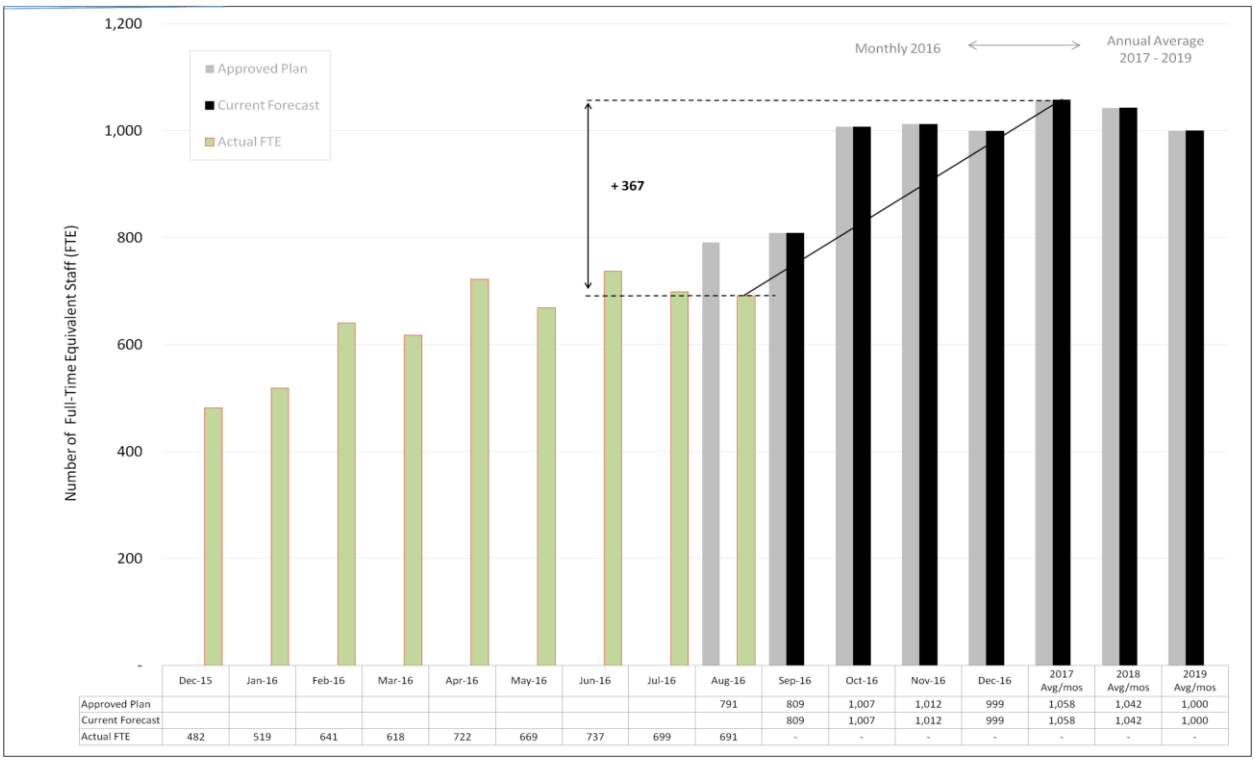
a) The project has a centralized Resource Management Team looking after all resource planning initiatives for the project, including advancing hiring and working with the recruitment organization to resource staff as efficiently as possible. In addition, OPG's recruitment organization has made several process improvements with regards to hiring, all aimed at helping the project to resource qualified candidates as quickly as possible.

b) The project continues to staff positions in a number of ways to ensure work is completed. This includes the use of augmented staff, utilization of Owner Support Services and managed task contracts, as well as movement of staff from other parts of OPG as needed and where work is emergent.

c) OPG has not had to staff to the levels required for the Darlington Refurbishment Program (DRP) in some time. Given the complexity of the DRP and the large numbers of staff required, OPG has recognized this and put in place process improvements and a dedicated team to advance all hiring.

d) The following chart (Figure 1) shows the current OPG resource demand (as of August month end, 2016) and the expected ramp-up over the next four months. The chart includes all resources working on and funded by the DRP including those that are provided by the station and or other business units, such as Corporate Finance or Supply Chain. A hiring campaign, as noted in part a), is underway to ensure that the resources are available when needed and to eliminate any resource shortfalls. Ramp-up of staff is underway via the use of station staff including Fuel Handling and Operations staff, and Radiation Protection staff that will transfer over to Refurbishment as required. In addition, hiring is underway for the Project Office, Construction, Engineering, and Project Planning & Controls and in the Project Management job categories.

Figure 1 - DRP Staff Demand Curve and Ramp-up (as at end of August 2016)



	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	2017 Avg/mos	2018 Avg/mos	2019 Avg/mos
Approved Plan									791	809	1,007	1,012	999	1,058	1,042	1,000
Current Forecast										809	1,007	1,012	999	1,058	1,042	1,000
Actual FTE	482	519	641	618	722	669	737	699	691	-	-	-	-	-	-	-

e) Through the Definition Phase, OPG was unable to staff up to its planned levels and as a result had to rely on other service providers to meet the work demands, as noted in part b). In recognition of this, as noted in part a), OPG took actions to establish a recruitment program and put in place a centralized Resource Management Team to help the organization meet its staffing needs.

f) The new Resource Management Team is now accountable for 1) assessing the total staff demand, and 2) forecasting the timing of resource on boarding. This will continue to be monitored throughout the project and through monthly reporting. This shortfall in resources has put challenges on the organization; however, through the use of augment staff, contracted services, and other OPG staff, all of the deliverables to ensure readiness to commence Unit 2 refurbishment were met.

g) Yes, all functional roles and responsibilities for the project have been assigned. Functional Management Plans provide details about the work being performed.

h) All functional roles and the support provided to the major work bundles are detailed in the respective Functional Management Plan.

AMPCO Interrogatory #88

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-8 Attachment 2 page 30

Preamble: Modus/Burns McDonnell states "The commitment from the NPET to further rationalize and organize the functions on the basis of a division of responsibility matrix ("DOR") has been held over to the Readiness to Execute phase. The DR Team committed to putting a DOR in place that defines each function's accountability and responsibility by early 1Q 2016, which in turn should result in optimizing the organization. This DOR is intended to also define roles and integration responsibilities between the DR Team, the contractors and the Station. Such an undertaking will certainly require some shake-out, which the team intends to do during the Readiness to Execute phase."

a) Please provide the current status of the commitment from the NPET to further rationalize and organize the functions on the basis of a division of responsibility matrix ("DOR")?

b) Please provide the latest version of the DOR.

Response

a) The commitment has been met. The DOR was produced in Q1 of 2016. It was in place for the Ready to Execute phase prior to Breaker Open for Unit 2.

b) The current version, adapted for the Execution Phase (Post-Breaker Open) is provided in Attachment 1.

Refurbishment Project – Execution "Division of Responsibilities" Activities – Post Breaker Open (Page 1)

Vendors	Project Managers	Construction Oversight	Project Office	Ops & Mtce
Support and Monitoring of Work Executed	Support and Monitoring of Work Executed	Support and Monitoring of Work Executed	Support and Monitoring of Work Executed	Support and Monitoring of Work Executed
Safety / Quality / Work Practices • Support and Monitoring of Work Executed • Safety / Quality / Work Practices • Perform Paired observations with OPG Leaders • Maintain sufficient and competent Supervisory field presence • Manage, coach and correct staff performance/compliance to key OPG and Vendor Programs including Hu, Safety, FME, RP and Quality. • Ensure Sub Contractor Quality & Oversight Plans are in place and maintain oversight of their effectiveness • Ensure staff are qualified and their equivalency with OPG requirements established • Ensure work is adequately staffed and onboarding requirements are met • **Perform paired observations with OPG to demonstrate coaching is to the standard** **Progress of Work** • Maintain competent field/trade supervision to manage successful completion of scheduled work per the milestones • **Provide timely notification of schedule progress/delays or other adverse conditions through established protocols with PCC (including work reports** • Submit CARs/SCRs as required • Manage communications with OPG/TSSA/Other Vendors to ensure progress of work • Provision of tools, consumables and escorts as require for their work • Provide validation of installed commodities • Commissioning field support • **Ownership of the Vault rests with the Joint Venture who must produce a plan for all work completed by any party in the vault when the airlock doors are available to be opened. This includes the accountability to actively participate in work planning and proactively manage the work per the plan to avoid conflicts.** ***(enshrined in a vault integration plan document)***	**Safety / Quality / Work Practices** • Project Director/Manager frequent observations on job sites with Engineers constant presence • Monitor and correct Vendor Hu and Quality performance (onus to ensure it happens) • Review Construction Field Reports for performance improvements, ensure CARs/SCRs/corrective actions processed/administered as required. **This includes effectiveness reviews.** • Perform paired observations with vendors to have vendor demonstrate they are coaching to the standard • **Monitor compliance to vendor and sub(s) Contractor Quality Plans in tandem with QM group when QM is not at the job site, again coaching to the standard** **Progress of Work** • Execute work to meet milestones and provide recovery plans as appropriate. • Supervisor of the Work / Intervene work activities as required • SPOC for communications and direction to vendor • Maintain oversight and direction on issue resolution • Interface with PCC & Scheduling Team • Acquire E-FIN as required via PCC • Act as main OPG interface for issues management. Seek support from Construction \ Ops \ Mtce as required to ensure timely and consistent response • Accountable to escalate for resolution • Commissioning support – Field Engineers and Plans/Spec	**Safety / Quality / Work Practices** • Perform paired observations with vendors to have vendor demonstrate they are coaching to the standard • Monitor Vendor trades performance/compliance to key OPG and Vendor Programs including Hu, Safety and FME • Provide enhanced oversight for high risk jobs (FOAK , FIAW) • Intervene work activities where field observations deem appropriate • **Sign-off OPG witness/verification/hold points as required** • Station interface for Hu, Safety and Conduct of Maintenance **Progress of Work** • Assist Vendors in removing road blocks/issue resolutions. • ***SPOC for resolution for emergent and immediate facility infrastructure and trades issues*** • **First point of contact for vendor field supervisors (10-30-60)** • Interface with PCC & Scheduling team • Issue Daily Construction Field Reports. File observations and SCR where	**Safety / Quality / Work Practices** • Safety / Quality / Work Practices • Communicate expectations for PCC behaviours and coach as required • Train PCC participants **Progress of Work** • Establish and maintain PCC run stream including roles, accountabilities, expectations, authority, daily/weekly process, calls, meetings, reporting • **Unit Manager integrates and manages overall compliance and execution of schedule** • Coordination and Communication with the station • Milestone validation, document control and validation • Schedule commissioning activities • ***Overarching planning SATM coordination and footprint logistics***	**Safety / Quality / Work Practices** • Monitor conduct of maintenance & operations for PWU staff • Monitor use of Event Free Tools / Hu Performance for Ops & Mtce & RP /Chem/Envn for PWU staff • **Perform in-service monitoring for operating/chemistry/environment parameters** • Perform and support Paired Observations with both PWU and Assigned contract staff • **SCR only if OPG program needs correction or incident triggers a significant SCR, HULL for all** • Call and conduct ODM/ SIMS as required **Progress of Work** • Maintain field supervision to manage successful completion of scheduled work including D1621 • Execute schedule O&M scheduled tasks per schedule • Report/address schedule progress/delays through establish protocols with PCC. Validate task completion of PWU work • Staff Work Control Area • Assist/perform plant alignment activities (permitry, testing, lay-up, RTS) • Coordinate and direct RTS field work as required • Ensure completion and issuance of required RCHP documentation • Commissioning lead and acceptance
Schedule	Schedule	Schedule	Schedule	Schedule
• **Vendor leadership to participate in PCC, T-meetings and W-meetings** • Initiate and lead discussions of on schedule and work program • **Forecast schedule well in advance** • **Ensure percentage complete is accurate at all times** • **Any change to a schedule that has an impact to another work group or to a milestone must be approved well in advance by the Project Manager. Impacts of schedule changes must be flagged to the PM by the Project Office.** • Submit changes to schedule for consideration authorized by OPG PM. • Prepare and initiate recovery plans as required, ensuring required consideration for support from other workgroups including OPG work groups. • Submit CCD and AFS as required • Prepare schedule logic and forecast schedule	• PCC and W-Meeting participation • Approve Vendor's forecasted schedule • **Approve schedule** • Next Week's schedule review • Logic review and acceptance. • CCD , MAFS, AFS acceptance from vendor • (validate progress)	• Daily monitoring of schedule. Review and align resource to support oversight and coordination activities. • Assist with completion validation eg spot check complete in the field.	• Prepare and publish schedule. • Maintain standards and ensure uniformity across bundles. • Perform Integrated Schedule Analysis including critical path, total float, low float, contingency management, resource scenarios, crew schedule management, coding integrity • **PCC Manager determines priority of work in the event of cross-bundle schedule conflicts due to changes in schedule** • Maintain IT tools and all projects – OMS, ROOMS, ATK, Work List Tool, Work Management Website, Station/Refurbishment Resource Balance Tool Kit	• Participate in PCC and W-Meeting • Perform reactor safety review of schedule • Utilize FIN team to protect schedule for their own work • Maintain oversight and execute permitry strategy • Maintain and execute work protection strategy • Perform Ops scripting • Approve CCD , MAFS, AFS
Work Readiness	Work Readiness	Work Readiness	Work Readiness	Work Readiness
T-6 / T-3 Months • Assign crew to Perform comprehensive walkdown of field packages looking for barriers preventing execution using assigned construction staff • Lead and conduct look ahead/challenge meetings prior to work execution • Complete all outstanding actions to ensure work is ready for execution • Ensure Sub(s) Contractor Quality & Oversight Plans are developed and in place • Ensure resource and staffing plans are developed, including skill of craft and supervisor and job specific training **Walkdown W-4 to W-0 Weeks** • Assign crew performing work the walkdown duties • Ensure walkdowns performed per standard. For example: Pressure Boundary, Work Protection, Hoisting and Rigging, FME, SATM, scaffolding ,Material readiness, work assignments/qualification requirements and provision of tools. • Document findings and adjust work package accordingly.	**T-6 / T-3 Months** • Participate in the look ahead teams and challenge meetings/critical evolution meetings. • Communicate with Vendor to ensure they participate in look ahead, walk downs & challenge meetings. • Ensure finding are documented and action assignment/resolution. **Walkdown W-4 to W-0 Weeks** • Ensure vendor walkdowns performed and documented. Participate in walkdown as requested • Seek support as required and adjust work package accordingly • Ensure vendor and OPG resourcing plans support work execution • Sole authority to ensure work program readiness and risk mitigation	**T-6 / T-3 Months** • Lead vendor team on comprehensive walkdown looking for barriers preventing execution. • Oversee potentially impactful field work (high impact) • Facilitate Vendor Led challenge meetings. • Review of Issues Tracking File of completed and open actions. • Document any new findings and inform PM • Validate vendor staffing plan including qualifications. **Walkdown W-4 to W-0 Weeks** • *Perform walkdown of tasks just prior to execution with Vendor Execution Team enduring no barriers to prevent execution of the task and work is field-ready to execute. Recommend to proceed/reject to PM* • *Conduct constructability challenge meetings on PM's behalf. Provide recommendations on work program readiness*	• Perform overall window schedule integration between all work groups. • Manages issues and holds resolution processes including re-scheduling work in collaboration with PM • Manage data integrity • *Ensures that CCD, MAFS, SAFS and RTS logic (from vendors and OPG) is correct for each window/mod/non-mod and has been reviewed and accepted by Operations and the RTS Manager* • Ensures regulatory and operations approvals are identified and will be obtained to support the schedule as planned • Ensures all window execution groups have provided ALARA plans to support the window work • Ensures handoffs for window lead-in and lead-out are defined and understood by accountable parties	**T-6 / T-3 Months** • Review and execute Level 3 schedule for TPAR Flowsheet and PSC requirements. • Participate in the look ahead teams and challenge meetings/critical evolution meetings. • Ensure scheduling and coordinating of Mod AFS, System AFS and RCHP release meetings. • Co-ordinate with CNSC to required transitions through regulatory RCHP's via Quality Management group • Perform assessing/planning of Ops, Mtce, RP/Chem/Envn activities • Provide technical support for O&M field execution of SDLU TMods and RCHP deliverables. Follow up with engineering for intent field issues. **Walkdown W-4 to W-0 Weeks** • Perform walkdown of O&M tasks required. Participate in Vendor task walkdown as requested/required (permitry, materials, REP, etc)

Refurbishment Project – Execution "Division of Responsibilities" Activities – Post Breaker Open (Page 2)

Vendors	Project Managers	Construction Oversight	Project Office	Ops & Mtce
Scope Management	**Scope Management**	**Scope Management**	**Scope Management**	**Scope Management**
• Scope change communicated/concurred by OPG • Attend scope review meetings • Submit Field Changes as required • Adhere to COIR. Check with PM when uncertain • Timely identification and submission of PCA\PCP\CTP to project bundle • Submit recommendations for overtime and schedule changes	• Engineering review for rapid field changes • Participate in scope review meetings • Approve OT and shift schedule changes. Consult construction oversight, operations for support • Accountable for Construction Completion Declarations (CCD) • Manage submission of PCA\PCP\CTP to project bundle • Review and facilitate non conformances • Manage COIR. Consult/direct vendor as required	• Provide input to vendor on field change submittals • Recommend/review OT and shift schedule changes to PM for both vendor and OPG support groups	• Scope Management • Conduct New Work Screening, implement PSRB decisions, scope transfers/changes • Perform scope growth reporting and trending (WO, TASK, PCD's, PCA's, Change Orders, DSR's, Project #'s) • Conduct U2 Work Package Scope Management • Maintain standards and ensure uniformity across bundles.	• Participate in new work meetings and scope review meetings • Manage scope growth (corrective) resulting from preventive maintenance tasks • Review scope changes for impacts on RCHP plans
Risk Management	**Risk Management**	**Risk Management**	**Risk Management**	**Risk Management**
• Conduct assessing and preps for contingency items as required • Maintain/manage record of Witness, verification and hold points • Submit and execute environmental and wastes plans • Submit plan and monitor "laid-up" unit systems. • CNSC reporting requirements are communicated to OPG in timely manner. • Manage VENDM backlogs. Ensure traceability to COIR. • Submit and process CARs / SCRs as required. Ensure corrective actions drive effective resolution.	• Risk Register Review / Maintenance of Risk / Use of Contingency • Review Materials demand/issues per scheduled/planned work • Contingency readiness for breakage/unanticipated findings – tied to risk register • Maintain required communications with CSNC on IIP and other areas of interest via the Quality Management group. • Maintain POP (Project Oversight Plan) • Review/Request CARs/SCRs as required. Ensure corrective actions drive effective resolution. • Accept vendor envirn, chemistry and lay-up plans; ensure compliance	• Proactive identification and management of field risk associated with Vendor activities • Risk Rank Projects T-6 to T-3 Months prior to segment (FOAK, FIAW) • Comprehensive review of all task requirements. • Evaluate Vendor knowledge/understanding with execution of the MOD. • Confirm PM has documented any new risk findings • SPOC for JHSC, Union Halls, Stewards, EPSCA, CPAA, Bargaining, labour and MOL issues.	• Assist project teams in pursuing adequate resolution on risks including contingency planning/expectations/review/acceptance of proposed mitigation plans • Ensure contingency plans are in place and acceptable and ready for the execution window/risk time period • Central SPOC for integrated risk resolution and robust risk mitigation plans • Maintain standards and ensure uniformity across bundles.	• Conduct assessing and preps for contingency items as required • Provide SME staff to project bundles as required to assist with work plan development & reviews. • Monitor RCHP plans to identify risks, update risk registry and develop dispositions or mitigating actions • Provide standards and validate vendor chemistry, environment and waste plans. • Execute risk mitigation actions as identified • SPOC for MOE with the station
Cost Management	**Cost Management**	**Cost Management**	**Cost Management**	**Cost Management**
• Reconcile OnCore time processing daily • Submit cost and schedule forecasting • Perform commodity tracking • Minimize cost/increase value for Implement lessons learned for future units • Monitor and maintain resource plans. Submit hiring requests to PM as required.**Validation of % complete in the field (Construction validates on PMs behalf)** • **Provide input on cost metrics** • **Need to allocate accruals correctly to level of effort vs. physical work that is earned** • **CTPs for funding release need to be excluded from performance metrics**	• OnCore processing/rejection/rework • Accountable for Contract Management • Review and process vendor cost and schedule forecasting • Monitor resource plans. Submit hiring requests to Function Manager as required • Using Schedule , EV and cost metrics, remain within baseline schedule/cost funding envelope • Request contingency per approved process and limits • Develop materials in accordance with CCB and Gated process. • Monitor and maintain resource plans • Participate in P&C processes to monitor and control budgets • Implement lessons learned for future units	• Assist with completion validation. % complete in the field. • Perform periodic validation on resource to cost. • Monitor and maintain resource plans • Implement lessons learned for future units	• **None**	• Monitor and maintain resource plans • Implement lessons learned for future units for their own work • Participate in P&C meetings and processes to monitor and control budgets

AMPCO Interrogatory #89

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-8 Attachment 2 page 30

Preamble: Modus/Burns McDonnell states "While the DR Team's goal for RQE was to identify the outer cost limit for the functions, BMcD/Modus is more concerned that the DR Team operate efficiently, have highly qualified and skilled resources, and actively manage the field work during the Execution Phase. One of the primary complaints from OPG's contractors is the company's track record of having too many decision-makers involved, particularly when problems arise. Thus, the risk to the Project's cost from a poorly defined functional team extend well beyond the cost of the team itself."

a) Please explain what BMcD/Modus is referring to in stating the company's track record of having too many decision-makers involved, particularly when problems arise.

b) Please explain how OPG has addressed the issue of having too many decision-makers involved.

c) As problems arise, please explain the difference in how they will be managed.

d) How has the DOR been integrated in the major work bundles to ensure an efficient process to resolve problems on a timely basis to ensure that work continues without jeopardizing schedules and costs?

Response

a) The quote is taken from an oversight report provided by BMcD/Modus to the OPG Board of Directors. This reference pertains to the fact that while work is being performed in an operating plant, the contractors must respond to the needs and request of the Project Manager and/or his/her team members in executing a project, as well as the Engineering organization, which is responsible for overseeing design decisions, and/or Station Operations staff (i.e., Shift Managers), who, due to station operational priorities, may also provide direction to a contractor.

The management system for the nuclear industry is complex with many checks and balances when a unit is in operation and decisions often require input from multiple

sources. This can be confusing to contractors accustomed to working within a less complex decision-making environment.

b) Prior to October 15, 2016, much of the work being done for the Darlington Refurbishment Program (DRP) was within the decision-making framework of an operating station. During the refurbishment execution of Unit 2, which commenced on October 15, 2016, the control of the unit, and the decision making process, is turned over to the DRP team. Additionally, OPG has developed a Division of Responsibilities Matrix (DOR) and a Work Progression Escalation Process model which explains the decision flow and decision-making accountabilities for the project execution group in accordance with the DOR.

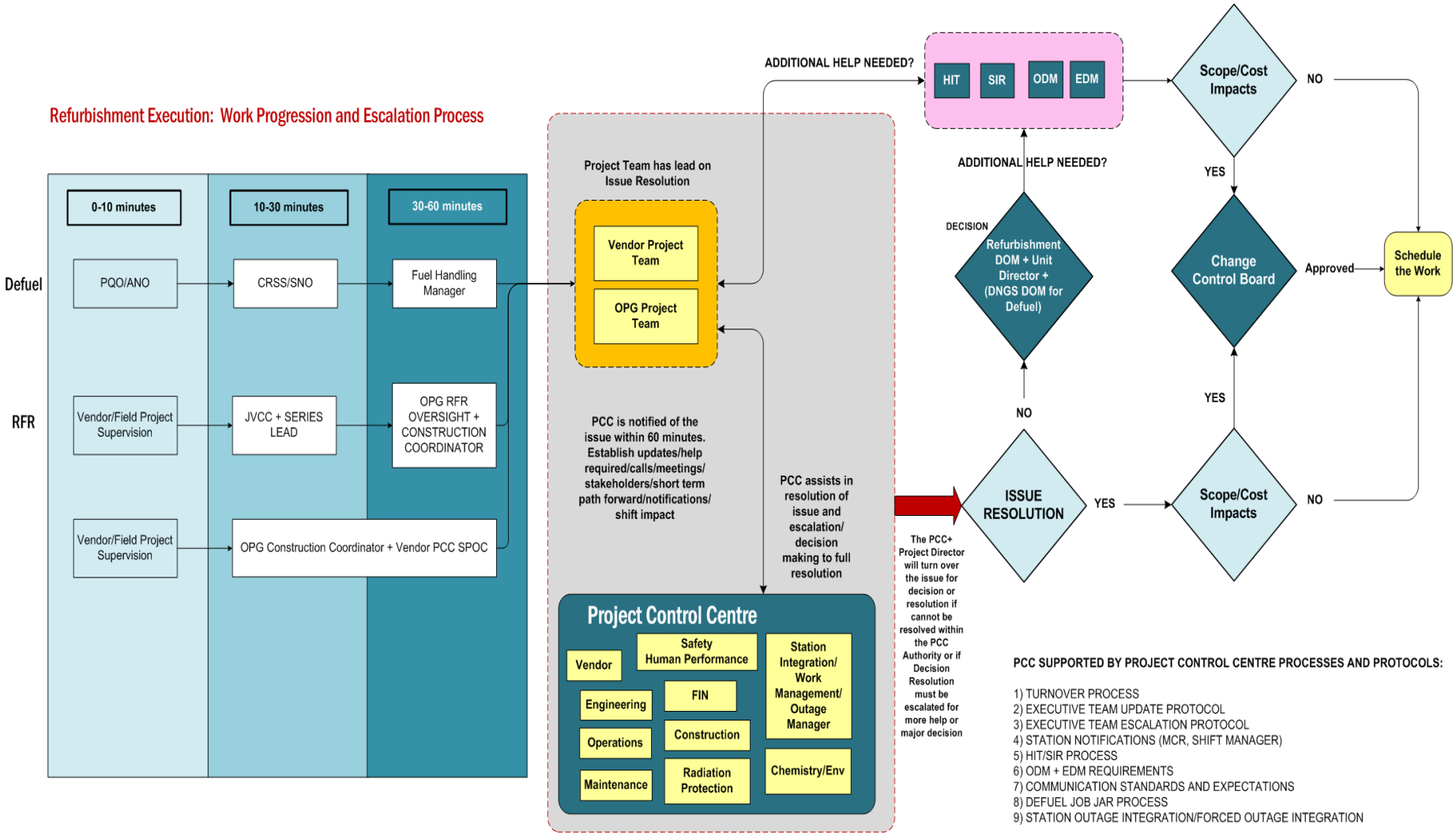
c) Please see the Work Progression Escalation Process model provided in Attachment 1. OPG and its contract partners have agreed to defined accountabilities for the resolution of issues as they arise during field work.

d) In addition to the Work Progression Escalation Process model referenced in part c) and the DOR attached to L-4.3-2 AMPCO-088, section 3.0 of Exhibit D2-2 9, pp. 3 to 5, describes the role of the Work Control Function (now referred to as the Project Office Function), including the role of the Project Control Centre in ensuring issues are quickly identified, escalated, and resolved.

NR Execution – Work Progression Escalation Process

Filed: 2016-10-26, EB-2016-0152
Exhibit L, Tab 4.3, Schedule 2 AMPCO-089
Attachment 1, Page 1 of 1

Refurbishment Execution: Work Progression and Escalation Process



PCC SUPPORTED BY PROJECT CONTROL CENTRE PROCESSES AND PROTOCOLS:

1) TURNOVER PROCESS
2) EXECUTIVE TEAM UPDATE PROTOCOL
3) EXECUTIVE TEAM ESCALATION PROTOCOL
4) STATION NOTIFICATIONS (MCR, SHIFT MANAGER)
5) HIT/SIR PROCESS
6) ODM + EDM REQUIREMENTS
7) COMMUNICATION STANDARDS AND EXPECTATIONS
8) DEFUEL JOB JAR PROCESS
9) STATION OUTAGE INTEGRATION/FORCED OUTAGE INTEGRATION

AMPCO Interrogatory #90

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-8 Attachment 2 page 30

Preamble: Modus/Burns McDonnell states "In particular, the DR Team should sharpen its focus on commercial management of the contractors work in the field, which will entail a team effort between the commercial managers, project managers and field execution team. The DR Team intends to focus on these functions during the Readiness to Execute period, and their seamless integration will be essential to avoid claims and commercial disputes that can negatively impact work if allowed to fester.

The team has considerable work ahead to meet these goals, and we rate the current risk level in this area that the DR Team will not meet its plan as medium-high if the DR Team does not dedicate time and resources in this area in the short term."

a) Please describe OPG's plan for commercial management of the contractors work in the field?

Response

The Darlington Refurbishment teams has integrated experienced commercial resources and contract managers for each major work bundle with the project teams to ensure commercial considerations are embedded in the decision making process and that the commercial support is in place to address issues expeditiously.

AMPCO Interrogatory #91

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-8 Attachment 2 Page 19

Preamble: In total, OPG is carrying $617M in contingency for RFR or RFR-related risks over and above the contingency that is built into the contract. With a remaining EPC contractor base cost for RFR of $2.33B (excluding contractor fees), this equates to 26%.

a) Please provide the contingency built into the RFR contract.

Response

a) The contingency built into the RFR contract is $368M.

AMPCO Interrogatory #93

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-9 Program Execution Page 3

a) Please explain the role of OPG's work control function group or project execution support group in terms of managing the contractor work force, tracking and recording working hours and all the allowable expenses incurred on the site and the proper approval for all costs by the contractor.

b) Has OPG put in place all the necessary processes to ensure a safe and controlled environment for the protection of non nuclear contractors who have never been exposed to the nuclear environment nor understand the nuclear safety protocols?

c) In the work processes between the contractors and OPG, is there a clear understanding/written procedures of who is to manage each of the activities/processes in the field work? If yes, please provide details.

d) Do OPG and the contractor have a written procedure on the resolution of problems that is understood by all parties, is robust enough to resolve the problems and actions can be documented and activities scheduled during the field work?

Response

a) OPG's Work Control Function and Project Execution Support Function do not play a role with the tracking and recording of hours and costs, nor do they have a role with approving contractor costs. The Construction Execution and Field Support team, who are a part of the Project Execution Support Function, do have a role with managing the contractor work force. Please see a description of their role in Ex. D2-2-9, p. 3.

b) Yes, OPG has put into place all of the necessary processes and controls to protect contractor personnel with no previous experience with working in a nuclear power plant. An intensive training program has been developed and implemented for contractor supervisory personnel. This training program provides expectations and requirements that address the unique factors associated with working in a nuclear power plant environment and the reasons why we have the requirements. This training addresses the four pillars of refurbishment - Safety, Quality, Schedule and Cost.

c) Yes, there are detailed written procedures that control the work in the refurbishment and identify who is doing each activity/process. The work is controlled through a set of documents that includes Work Plans, Comprehensive Work Packages, and Inspection and Test Plans, among others.

d) OPG has a Project Control Centre (PCC) that will be active 7 days a week during the refurbishment outage. The PCC will be the central location for elevating and resolving problems, in real time, that impact the execution of ongoing or upcoming field work. The PCC Manager has at his/her disposal the required resources to resolve the majority of field work delays, and for larger or more complex problems, to immediately engage the remainder of the refurbishment team to deal with them.

AMPCO Interrogatory #94

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-9 Attachment 2 Page 4

a) How are contractors providing timely information on labour and expenses incurred to support the project planning and monitoring processes?

b) Have the problems experienced in this area by ES Fox on EPG3 been addressed? At whose cost?

Response

a) Contractors provide their labour and non-labour details through OPG's ONCORE billing system on a weekly and/or monthly basis. This system captures vendor invoicing details and provides a distribution of their costs against project cost accounts. Contractors also provide accruals each month for any labour or non-labour amounts not billed. This is the same system used by other projects in Nuclear.

b) Refer to Ex. L-4.3-2 AMPCO-98.

AMPCO Interrogatory #95

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-9 Attachment 2 Page 10

a) Please explain why OPG is carrying contingency for schedule risk caused by AECON JV or any of the other major contractors.

Response

a) OPG as the program owner carries contingency for all risks that may impact the planned duration of the Darlington Refurbishment Program for the following reasons:
    a. Any contractor delay will cause OPG to incur additional carrying costs related to the project management team as well as increased interest costs,
    b. A delay by SNC AECON JV may impact the schedule of other contractors and result in additional costs, and
    c. OPG is accountable to pay actual costs of any hours billed by SNC AECON JV including those beyond the amounts included in the base cost estimate. This amount would be offset by any schedule disincentives payable by SNC AECON JV.

AMPCO Interrogatory #96

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-9 Page 6

Preamble: Given that OPG has expressed the principle that costs should be allocated where they are best controlled, please explain:

a) Why is OPG managing non-radiological waste instead of the contractor?

b) Please provide a table showing the amounts OPG has budgeted for each of radiological and non-radiological waste for each major contract.

Response

a) Managing waste is a key risk to the Darlington Refurbishment Program (DRP) which OPG as the Owner determined was best kept within OPG's control since a failure to properly manage waste streams could eventually impact critical path activities.

   OPG collects and segregates its non-radiological waste in the same manner, whether the waste arises from ongoing Operations and Maintenance activities while the units are operating, from a project, from a normal planned outage, or from refurbishment. Station staff or contractors collect and segregate the waste into waste streams and recycling streams in appropriate containers. These segregated waste and recycling containers are then picked up by a contracted waste and recycling service provider and sent to an appropriate processing facility. These service providers are registered by the Ministry of the Environment and Climate Change for haulage and processing of all waste and recycling at OPG.

   Since (1) OPG already had a contract in place with a waste and recycling service provider for the waste produced from station operations, (2) based on an internal OPG assessment, it was more effective to simply extend that contract, and (3) because this gave OPG more control over this risk, it was determined that this was the preferred path forward for non-radiological waste from refurbishment.

b) OPG did not develop the budgets for non-radiological waste and radiological waste on a contract by contract basis. However, OPG can provide the following:

Non-Radiological Waste:
OPG does not budget separately for the non-radiological waste which arises from station operations versus that from refurbishment. The annual budget for the waste and recycling service provider which, going forward, will cover non-radiological wastes from both station operations and refurbishment, is $600k.

Radiological Waste:
The costs to manage Low and Intermediate Waste (L&ILW) are based on a usage fee to the DRP from OPG's Nuclear Waste Management Division and represent the estimated long term life cycle costs required to manage each cubic meter of new waste produced by DRP.

Annual L&ILW variable expenses are included in Ex. F2-7-1, pp. 2-3, sections 5.1 to 5.5. To summarize, the annual amounts for L&ILW variable expenses are:

Chart 1

Year	L&ILW Variable Expenses ($M)
2017	2.5
2018	2.1
2019	2.8
2020	2.9
2021	3.8
Total	**14.1**

For greater clarity, the Operations and Maintenance Release Quality Estimate (RQE) total cost estimate included in Ex. D2-2-8, Chart 3 includes the above costs, as do Ex. F2-7-1, Tables 1 and 2 regarding DRP OM&A costs.

AMPCO Interrogatory #97

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-9 Page 6
Ref: D2-2-9, Attachment 2 Page 10

Preamble: "In total, OPG is carrying $616M in contingency for RFR or RFR-related risks over and above the contingency that is built into the contract."

a) Explain why OPG is carrying schedule risk for the contractor's performance?

Response

a) Please refer to Ex. L-4.3-2 AMPCO-095 for an explanation why OPG is carrying schedule contingency for the DRP. Specifically for the Retube and Feeder Replacement (RFR), OPG retained certain schedule risks which it was in a better position to manage. Please note that the $616M quoted in the reference is not only for RFR schedule contingency, it includes $282M for RFR-related discrete risks. This is discussed in more detail in Ex. D-2-2-9, Attachment 2, p.10.

AMPCO Interrogatory #98

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-9 Attachment 2 Page 4 and 16

a) Given the performance of ES Fox on EPG3 referenced above, how can OPG ensure that contractors are capable of providing timely information flow to support project planning and execution? Please detail the extent to which OPG personnel are picking up the slack (and costs) for these shortfalls.

Response

a) OPG has secured a project resourcing plan from each of the major contractors with specific identification, by name, of critical resources assigned to the work. This will ensure that each contractor supporting the project bundles is sufficiently staffed to support refurbishment program requirements including safety, quality, schedule, and cost information flow.

In order to reinforce these requirements, OPG has emphasized that the contractors must focus on effective implementation of their quality programs, specifically low level reporting and corrective action processes, which will ensure negative trends are identified and addressed. OPG is actively monitoring contractor performance on these focus areas.

OPG as the overall program manager has resources to provide project oversight on contractor performance and integration roles to unite the multiple contractors and station resources executing work. OPG has not incurred any supplemental resource costs to augment contractor shortfalls in information flow, as the roles were planned in the organization. However, OPG has shifted the nature of these roles to ensure a focus on collaboration and facilitation of positive project outcomes based on the lessons learned on projects such as EPG3.

AMPCO Interrogatory #99

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-11 Attachment 3 Page 64

Please provide any benchmarking material on construction or operations available from Bruce Power?

Response

Please refer to L-4.3-2 AMPCO-52, part e).

AMPCO Interrogatory #100

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-11 Attachment 3 Page 70 Footnote 86

Please provide the Memorandum of Understanding on Collaboration during Ontario's Refurbishment Period Between Bruce Power LP (Bruce Power) and Ontario Power Generation (OPG), November 12, 2015

Response

Please see the requested Memorandum of Understanding between Ontario Power Generation Inc. and Bruce Power L.P. dated November 12, 2015 attached.

ONTARIOPOWER GENERATION

Bruce Power

Jeff Lyash
President and Chief Executive Officer

Duncan Hawthorne
President and Chief Executive Officer

Memorandum of Understanding on Collaboration during Ontario's Refurbishment Period

Between

Bruce Power LP (Bruce Power)

and

Ontario Power Generation Inc. (OPG)

Effective Date: November 12, 2015

BACKGROUND

I. The Bruce Power and Darlington generating stations provide a low-cost, reliable and clean source of electricity for the province. Ontario's 2013 Long Term Energy Plan (2013 LTEP) outlines an important continued role for nuclear power in the Province meeting approximately 50% of the Province's electricity for decades to come through the refurbishment of the Bruce Power and Darlington Units.

II. The 2013 LTEP also outlines the importance of collaboration between the Province's two nuclear operators in order to *"find ways of finding ratepayer savings through leveraging economies of scale in the areas of refurbishment and operations. This could include arrangements with suppliers, procurement of materials, shared training, lessons learned, labour arrangements and asset management strategies"*.

III. Bruce Power operates the world's largest operating nuclear generating facility and is the source of roughly 30 per cent of the electricity for the Province of Ontario in Canada. The company's site is in Tiverton, Ontario and is Canada's only private sector nuclear operator. Formed in 2001, Bruce Power is an all-Canadian partnership among Borealis Infrastructure Management (a division of the Ontario Municipal Employees Retirement System), TransCanada, the Power Workers' Union and the Society of Energy Professionals. Bruce Power operates 8 CANDU nuclear Units under long-term lease from OPG.

IV. OPG, a successor in title of Ontario Hydro, was established in 1999 under the *Business Corporations Act* (Ontario) and is wholly owned by the Province of Ontario. The company operates a diversified generating portfolio, consisting of two nuclear (Darlington and Pickering), 65 hydroelectric, and three thermal generating stations. Through these generating facilities, OPG generates about 50 per cent of Ontario's electricity.

V. All nuclear facilities in Canada are regulated by the Federal Government through the *Canadian Nuclear Safety Commission* (CNSC) and as such the Bruce Power and OPG facilities share a common regulatory model.

VI. Bruce Power and OPG have a long-standing relationship as operators of CANDU reactors sharing best practices and information through a range of industry forums including the CANDU Owners Group (COG) and the World Association of Nuclear Operators (WANO).

VII. Both organizations historically and since the release of the 2013 LTEP have been collaborating in a range of areas that allow both operators collectively to leverage economies of scale to continue to position nuclear power as a low-cost provider of electricity to ratepayers.

VIII. Bruce Power and OPG have developed a range of lessons learned and strengths through their respective operation of CANDU reactors and are committed to building a long-term relationship to enhance the co-operation between the two organizations.

IX. Bruce Power and OPG have experience with the refurbishment of CANDU nuclear reactors and a range of other important investment activities that will be continued for many years to come as these CANDU Units play an important role in meeting the electricity needs of the province.

X. Both organizations share a similar labour relations environment with their two primary unions – the Power Workers Union and the Society of Energy Professionals, along with bargaining arrangements through the Electrical Power Systems Construction Association (EPSCA) for construction labour.

XI. As nuclear operators, Bruce Power and OPG are committed to the value of 'Safety First' and achieve this high standard through active collaboration, transparency and continuous improvement.

XII. Bruce Power and OPG have a joint liaison committee that meets to work together on issues related to the lease of the Bruce Site and related ancillary agreements including waste and heavy water services.

The parties accept the following non-binding Memorandum of Understanding.

PURPOSE

The purpose of this MOU is to confirm a bilateral collaboration framework in which Bruce Power and OPG can build on their successful working relationship over the last 14 years with a particular focus on further leveraging the economies of scale of both organizations and successfully delivering the refurbishment programs anticipated at both Bruce Power and Darlington nuclear generating stations.

AREAS OF COOPERATION

The parties endeavour to collaborate with each other to implement the following objectives which will focus on improving both parties' refurbishment programs.

a) Ensure strong alignment between the Executive Team at both Bruce Power and OPG to continue to leverage economies of scale wherever possible in the operations and refurbishment programs for both facilities. This will be achieved by establishing a joint forum of the leadership from both organizations who will review the areas of collaboration on a regular basis.

b) To build on a strong, long-standing relationship as operators of CANDU reactors sharing best practices and information through a range of industry forums including the CANDU Owners Group (COG), Operational Safety and Review Team (OSART) Missions and the World Association of Nuclear Operators (WANO).

c) To consider opportunities to leverage economies of scale in the areas of procurement, contract services and strategic spares of key plant components in both refurbishment and operations activities.

d) To pursue a continued collaborative approach to labour relations as both organizations work with the Power Workers Union and the Society of Energy Professionals, along with bargaining arrangements through the Electrical Power Systems Construction Association (EPSCA) for construction labour.

e) To identify opportunities to become more efficient in the reduction of waste generated from nuclear facilities and refurbishment activities using best practices and new technology.

f) To advance innovation and business development opportunities

g) Seek opportunities to develop a joint approach to solving issues facing both operators in order to reduce the cost of operation or refurbishment activities.

h) To share and collaborate on approaches and strategies to communicate openly with the public and on the safe, cost-effective and reliable operations from CANDU reactors.

ENGAGEMENT & REPORTING

a) Bruce Power and OPG will continue to engage and advance these areas of co-operation. A joint steering committee will meet on a regularly scheduled basis to align and advance these various issues with management representatives from both organizations.

b) Bruce Power and OPG will create the Executive Committee responsible for setting strategy and objectives and reviewing results of collaboration. The Executive Committee will consist of senior executives of both organizations and will be chaired by Chief Nuclear Officers of Bruce Power and OPG. The Executive Committee will meet on an as required basis. It is estimated that the Executive Committee will be meeting approximately twice a year.

c) This MOU will be made available to the public through the Bruce Power and OPG websites.

d) An annual *summary report* of collaboration activities will be prepared through mutual agreement by Bruce Power and OPG, and the report will be jointly published by both organizations.

e) Both the annual *summary report* and a more detailed technical report will be submitted annually to the Ontario Ministry of Energy for review and to follow-up on activities taking place under this MOU.

CHANNEL OF COMMUNICATION AND NOTICES

For the purpose of facilitating the implementation of this memorandum, the single points of contact are:

a) For execution:

Bruce Power:
Jeff Phelps
Vice President, Project Management and Construction
P.O. Box 1540, 177 Tie Road
R.R.#2
Tiverton, ON N0G 2T0
226-930-0380
jeff.phelps@brucepower.com

OPG:
Michael H. Allen
Vice President, Nuclear Refurbishment
1855 Energy Drive
Courtice, ON L1E 0E7
289-388-6746
michael.allen@opg.com

b) For commercial:

Bruce Power:
Richard Horrobin
Vice President, Commercial Services
P.O. Box 1540, 177 Tie Road
R.R.#2
Tiverton, ON N0G 2T0
519-386-0562
richard.horrobin@brucepower.com

OPG:
Meg Timberg
Vice President, Nuclear Projects Oversight
1855 Energy Drive
Courtice, ON L1E 0E7
416-788-8523
meg.timberg@opg.com

c) For communication with the Ministry

Bruce Power:
James Scongack
Vice President, Corporate Affairs
P.O. Box 1540, 177 Tie Road
R.R.#2
Tiverton, ON N0G 2T0
519-361-3900
James.scongack@brucepower.com

OPG:
Ted Gruetzner
Vice President, Corporate Relations & Communications
700 University Avenue
Toronto, ON
416-592-6806
Ted.gruetzner@opg.com

The parties have, by their duly authorized representatives, executed this non-binding Memorandum of Understanding on the Effective Date.

Bruce Power L.P., by its General Partner
Partner Bruce Power Inc.

Duncan Hawthorne
President

Ontario Power Generation Inc.

Jeff Lyash
President and Chief Executive Officer

AMPCO Interrogatory #101

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-11 Attachment 1

a) Page 5: Concentric indicates it did not independently verify the appropriateness, sufficiency or correctness of the Program schedules, cost estimates, or scope. Please confirm the third party that undertook this verification.

b) Page 6: Please provide OPG's benchmarking analysis of its Program against other CANDU refurbishments such as those at the Wolsong nuclear plant in South Korea, the Bruce nuclear plant in Ontario, and the Pt. Lapreau nuclear plant in New Brunswick.

Response

a) There was no third party review undertaken to verify or validate the final schedule duration, cost estimate, or scope definition for the refurbishment. The purpose of the third party reviews of the RQE was to validate that the processes and practices to develop the final cost, schedule, and scope for refurbishment met or exceeded industry standards, and, to confirm that OPG was effectively following those processes and practices.

b) Please refer to Ex. L-4.3-2 AMPCO-52.

AMPCO Interrogatory #102

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-11 Attachment 3, Page 7

Preamble: Dr. Patricia D. Galloway provides testimony on the DRP.

a) Page 6: Please provide OPG's evidence reference for DRP being a FAOK.

b) Page 7: Please provide the matrix organization for the DRP.

c) Page 8: Please provide the available cost data from other refurbishment projects.

d) Page 9: Please provide documentation of the lessons learned from other refurbishment projects, other nuclear projects, and other megaprojects and megaprograms.

e) Page 10: Please describe the infrastructure for metrics and integrated reporting plans.

f) Page 41: Please provide OPG's Project Oversight Standard.

g) Page 42: Please provide the risks and mitigation plans for FOAK/FIAW risks.

h) Please provide Dr. Galloway's assessment of the key challenges in executing the DRP successfully.

Response

The following responses have been prepared by Pegasus-Global Holdings:

a) Please see Ex. D2-02-09, Attachment 2:

> "The digital controls upgrade will be a first time evolution for OPG and will require significantly more planning than the limited maintenance scope for Unit 2. The risk profile of the subsequent units has been developed with this in mind." (p. 11)
>
> "Unit 3 will also be the first replacement of the generator mid-section and stator rewind. A new stator will be installed for Unit 3, and the existing Unit 3 stator will be

rewound and installed in Unit 4. These evolutions have been planned sufficiently in advance that this work should not be a threat to the schedule of the later units." (p. 11)

"The process for vetting the estimates for these sub-projects was robust, included a team drawn from the station and the project and involved an assessment of a reasonable performance in light of past CANDU refurbishment execution, station and vendor performance, and the first-of-a-kind nature of some of this work." (p. 12)

See also, "Darlington Nuclear Refurbishment Project Controls Overview" (filed at L-4.3-15 SEC-022) which explains the process of evaluating risks in the context of FOAK/FIAW work.

See also, "Risk Report by Project with Associated Actions" (filed at L-4.3-1 Staff-073, Attachment 7), which includes:

- 14324 – Project 73312: BoP FOAK/FIAW projects – Strategic Risk Assessment/Mitigation Plan Required
- 14327 – ASDC pump-motor assemblies ceiling mounting
- 12322 – End Fitting Waste Processing – First of a Kind (FOAK) risk: *"Execution Phase Risk:*
- 14410 – TG – FOAK LP Spindles Removal for U2 Refurbishment
- 14407 – TG – FOAK Cost and schedule impact due to high voltage bushings and current transformers replacement
- 14409 – TG – FOAK Generator Stator drain and dry during U2 refurbishment
- 844 – Initial vault crane maintenance (FOAK work in plastics, in the vault).

b) Please see the presentation included as Attachment 1, which includes the Unit 2 Refurbishment Execution Organization Chart.

c) Please refer to Dr. Galloway's Testimony (filed at Ex. D2-2-11, Attachment 3):

"Based on my review and the interviews conducted, it is my understanding that OPG benchmarked against the available cost data from other refurbishment projects at Point Lepreau, Pickering, and Bruce Units 1 and 2, incorporating lessons learned from these projects into the DRP estimate. Due to the limited available data as a result of the uniqueness and FOAK nature of the Program, I understand that benchmarking was largely tied to OPG's operating experience and subject matter expertise." (p. 52)

Please see also, Release Quality Estimate (RQE) - Basis of Estimate Report (Doc. No. NK38-REP-09701-0548257, filed at L-4.3-15 SEC-33, Attachment 4):

> "Based on the infancy of the estimating role within OPG and a lack of consolidated data store or Refurbishment track record, benchmarking of estimates is constrained to internal OPEX and subject matter expertise inputs,

and particular to RFR as example, an overall comparative of various durations of RFR campaigns with different Utilities.

d) Please see:

- "Refurbishment Construction Review Board" (Attachment 1).
- "Darlington Refurbishment Program – Application of Lessons Learned from Vogtle Nuclear Generation Station" dated March 3, 2016 (Attachment 2).
- "Appendix 1: Darlington Refurbishment Pre-Requisite Projects Key Lessons Learned Summary" (Attachment 3).

e) Please refer to Dr. Galloway's Testimony (filed at Ex. D2-2-11, Attachment 3):

> "I found that OPG has established a repository within the DRP Data Warehouse for metrics and reporting data. A comprehensive, tiered metrics infrastructure has been established and will be maintained at the program, project, and functional levels to measure progress in areas of: environment, health, and safety; scope; schedule; cost; and, quality." (p. 73)

f) Please see part b) of L-4.3-1 Staff-73.

g) Examples included within larger risk register "Risk Report by Project with Associated Actions" (filed at L-4.3-1 Staff-073, Attachment 7).

h) Dr. Galloway's assessment of the key challenges in executing the Darlington Refurbishment Program (DRP) successfully is essentially her testimony. Challenges to any project are identified in the risks a project could face. Her assessment focused on those risks as identified by the DRP Program. Dr. Galloway's assessment of how the DRP will address those risks and challenges is fully described in her testimony and specifically describes her assessment regarding how the DRP Program will address those challenges through its management of the Program, its processes, procedures and program control tools and its assessment of risk through its Risk Management and Oversight Tool.

Dr. Galloway's assessment of how the key challenges will be addressed to enable a successful execution is summarized in her opinions presented in her testimony including:

> "It is my opinion that the extensive pre-execution planning that was undertaken places OPG in a favorable position to have successful execution of the Program. This pre-execution planning includes: the incorporation of lessons learned from Darlington and other nuclear projects including Point Lepreau Nuclear Generating Station, Bruce Nuclear Generating Station, Pickering Nuclear Generating Station, Vogtle Electric Generating Plant, Watts

Bar Nuclear Generating Station, as well as non-nuclear megaprojects such as the London Olympics and Heathrow International Airport; the use of industry best practices for development of the Release Quality Estimate (RQE); and, the policies, procedures, and project control tools that were developed and in use for Program execution." (p. 14)

"By performing a detailed cost estimate and schedule based on a thorough and robust probabilistic risk assessment of the Program, OPG has established a P90 confidence level of the cost to complete the Program and established an appropriate level of contingency, which in my opinion, is a reasonable cost estimate." (p. 14)

"Through my review of the Program record and my interviews with OPG personnel, I found that risks were identified through a number of sources, including operating experience and external lessons learned, project manager direction, and through the Program Management Office (PMO) risk department proactively seeking input and providing oversight support. Specific activities that facilitated the identification of risks include: facilitated risk workshops; Basis of Estimate and contingency development reviews; and, project schedule reviews." (p. 68)

"It is my opinion that OPG has, through a reasonable and prudent process, identified those risks that could potentially impact the Program's cost and schedule and has instituted practices in accordance with industry standards that will allow OPG early identification should any of those risks emerge, allowing OPG to quickly implement the mitigation plans, thereby either avoiding or minimizing the impact of that risk. Further, I found that OPG developed through its Monte Carlo risk simulation modeling, the necessary risk contingency to address such risks, thereby providing a high confidence that the Program can be executed within the $12.8B RQE." (p. 72).

Refurbishment Construction Review Board

April 25, 2016

Introduction and Organization

BEHAVIOURS

- Say It, Do It
- Simplify It
- Think Top and Bottom Line

VALUES • SAFETY • INTEGRITY • EXCELLENCE • PEOPLE & CITIZENSHIP •

PEOPLE POWERING THE FUTURE
OPG NUCLEAR

ONTARIO POWER GENERATION

Safety Pre-Job Brief

- Fire/First Aid
  - Medical Emergency – Dial 9-911
- Emergency Exits Walk, Do Not Run
- Assembly Area
  - Proceed to our assembly area (Sign posted in East Parking Lot)
  - DO NOT RE-ENTER THE BUILDING
- Address: Darlington Energy Center
  1855 Energy Drive, Courtice

DARLINGTON REFURBISHMENT
Repowering Ontario

Weekly Refurbishment Message

Week of April 25

Business Focus: Nuclear Safety Culture

Our recent Nuclear Safety Culture assessment has been completed. Many thanks to everyone who participated. The assessment revealed that overall Nuclear Projects and Refurbishment have a good Nuclear Safety Culture. The team saw clear indications that we are firmly committed to safety, feel empowered to ask questions and escalate our concerns to our supervisors

The team also identified opportunities which will require follow up actions:

1. Ensuring we do not lower our standards when faced with time and schedule constraints.
2. Ensuring we take action to quickly resolve issues and lessons learned.
3. Ensuring our Nuclear Safety traits and expected behaviours are well understood by everyone on the Project such that we understand how our actions and behaviours impact nuclear safety.
4. Ensuring we always work collaboratively and respectfully, that regardless of employer or department we are all equally important.

The next phase in this assessment is to work together (OPG and Vendor Partners) to develop a corrective action plan to address these findings.

A healthy Nuclear Safety Culture goes hand in hand with ensuring our projects are executed safely and with quality.

The assessment team noted that our team has a strong sense of pride to accomplish our mission at Darlington, let's continue to strengthen our Nuclear Safety Culture through our daily communications and interactions with each other recognizing there is only one team here with a common goal.

Thank You for Participating

Nuclear Safety Principles

#2 Questioning Attitude

Individuals avoid complacency and continuously challenge existing conditions, assumptions, anomalies, and activities in order to identify discrepancies that might result in error or inappropriate action.

Project Excellence Principles

#4 Schedules are Realistic and Understood

Effective project controls and detailed planning are key factors in the success of any large construction projects.

Welcome and Introductions

- Introduction of the Refurbishment Construction Review Board
- Introduction of the OPG team present

Refurbishment Project Development

Initiation Phase 2007-2009

PHASE 1

SCOPE OF WORK

- Initial determination of refurbishment scope through completion of:
  - Technical assessments of all major components
  - Condition assessments of balance of plant components
  - Initiation of regulatory processes; Integrated Safety Review and Environmental Assessment
- Develop reference plans for cost and schedule
- Complete economic feasibility assessment
- Establish project management approach and governance
- Establish overall contracting strategy
- OPG Board and Shareholder agree with recommendation to proceed with preliminary planning within the Definition Phase of the project

Execution Preparation Phase 2010-2015

PHASE 2

SCOPE OF WORK

- Obtain regulatory approvals:
  - Environmental Assessment
  - Integrated Safety Review
  - Integrated Improvement Plan
- Implement project management and oversight
- Complete infrastructure upgrades, i.e. Darlington Energy Complex
- Implement safety improvements
- Award major contracts
- Finalize project scope and complete engineering work
- Procure long lead materials
- Complete unit prerequisite work
- Construct reactor mock-up and fabricate and test tooling
- Develop release quality cost and schedule estimate
- Obtain all permits and licences
- Mobilize and train Trades staff

Outage Execution Phase 2016-2025

PHASE 3

SCOPE OF WORK

- Unit shutdown and defueling
- Island unit and lay up systems
- Execute all refurbishment scope:
  - Reactor components
  - Fuel handling systems
  - Turbine / generator
  - Steam generators
  - Balance of plant
- Meet all regulatory commitments
- Plant maintenance and inspection activities
- Manage plant configuration
- Load fuel
- Commissioning
- Unit start-up
- Apply lessons learned to subsequent unit refurbishments
- Project close-out

Approach to Refurbishment

- All of the elements are in place for a successful refurbishment of Darlington.

One of the top performing nuclear stations in the world.

Condition of Plant well understood

Strong Planning approach considering lessons learned from other refurbishments

OPG as integrator of a Multi Prime Contracting Strategy

Successful Refurbishment delivered on time and on budget.

OPG Continued low cost operator in Ontario

Scoping Process

OPG applied a robust scoping process to evaluate investments.

Scope Identification

- Component Condition Assessments (2893)
- Life Cycle Management Plans
- Integrated Safety Review
- Environmental Assessment
- Regulatory Action Items
- Corrective Action Program
- Capital Modification Portfolio
- Operator Burden Program / Panel Deficiencies
- 40 Day Outage Improvements
- Hardened Elective Maintenance Backlog
- Cycle Outage Work
- Life Cycle Work
- Maintenance
- Engineering Inventory Backlog
- Unit Islanding
- Temporary Mods to Support Refurb
- Business Transformation Opportunities
- Beyond Design Basis Event Reviews
- OPEX from other plants
- Station Improvements
- Campus Plan / Facilities for Refurb
- Safety Improvements

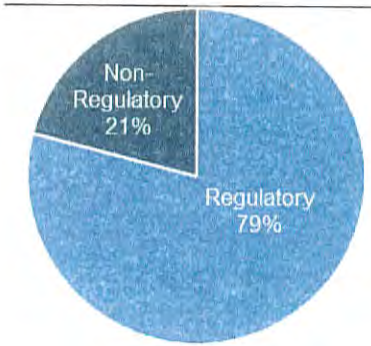
Scope Assessment

- Campus Plan
- Modifications
- Repair and Replace
- Engineering Studies
- Inspections

Scope Execution (% of total scope)

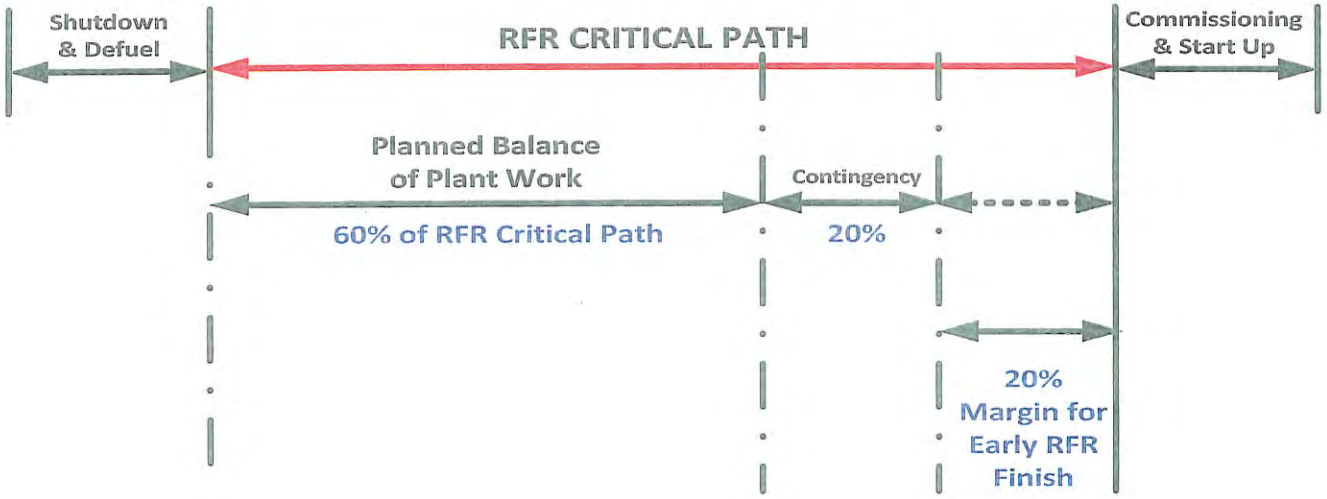
- Retubing & Feeder Replacement (RFR) - 61%
- Campus Plan (FIP SIO) 14%
- Turbine Generator (TG) 11%
- Fuel Handling (FH) 3%
- Steam Generator (SG) 2%
- Balance of Plant (BOP) 5%
- Shutdown, Layup and Services 4%
- Other (RSF, SP, UI) 1%

Refurbishment Work Scope
% of Estimated Cost



Schedule Management

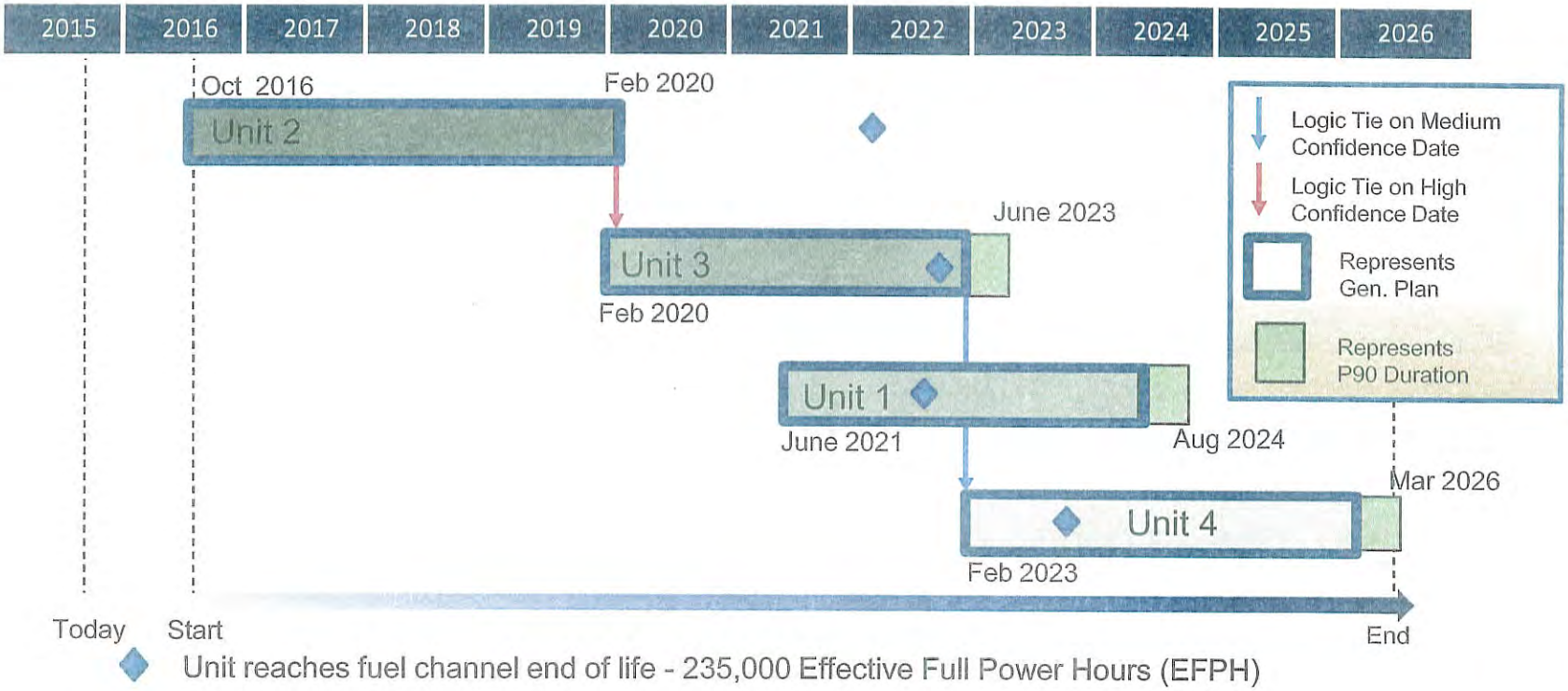
- In order to maximize success of Refurbishment, planned non critical path work (i.e. Balance of Plant work) will not exceed 60% of a critical path (Re-tube and Feeder Replacement) execution window.



- Opportunities to reduce schedule duration continue to be assessed.

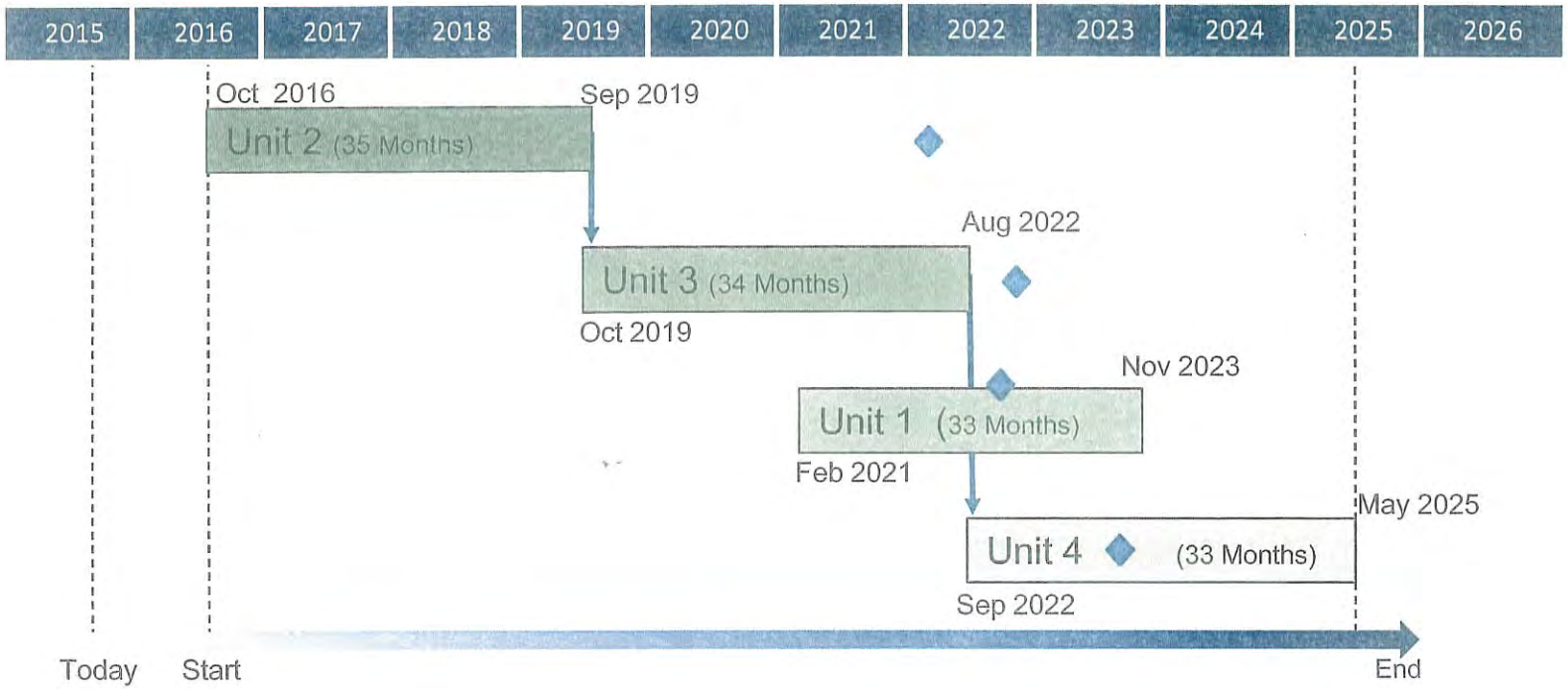
Schedule: Business/Generation Plan View

- The **APPROVED** high confidence schedule, which <u>includes</u> contingency, assumes the first unit outage will commence in Oct. 2016 with each unit lasting 37 to 40 months.
  - For Generation planning, OPG assumed the high confidence 40 month schedule for the first unit and the medium confidence schedule for the subsequent units.
- The LTEP and the Shareholder require us to incorporate off-ramps, thus, it is imperative that we succeed on each unit in order to get the approval to proceed to the next unit.



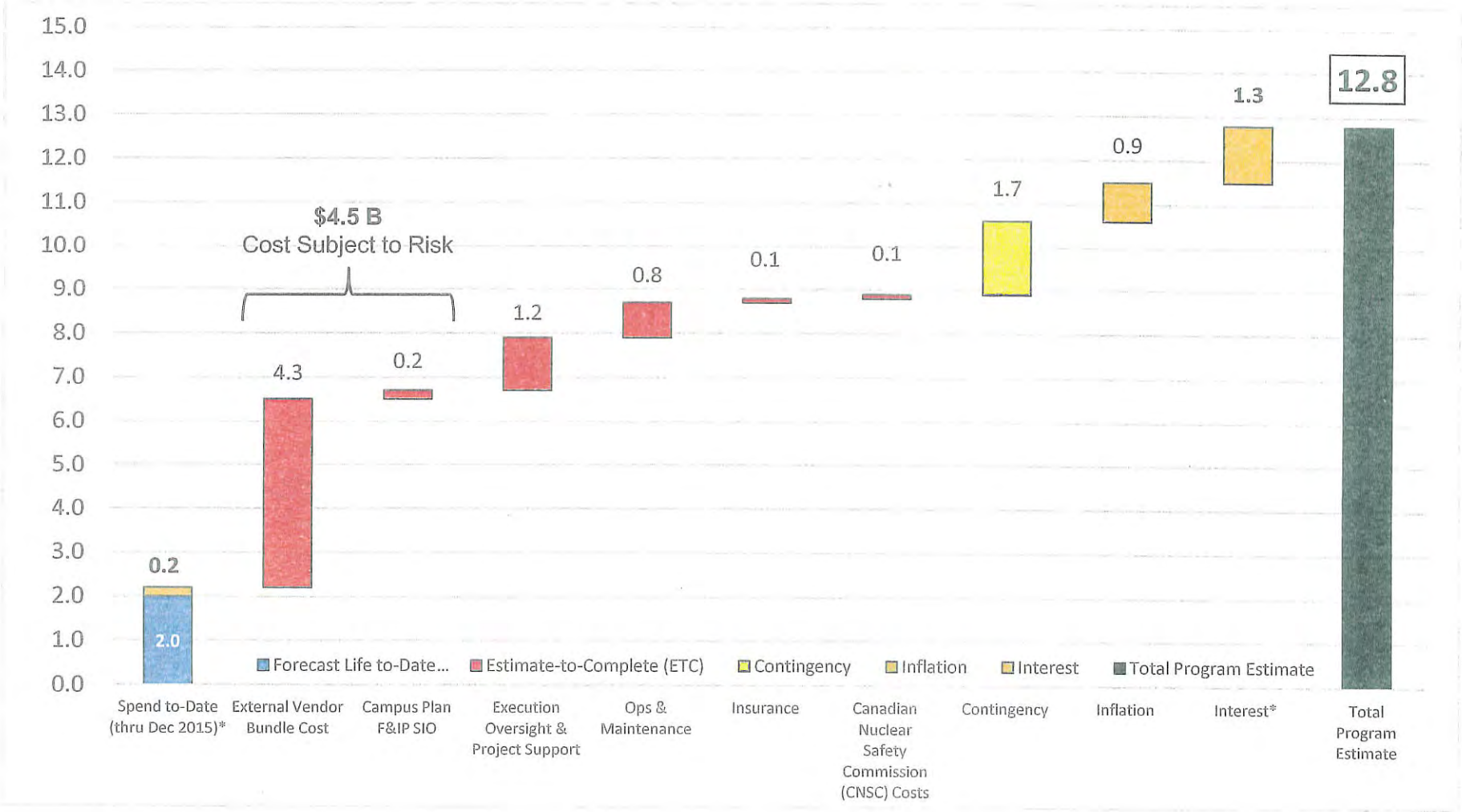
Schedule: Execution Phase View

- For purposes of managing the project, OPG will pursue a target schedule (as shown below) based on the Level 3 schedules provided by each of the vendors and integrated into OPG's master schedule.



◆ Unit reaches fuel channel end of life - 235,000 Effective Full Power Hours (EFPH)

4-Unit Cost Estimate Build-Up



OPG's Preparation for Successful Execution of DRP

OPG has taken steps to properly plan and prepare for the Execution Phase of the Refurbishment Program.

Lessons Learned

OPG has incorporated lessons learned from past CANDU refurbishments and other large projects and is applying these lessons to ensure a successful outcome. Project management improvements are being implemented as a result of the experience with the Facility and Infrastructure and Safety Improvement projects.

Front End Planning

OPG has expended significant effort in planning including detailed scoping, completion of Detailed Design , full development of a detailed cost and schedule estimate, and obtaining regulatory certainty.

Management of Risk

OPG has implemented a framework with the appropriate controls that can effectively manage the risks associated with Refurbishment. Contracts ensure an appropriate allocation of risk.

Right Team

OPG has the right team to successfully lead and execute DRP and are well integrated with the operating units.

Application of Major Lessons Learned

OPG has compiled lessons learned from DNGS, large projects, and past CANDU refurbishments to ensure a successful outcome.

- Lessons are tracked in a database and actioned to closure by management.

Lesson	Actions Taken
Management Team must be as Experienced and Qualified as possible, and hire third-party experts where appropriate	• A high caliber team with significant major projects and refurbishment experience is in place
Full scale Reactor Mock-up is necessary for training and tool development	• Major tool development and testing are complete and staff training is underway • The Contractors use of the mock-up has provided greater confidence in cost and schedule estimates
Scope should be defined as early as possible	• Detailed scope validation was conducted as part of the Release Quality Estimate process • High percentage of scope defining station equipment inspections were complete with no significant additional work identified
Select the right contract partners and contract models	• Contractors were selected through a comprehensive bidding process with appropriate financial incentives and disincentives
Implement a robust and independent program oversight function	• Project Assurance and Project Controls functions have been established separate from the project execution team. • Strong oversight and governance is in place
Front End Collaborative Planning has been implemented including the completion of Engineering before commencing construction work	• Collaborative Front End Planning has been used in the Engineering phase of the work and will be extended to the remaining phases to ensure highly predictable results • Major engineering design work was completed prior to August 2015, well before breaker open and construction starts.

Application of Major Lessons Learned

Project management improvements are being implemented as a result of the experience with the Facility and Infrastructure and Safety Improvement projects.

Lesson	Actions Taken
Collaborative Planning	Collaborative front end planning was put in place to complete engineering, procurement, and detailed work planning to ensure effective integration with the site
Scope Clarity and Control	Processes are being enhanced to align stakeholders on scope early in the process. Controls are put in place for effective management of scope changes.
Estimating	The DRP has centralized its estimating effort and enhanced it's review and classification process.
Scheduling	Scheduling standards including work breakdown structure and earned value methods are in place an all vendors are preparing schedules in accordance with those standards.
Material Tracking	A material tracking database is now in place which provides metrics for each project.
Contractor and Construction Oversight	Resources to perform construction oversight, clear barriers for contractors, and measure performance and progress, are included in the refurbishment plan. Existing Contractor Management Office (CMO) is being enhanced.
Field Engineers	Engineering to support construction activities in the field is built into refurbishment plans.
Sub-surface Risks	Additional ground surveys are planned and additional allowances to deal with the unknown sub-surface conditions have been built into project plans.
Contract Claims Management	The effort, capability, and timeliness required to monitor and control contract issues and related claims is being enhanced and integrated with project controls systems.
Project Management	OPG is maintaining overall project management accountability and acts as integrator of a Multi Prime Contracting Strategy.
EPC Contracting Approach	Selected a contracting approach where full engineering, procurement and construction responsibility resides with the prime contractor. This avoids issues with hand-offs between engineering, procurement and construction.

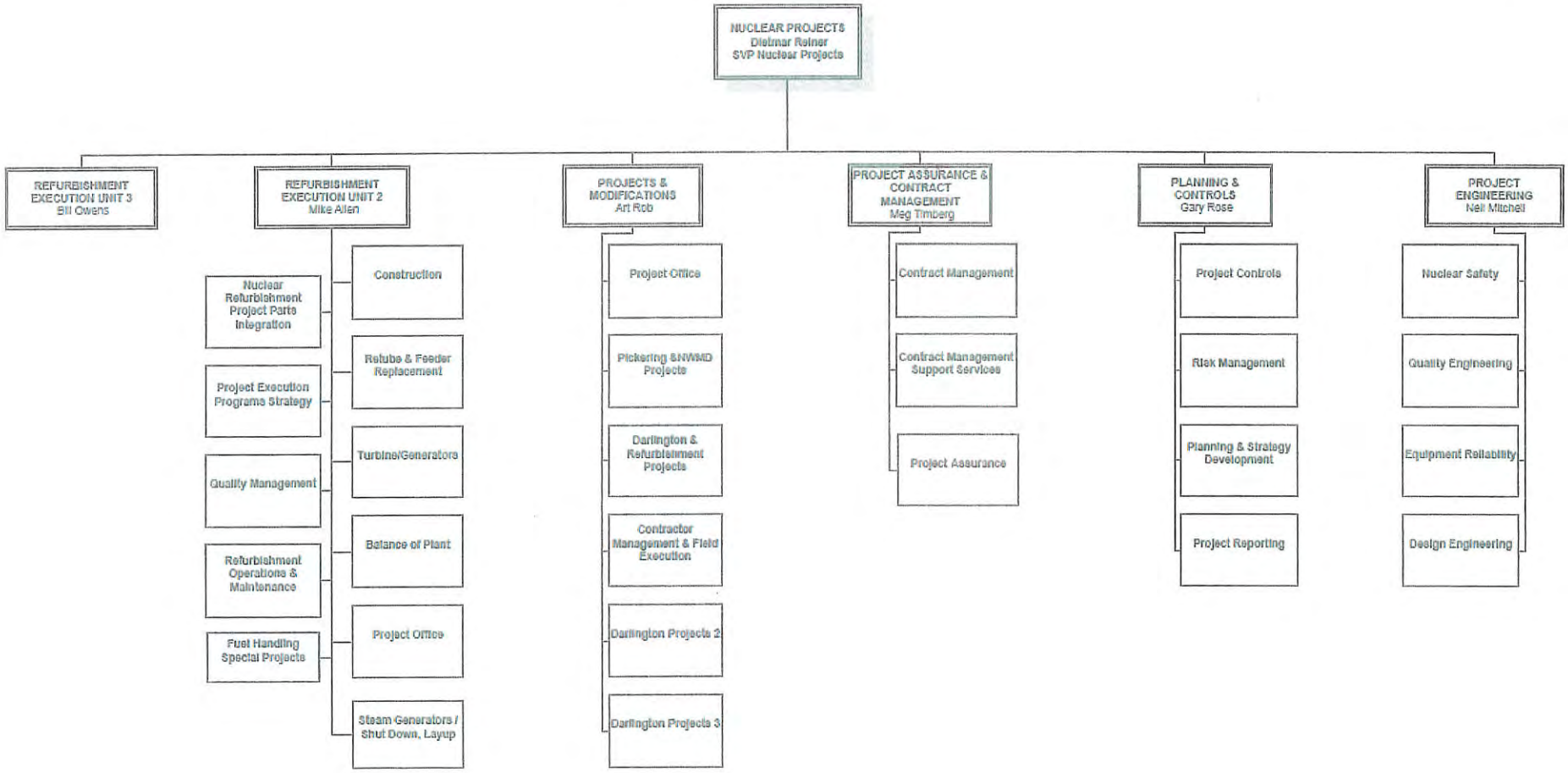
Nuclear Projects Organization

- Refurbishment Execution
- Projects & Modification (F&I Projects)
- Project Engineering
- Planning & Controls
- Project Assurance & Contract Management
- Supply Chain
- Finance
- People & Culture

Nuclear Projects Organization

NUCLEAR PROJECTS ORGANIZATION

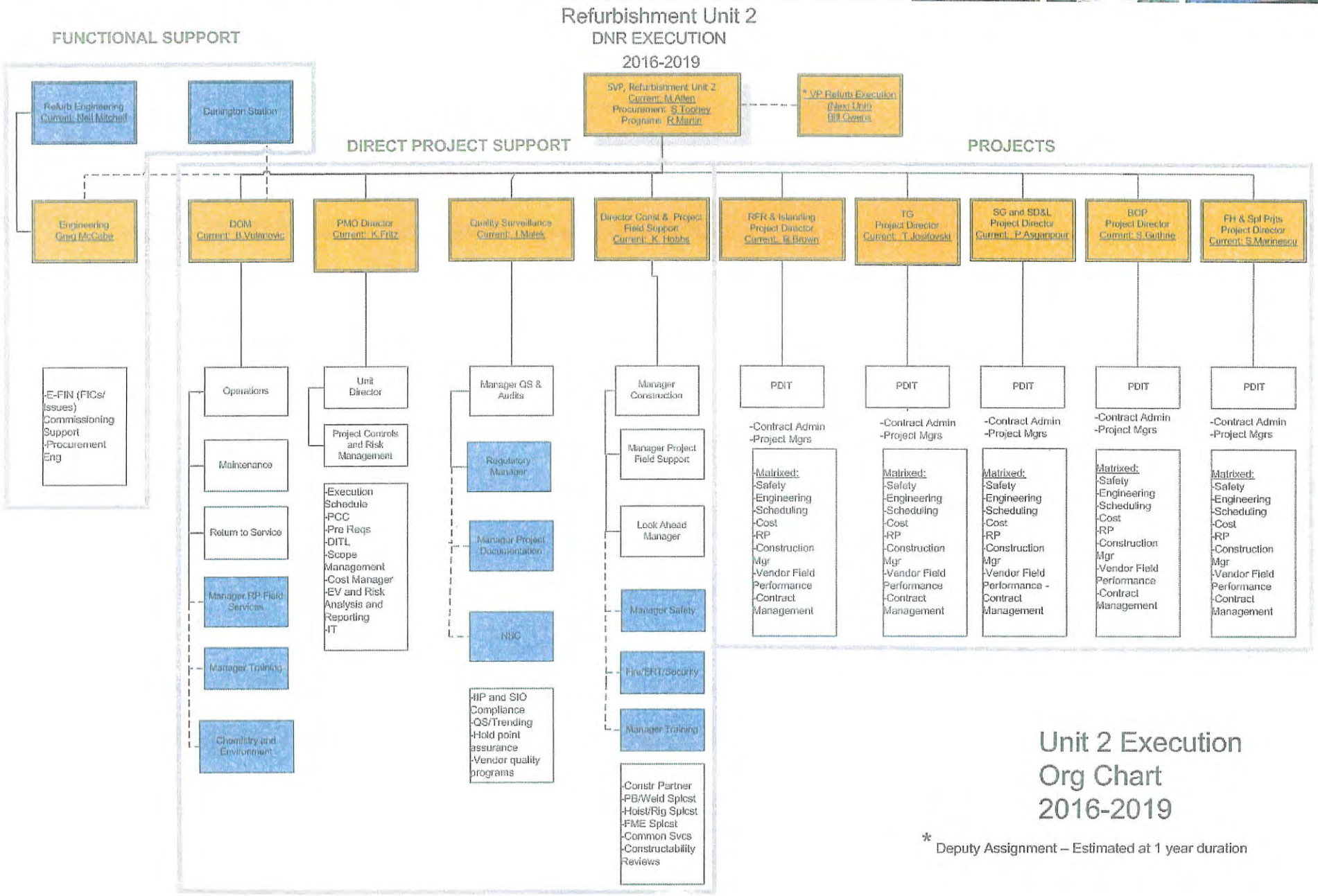
Updated as of: April 21, 2016



Darlington Nuclear Refurbishment Organization

- Darlington Refurbishment Projects is a strong matrix organization
- Refurbishment has an experienced team
- Project Bundles
  - Retube & Feeder Replacement & Islanding
  - Turbine Generator
  - Steam Generator/Shutdown & Lay-up
  - Balance of Plant
  - Fuel Handling/Specialized Projects
- Direct Project Support
  - Operations & Maintenance
  - Quality Surveillance
  - Construction and Project Field Support
  - Project Management Office
- Functional Support
  - Refurbishment Engineering
  - Darlington Station

U2 Refurbishment Execution



Unit 2 Execution Org Chart 2016-2019

* Deputy Assignment – Estimated at 1 year duration

ONTARIO POWER GENERATION

OPG Confidential Exclusive

FOR INFORMATION to the Darlington Refurbishment Committee

March 3, 2016

DARLINGTON REFURBISHMENT PROGRAM – APPLICATION OF LESSONS LEARNED FROM VOGTLE NUCLEAR GENERATING STATION

REASON FOR REPORT

This report provides feedback on the recent article published in the Nuclear Intelligence Weekly regarding the progress of the new build at Vogtle Nuclear Generating Station**.**

HIGHLIGHTS

Recently, an article in Nuclear Intelligence Weekly detailed the continuing new build efforts at Vogtle NGS in Waynesboro, Georgia. The theme of the story was to highlight the ongoing delays of the project, and the continued lack of public confidence in the forecasted completion dates. According to the article, the project is now forecasting a 39 month delay compared to the original project completion date.

Specifically referenced as causes of the delay are:
1) Overall lack of schedule adherence;
2) Late designs and design changes;
3) Complex and congested rebar installations; and
4) A high rework rate.

The article also identified as impediments to progress:
1) Low confidence in the contractors' competency to complete the job; and
2) Insinuation of contractual and commercial friction between the owner and contractors that has only just been resolved.

The observations in the article reflect the major issues of a megaproject engaged in an ongoing execution phase, which the Darlington Refurbishment Program (DRP) is just entering into. The DRP is, however, well positioned to avoid these types of events based on detailed planning and the incorporation of lessons learned during the execution of the Facilities and Infrastructure (F&IP) and Safety Improvement Opportunities (SIO) projects. The Unit 2 definition phase work is complete and the facilities and infrastructure projects are now substantially progressed and approaching completion. The leadership team has already integrated the major learning's from this phase into refurbishment outage planning and have exhibited an ability to work collaboratively with the vendor partners to meet project milestones despite challenges in both design and execution.

The refurbishment outage scope underwent an extensive five year planning phase, specifically learning from other comparable projects that experienced similar issues as Vogtle due to inadequate planning. This sets the DRP up for successful execution during the refurbishment outages. It also gives confidence that major issues experienced on the Vogtle project can be avoided entirely or predicted early and managed in the event they begin to emerge.

The table below compares the Vogtle project issues, similar F&IP and SIO challenges faced and U2 Execution strategies to avoid them during the in-plant work.

Vogtle Project Issues	Past Experience and Darlington Unit 2 Execution Strategy
Lack of Schedule Adherence	During the F&IP projects, many of the schedules, such as the Heavy Water Storage Project, were not of sufficient quality and detail to effectively manage the project and understand progress. Changes to schedule and forecasts resulting from realized risks were not updated quickly and effectively, exacerbating these challenges. The refurbishment outage work will be run with a fully integrated schedule,

Vogtle Project Issues	Past Experience and Darlington Unit 2 Execution Strategy
	closely managed on a daily basis by the project team. A detailed review and validation of the schedule with all vendors will take place in a set of three day offsite meetings in February and March, 2016. During execution, daily schedule reviews and progress meetings will be held to ensure the project is progressing as planned, and to implement recovery plans when necessary. These meetings will be regularly attended by executive leadership to ensure accountability and emphasize the importance of maintaining the schedule. A schedule centric focus, combined with effective forecasting and change control processes will ensure that the schedule is always up-to-date, useful, and viewed as the fundamental tool to manage project execution.
Late Designs and Design Changes	The designs for the F&IP and SIO projects were not 100% complete prior to starting field work in most cases. Changing seismic requirements (Heavy Water Storage Project) and the discovery of field conditions such as soil contamination and abandoned buried services required design revisions and impacted schedule significantly. A major focus of the DRP planning and definition phase was to ensure the completion of detailed designs well in advance of starting execution work. This milestone was achieved in late Q3 2015, such that assessing work and comprehensive work packages could be completed to support the finalization of the integrated schedule for Unit 2 execution. In addition, a rigorous condition assessment, inspection program, and integration in normal station outages provides confidence that the scope identified is stable and there is low risk that new design packages will be required. As is the case in any project of this magnitude, a certain amount of design change, field implemented changes (FICs) are anticipated and the execution organization is resourced to efficiently support this requirement. As the refurbishment outage work will take place inside the station, which is a very well controlled and documented environment, unanticipated or unknown conditions are bounded and contingencies are in place for items such as discovery work.
Complex and Congested Rebar Installations	During the installation of Emergency Power Generator 3, the project experienced exactly this type of issue that has resulted in schedule delays. The in-plant DRP work does not have the complex rebar installations that would be required to construct a new power plant, however there are a number of very complex projects requiring very careful planning and execution in order to ensure quality and schedule adherence. One example of such work is defueling the reactor at the outset of each refurbishment outage. This work, as with all DRP work, is being challenged rigorously in the schedule development process in a series of horizontal and vertical schedule reviews involving inputs from experienced trades and construction resources, operations resources, safety resources and a panel of others to ensure there is no element overlooked in the planning of the work. Further, risks associated with the work have been considered in the planning of the execution windows, and reasonable durations, simulated in a test environment where possible, were used as the basis for planned durations represented in the schedule.
High Rework Rate	A recent quality issues report conducted for Emergency Power Generator 3 indicated there were areas for improvement related to records management, quality, and technical rigour. This specific project has implemented corrective actions but in a broader application DRP has identified key focus areas for Unit 2 to minimize rework. This includes the implementation of processes and critical check points to ensure parts have pedigree, engineering records are in place with verification that proper steps were followed, and inspection and test plans are witnessed and signed off. To assist in ensuring effectiveness, the DRP has dedicated construction oversight resources to augment the vendor partners own oversight and quality programs to ensure the work being performed in the DRP is done properly, the first time. Industry expertise has been retained (Kiewit) and is overseeing construction activities, alongside OPG's and the vendors' own construction management organizations. Quality of installation and minimization of rework is a key

Vogtle Project Issues	Past Experience and Darlington Unit 2 Execution Strategy
	focus area of the organization during Unit 2 execution.
Low Confidence in Contractors	The F&IP and SIO projects have experienced challenges and the project has had to remove vendors who have not performed to expectations. This surfaced an issue of bench strength amongst the vendors with master services agreements (MSA) and DRP has taken action to onboard a new MSA vendor and is in the process of reviewing more potential service providers. For the Unit 2 work, a rigorous pre-qualification process was undertaken to select contractors that have a demonstrated ability to execute the scope of work for Refurbishment. With all contracts awarded early on in the planning phase, and the required detailed schedules and plans (such as procurement plans) in place and established, DRP is now working through the training and qualification programs to onboard the large number of contractor staff. Corrective actions are being taken early when required and the collaborative model of execution (a major lesson learned from the definition phase projects, where contractor performance issues resulted in major schedule delays) is being exploited to foster a team environment and emphasize the shared responsibility for project success.
Contractual or Commercial Conflicts	F&IP and SIO projects were performed under existing master services contract that were not specifically tailored to the type of work being undertaken. Some of these projects are large and complex. As such, some of the detailed planning work that typically results from project-specific contract discussions did not occur, including issues such as ensuring the contractor fully understands the scope, the allocation of responsibilities and risk, etc. The executed contracts for the bulk of the refurbishment work (such as Retube and Feeder Replacement and Turbine/Generator) were built from the ground up and were specifically tailored to the work being performed. They include well defined criteria outlining accountabilities and thresholds for key potential project issues such as rework and discovery work. The pricing mechanisms were designed to be appropriate for the various scopes of work, using a range of pricing models including fixed price, target price and cost plus a mark up. The intent is that risk should be borne by the party who has the best ability to mitigate the risk. Where items are not clearly defined and occur, conflict resolution mechanisms are in place to ensure field work progresses and the schedule is maintained while the issue at hand is dealt with. OPG recognizes that the volume of commercial discussions will likely increase as we move into the Execution Phase of the project. OPG is therefore conducting an RFP to retain a third party expert to assist OPG in resolving commercial issues before they become formal disputes.

CONCLUSIONS

Some refurbishment F&IP/SIO projects were carried out with an expedited execution strategy and experienced issues similar to the project cost and schedule drivers identified in the NIW article on Vogtle. The rigorous 5 year planning and development process and the in-plant nature of the work for Unit 2 combined with the focus placed on integrating lessons learned from the F&IP/SIO projects provides confidence that the DRP is well positioned to minimize the issues endured at Vogtle.

Submitted by:

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Dietmar Reiner
Senior Vice President, Nuclear Projects

APPENDICES

None

Appendix 1: Darlington Refurbishment Pre-Requisite Projects Key Lessons Learned Summary

During the Definition Phase of the Darlington Refurbishment Program (DRP), OPG will have constructed approximately $1 Billion of Facilities and Infrastructure and Safety Improvement Opportunity projects. These projects, which were performed in an expedited manner during the Definition Phase, provided a number of key lessons that have been applied to the DRP.

Key Lessons	Refurbishment Application of Lesson
Collaborative Planning	Collaborative front end planning was put in place to complete engineering, procurement, and detailed work planning to ensure effective integration with the site. Detailed design is complete for Unit 2, over 12 months in advance of the first unit.
Scope Clarity and Control	Processes are being enhanced to align stakeholders on scope, early in the process. Controls are put in place for effective management of scope changes.
Estimating	The DRP has centralized its estimating effort. OPG has completed detailed cost estimates for all scopes of work; over 90% of the Refurbishment scope is at Class 3 or better.
Scheduling	A detailed integrated schedule will be issued prior to the start of the first unit outage. Scheduling standards including work breakdown structure and earned value methods are in place and all vendors are preparing schedules in accordance with those standards. The Project Controls team validates that the schedule meets the required quality prior to acceptance. Work Management integrates the schedule to confirm that the work is doable within the timeframes provided.
Material Tracking	A material tracking database is now in place. Each Project Manager is developing a 'Playbook' that will outline the preparation milestones for Unit 2 Refurbishment. The Playbook dates will align with the Contract Milestones and will ensure the Unit 2 Outage Director that work will be ready to execute for Unit 2, including identification of all materials.
Contractor/Construction Oversight	The amount of field oversight of contractor work was underestimated. Resources to perform construction oversight, clear barriers for contractors, and performance measurement and progress, are included in the refurbishment plan. The existing Contractor Management Office is being enhanced.
Field Engineers	Engineering to support construction activities in the field is built into refurbishment plans.
Sub-surface Risks	An underestimation of sub-surface issues due to incomplete drawings, buried construction debris, groundwater ingress and dewatering, and soil contamination. Additional ground surveys are planned and additional allowances to deal with the unknown sub-surface conditions have been built into project plans. For the Re-tube Waste Processing Building, additional geo-technical surveys as well as allowances to deal with these risks are incorporated into the plan.
Contract and Claims Management	The effort, capability, and timeliness required to monitor and control contract issues and related claims is being enhanced and integrated with project controls systems.

AMPCO Interrogatory #103

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-11, Attachment 3, Page 27
Ref: D2-2-7, Page 6

Preamble: OPG and its experts claim that OPG's DRP project planning process is world class. In describing world-class project planning, Dr. Galloway describes "Management Reserve" as, "Unlike contingency, which covers identified, but not yet realized risks, management reserves are intended to address unforeseeable emergencies that cannot be effectively managed using contingency as they are such [sic] magnitude and rarity that they go beyond project-specific risks." OPG further states, "For a project of the size and duration of the DRP, there are a number of low probability high consequence events that could impact the Program and that are outside of the contingency determined for the Program." By its definition, Management Reserve covers items outside the scope of this hearing; however, it is within the scope of this hearing to determine if OPG has implemented its planning strategy appropriately, and to determine the magnitude of potential risks to the DRP. Therefore, given that OPG states that these risks exist, and given that world-class project planning includes Management Reserve, please:

a) Confirm that Management Reserve has not been included in the DRP estimates. If it has, please explain where and what risks it covers.

b) Confirm that OPG has calculated a Management Reserve estimate.

c) Report the magnitude of the Management Reserve calculated and list the risks it is intended to address.

d) If OPG has not prepared a Management Reserve estimate, explain why it has not in the context of its claims to have followed world-class procedures in project planning.

Response

a) Management reserve is not within the $12.8B estimate.

b) c) and d):

OPG considered management reserve during its project planning. During RQE planning, OPG performed a number of scenario analyses to determine potential impacts of a number of low probability high consequence events that could impact the project and that are outside of the contingency determined for the project, recognizing that these risks are outside of the control of the project to manage or influence. It is difficult to assess the impact of such events, however, OPG's assessment concluded that these low probability events, if they did occur, may result in a project cost impact of up to $800M. This was presented as information to the Board of Directors to consider as part of the decision to approve the RQE. The decision was to not include an explicit amount for Management Reserve within the approved budget. As noted in section 4.1 of Ex. D2-2-7, p. 6, should any of these risks occur, and should they result in the projected DRP cost to exceed $12.8B, Management would evaluate the cost and schedule consequences and provide a recommendation to the Board of Directors for approval on the appropriate response.

Please refer to section 4.1 of Ex. D2-2-7, p. 6, for examples of risks considered.

AMPCO Interrogatory #104

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-10 Page 2
Preamble: The evidence states that to the extent there have been unit-specific engineering costs incurred during the Definition Phase that are not related to Unit 2, such costs are not included in the amounts coming into service in Unit 2 in 2020.

a) Please provide the engineering costs for each unit.

b) Are there any other costs in addition to engineering costs during the Definition Phase that are not related to Unit 2? If yes, please provide details.

Response

a) The breakdown of the total $283 Million functional engineering costs noted in Ex. D2-2-8, Chart 3 is shown below:

Chart 1

M$	Definition Phase	Unit 2	Unit 3	Unit 1	Unit 4	Total
Engineering Costs	62	68	50	48	55	283

In addition to the functional engineering costs, the EPC contracts include engineering completed by the contractors.

b) There are no engineering or other costs for subsequent units in the Definition Phase. Engineering related to Early In-service Projects, the Facilities and Infrastructure projects, and the Safety Improvement Opportunities projects are included in the in-service amounts for those projects. Please refer to Ex. D2-2-10, Tables 2 and 3 for the detailed project list.

As also discussed in L-4.3-1 Staff-054, all of the Definition Phase costs to be placed into service with Unit 2 relate to preparation and planning work which was required to allow OPG to be ready to refurbish Unit 2.

CME Interrogatory #1

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit A1, Tab 3, Schedule 1, page 1 of 2

In reference to the Darlington Refurbishment Project ("RDP"), OPG cites the Conference Board of Canada as stating that construction phase alone is expected to generate $14.9 billion in economic benefits to Ontario. Furthermore, the Conference Board of Canada is also cited as confirming that, at its peak, refurbishment will create 11,700 jobs per year, with an average of 8,800 annually between 2014 and 2023, and it is also expected to increase household revenues in Ontario by $8.5 billion.

As OPG may be aware, CME has historically been interested the economic benefits of nuclear refurbishment. In July 2010, CME issued a report entitled "The Economic Benefits of Refurbishing and Operating Ontario's Nuclear Reactors".

CME wishes to better understand OPG's current understanding of those economic benefits. To this end, please provide the following:

(a) A copy of the report or presentation from the Conference Board of Canada which sets out the economic benefits cited by OPG;

(b) OPG's estimate of the annual direct employment of the refurbishment program from the years 2017 to 2024;

(c) All economic impact analysis in the possession of OPG that quantify the aggregate economic activity in Ontario as a result of the refurbishment program;

(d) To the extent that OPG is in possession of information with respect to the secondary benefits of refurbishment during the period of 2017 to 2024, please provide that information.

(e) To the greatest extent possible, please set out the annualized direct employment in Ontario as a result of refurbishment, and, if possible, set out the disaggregate amount of employees that would be outside of Ontario;

(f) An estimate of the labour income associated with that employment;

(g) An estimate of the annual benefit for Ontario equipment, materials and supplies related to refurbishment; and

(h) To the extent that OPG is capable of providing the direct impact and secondary impact of Ontario employment, labour income and equipment, materials and supplies, please set that out.

Response

a) The report from the Conference Board of Canada, which sets out the economic benefits cited by OPG, is provided in Attachment 1.

b) OPG's estimate of direct employment by OPG for the refurbishment program from the years 2017-2024, as provided to the Conference Board of Canada, is as follows:

Year	2017	2018	2019	2020	2021	2022	2023	2024
Full Time Equivalent Resource	902	913	919	892	972	1000	921	768

c) Please see the Conference Board of Canada Report.

d) Please see the Conference Board of Canada Report, pp. 13 – 16.

e) Please see the Conference Board of Canada Report, p. 16 Chart 3.

f) Please see the Conference Board of Canada Report, p. 25 Table 3.

g) Please see the Conference Board of Canada Report, p. 24 Appendix B.

h) Please see the Conference Board of Canada Report.

The Conference Board of Canada | Le Conference Board du Canada

Refurbishment of the Darlington Nuclear Generating Station.

An Impact Analysis on Ontario's Economy

At a Glance

- The Darlington Nuclear Generating Station is approaching the mid-point of its operating life, and its CANDU reactors require a $12.8-billion investment that is designed to allow the station to operate safely for another 30 years.
- The Conference Board of Canada's analysis shows that the refurbishment investment will boost Ontario's GDP by a total of $14.9 billion from 2010 to 2026, creating 8,800 jobs during that period.
- The project is expected to boost household income by a total of $8.5 billion and corporate profits by $2.8 billion over the project life.

BRIEFING NOVEMBER 2015

The refurbishment of the Darlington Station is expected to boost Ontario's nominal GDP by a total of $14.9 billion from 2010 to 2026.

Executive Summary

Ontario Power Generation's (OPG) Darlington Nuclear Generating Station meets approximately 20 per cent of Ontario's electricity needs.[1] Having been in operation since the early 1990s, the station is approaching the mid-point of its operating life. At this stage, its CANDU reactors require a major refurbishment to replace critical components. As a result, OPG is currently planning a $12.8-billion[2] refurbishment investment project that is designed to allow the station to continue operating safely for an additional 30 years.

The Conference Board of Canada was commissioned to estimate the economic impact of this refurbishment investment on Ontario's economy. The project is currently coming to the end of the Project Definition Phase, after having completed the Initiation Phase in December 2009. The project is expected to enter the Execution Phase in January 2016 as refurbishment work on the first of the four reactors will begin subject to shareholder approval. The Conference Board's objective was to estimate the economic impact of the project's Definition and Execution phases, which will span from 2010 to 2026.

To achieve this, the Conference Board relied on detailed project information provided by OPG. The information included planned expenditures by year, type of spending, nature of the sub-project, and location of vendor. This provided the Conference Board with enough data to perform detailed economic simulations that were used to estimate the impact of the refurbishment investment on Ontario's economy.

1 Hunt, *Nuclear Canada Yearbook 2014*.

2 This is the escalated (i.e., nominal) figure, including $1.5 billion in interest payments.

An input-output economic modelling framework was used to estimate the project's direct, indirect, and induced effects on Ontario's economy. The direct effect includes the income and value of production of economic agents (i.e., workers and firms) directly involved in the project. But to complete their work, these agents need to purchase services and materials from suppliers. These suppliers will themselves require materials and supplies. This sets in motion a chain reaction in the economy, whereby industries supply inputs to other industries that are directly involved in the project. The economic impacts of this chain reaction represent the indirect (or supply chain) effects. Finally, induced effects follow, largely owing to the widespread impact of employees spending the wages and businesses reinvesting the profits earned from the project's direct and indirect activities.

Statistics Canada's detailed model of Ontario's industrial structure was used to capture the direct economic impact of refurbishment and the supply chain impacts of the investment. Results from these simulations were then used to guide simulations with the Conference Board's own proprietary model of Ontario's economy to estimate the full economic impact of the refurbishment investment. The objective of using two models was to take full advantage of each model's unique strengths. In particular, the Statistics Canada model has a more detailed breakdown of industries by region, which allows for a more accurate estimation of the indirect effects. The Conference Board's model is more dynamic and provides results for a wider range of indicators, allowing for a detailed modelling of prices, interprovincial migration, the government sector, households, and businesses.

Our analysis shows that the refurbishment of the Darlington Station is expected to boost Ontario's nominal GDP by a total of $14.9 billion from 2010 to 2026. The boost to economic activity would increase the number of jobs in Ontario by an average of 8,800 over the same period. The impact on jobs is expected to peak at an average of 11,800 per year, from 2014 to 2023.

The refurbishment of the Darlington project is projected to result in a $3.1-billion increase in Ontario provincial government revenues.

Increased employment and GDP translate into increased income. The refurbishment investment would boost household income in Ontario by an average of $502 million per year from 2010 to 2026, or by a total of $8.5 billion. Corporate profits before tax would increase by $2.8 billion over the same 17-year period.

Higher labour income, increased corporate profits, and the purchase of supplies, raw materials, and services would all contribute to increasing government tax revenues. The refurbishment of the Darlington project is projected to result in a $3.1-billion increase in Ontario provincial government revenues—including $1.6 billion in taxes collected and another $1.5 billion in interest payments made by OPG to the government-owned Ontario Electricity Financial Corporation. Meanwhile, the federal government would collect $1.9 billion in revenue, while the local municipalities in Ontario would collect $407 million.

The economic impact analysis allows for the calculation of multipliers, which are rules of thumb that associate the refurbishment investment with employment and overall economic activity. The Darlington refurbishment investment has an estimated Total Multiplier of 1.3—that is, every dollar invested in the refurbishment is expected to increase Ontario's GDP by $1.3. It also has a Type II Multiplier of 2.1, suggesting that the total impact of the refurbishment is more than twice as large as its direct impact. These multipliers are considered strong, which can be attributed to the low import content of the refurbishment project. Data supplied by OPG show that approximately 96 per cent of the project's direct expenditures will take place in Ontario.

The Refurbishment Project

Introduction

Since its first reactor entered service in 1990, the Darlington Nuclear Generating Station has produced about 560 million MWh of electricity from its four CANDU reactors. Today, Darlington has a generating

capacity of approximately 3,500 MW[3] and meets about 20 per cent of Ontario's electricity needs.[4] Having been in service for well over two decades, the Darlington Station is currently undergoing a $12.8-billion[5] refurbishment that is designed to allow for an additional 30 years of continued operations.[6] The Conference Board of Canada was commissioned to estimate the economic impact of this refurbishment investment on Ontario's economy.

In the first part of this briefing, a brief overview of the refurbishment project is provided. In the second chapter, a description of our methodology and assumptions is followed by the findings of our economic impact analysis.

Nuclear Power in Ontario

There are currently three nuclear generating stations in Ontario: Darlington, Bruce, and Pickering. In 2014, nuclear plants generated 94.9 million MWh of electricity in Ontario, which constituted 62 per cent of the total 153.9 million MWh produced in the province. (See Table 1.)

For more than a decade, the Ontario government was committed to eliminating its reliance on coal for generating electricity.[7] The province achieved this goal in 2014, when its last coal-fired plant was closed.[8] During this period, the province's reliance on nuclear power increased significantly. The share of power generated in Ontario from nuclear steam turbines increased from 42 per cent in 2003 to 62 per cent in 2014. (See Chart 1.)

3 Ontario Power Generation, *Performance Report*.

4 Hunt, *Nuclear Canada Yearbook 2014*.

5 This figure represents the escalated (i.e., nominal) estimate of the costs, including interest payments of about $1.5 billion. Throughout the briefing, escalated costs are used to describe the project and its impacts.

6 Ontario Power Generation, *Submission to the Ontario Energy Board*.

7 Gross, "How Ontario Is Winning the War on Coal."

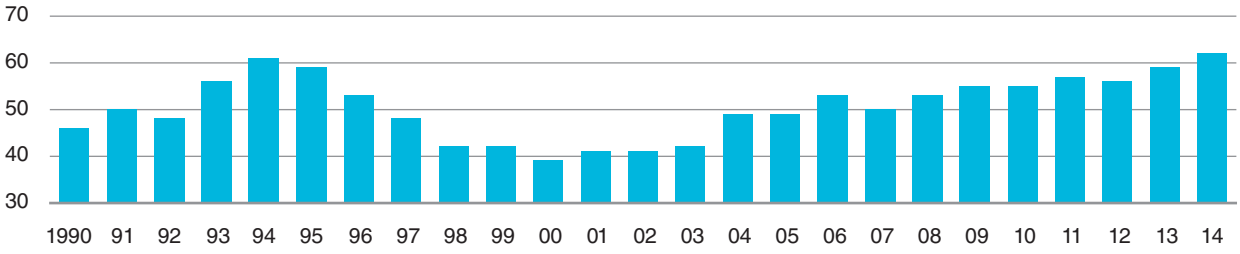
8 Ontario Newsroom, *Creating Cleaner Air in Ontario*.

Table 1
Electric Power Generation in Ontario in 2014
(per cent)

Fuel type	Share of production
Nuclear	61.6
Hydro	24.1
Gas/oil	9.6
Wind	4.4
Biofuel	0.2
Coal	0.1
Solar	<0.1

Source: Independent Electricity System Operator.

Chart 1
Share of Nuclear Power Generation in Ontario, by Year
(per cent)



Sources: Statistics Canada, CANSIM tables 127-0001 and 127-0002; Independent Electricity System Operator; The Conference Board of Canada.

The Darlington Refurbishment Project

The Initiation Phase of the refurbishment project began in late 2007 following direction from the province requiring Ontario Power Generation (OPG) to undertake feasibility studies on refurbishing its existing nuclear units. This work included technical assessments of the major systems,

Our economic impact analysis focuses on the Definition (2010–15) and Execution phases (2016–26) of the project.

a component condition assessment, initial outage planning to determine the refurbishment reference schedule, and the development of initial project governance, including a Project Execution Plan.

Based on this work, OPG prepared an economic feasibility assessment of the refurbishment project and a preliminary release business case. The Initiation Phase concluded on December 31, 2009, with OPG board's approval of management's recommendation to proceed with the refurbishment of the Darlington units and to perform detailed planning, in the Definition Phase, before commencement of the Execution Phase and each unit's refurbishment. The Minister of Energy concurred in February 2010 with OPG's decision and underscored the importance of the nuclear sector to the province's electricity supply in the future. This was reinforced in the 2013 Long-Term Energy Plan.

Our economic impact analysis focuses on the Definition (2010–15) and Execution phases (2016–26) of the project. The refurbishment project is currently in the final stages of the Definition Phase. This phase has two sub-phases: preliminary planning and detailed planning. Preliminary planning involved the establishment of the project management organization, confirmation of contracting strategies, formation of contracting relationships with key vendors, development of project controls governance, and submission of the Environmental Assessment and Integrated Safety Review to the Canadian Nuclear Safety Commission for approval. The detailed planning sub-phase involves implementing all major contracts, completing all planning, finalizing the scope of the project, and procuring key materials.[9] The detailed planning sub-phase is scheduled to conclude at the end of 2015, when OPG requests approval to proceed to the Execution Phase of the project.

9 Ontario Power Generation, *Submission to the Ontario Energy Board*.

The Execution Phase of the refurbishment project consists of three large sub-projects[10] and several smaller ones. The three largest are:

1. re-tube and feeder replacement—the largest of the sub-projects and the core of the refurbishment work—which includes replacing each of the four reactors' 480 pressure tubes and calandria tubes, as well as their 960 feeder pipes;
2. inspection, maintenance, and rehabilitation of the four turbine generators and their control systems;
3. defuelling of the reactors and refurbishment of the fuel-handling equipment.

Together, these three sub-projects consume more than $5 billion and constitute more than 80 per cent of the core refurbishment work.[11] In addition to the three sub-projects above, the Execution Phase includes mechanical cleaning, water lancing, installation of access ports, and inspection work on all of the station's steam generators. The rest of the core work includes the balance of plant work, including the replacement or repair of cooling systems, electrical systems, pipes, and valves. The project's overall budget includes a $1.7-billion contingency fund.

Economic Impact Analysis

Key Assumptions

OPG has committed to refurbishing its Darlington nuclear power plant in Clarington, Ontario. This multi-year, multi-phase project will require a total investment of $12.8 billion from 2010 to 2026. This figure includes cost escalation. In other words, it takes into account expected increases in the price of goods and services. It also includes $1.5 billion in interest payments that OPG will make to the Ontario Electricity Financial

10 Ontario Power Generation, *Performance Report*.

11 Ibid.

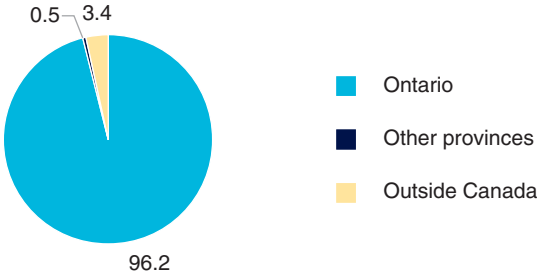
Corporation (OEFC) on loans to complete the refurbishment. The objective of the economic impact analysis is to estimate the economic impact of this investment on Ontario's economy.

It is important to note that the economic impact analysis presented in this briefing is based only on the evaluation of the refurbishment investment of the Darlington Station. In other words, the economic impacts of operating the station during or after the refurbishment are not included in the analysis.

OPG has provided The Conference Board of Canada with detailed information on the expenditures required to fully refurbish the Darlington Nuclear Generating Station over the 17 years of the refurbishment process. Specific assumptions were made about the quantity of construction, engineering and architectural services, and machinery and equipment required. The contingency fund was fully included in the analysis and was assumed to be spent across the refurbishment's sub-projects in proportion to the share of each in the project's overall budget. Interest payments made by OPG to the OEFC were not included in our model simulations. (See "Methodology.") Therefore, the total amount of the investment shock was $11.3 billion. Nevertheless, interest payments were listed as provincial revenues in the results section.

OPG also provided information on spending by the region in which the spending is expected to take place. This shows that 96 per cent of the project's direct expenditures will take place in Ontario. (See Chart 2.) This very low level of imports minimizes economic leakages and maximizes the project's impact on the provincial economy. However, there will still be a sizable quantity of imports in the project's supply chain, which includes machinery, parts, and other materials. Assumptions about the extent of imports in the supply chain were based on historical provincial data from Statistics Canada.

Chart 2
Refurbishment Expenditures, by Region
(per cent)



Source: The Conference Board of Canada.

Concepts and Definitions

The economic impact of any investment in the economy can be divided into three effects: the direct, indirect, and induced effects. The direct effects include the income and value of production of economic agents (i.e., workers and firms) directly involved in the project. But to complete their work, these agents need to purchase services and materials from suppliers. These suppliers will themselves require materials and supplies. This sets in motion a chain reaction in the economy, whereby industries supply inputs to other industries that are directly involved in the project. The economic impacts of this chain reaction are referred to in this briefing as the "indirect effects." Finally, induced effects follow, arising from the reactions of economic agents when production (and therefore income) increases. The majority of induced effects are due to the spending of income associated with the employment created by the initial impact of a project. However, induced effects can also occur due to reinvestment of business profits to expand capacity or replace depreciated capital stock.

The analysis used a two-step process (discussed in the next section) to evaluate the combined direct, indirect, and induced economic impacts of each of the building blocks and scenarios over the 2010–26 time horizon, as follows:

- Direct impact measures the value-added[12] to the Ontario economy of the increased demand for industries providing goods and services directly attributed to the refurbishment of the Darlington Station. A large number of industries are directly involved in the refurbishment. The most significant include electric power engineering construction, and architectural, engineering, and related services.
- Indirect impact measures the value-added that the direct impact firms generate through their demand for intermediate inputs or other support services. For example, the refurbishment of a nuclear reactor in Canada would lift demand for manufacturing, utilities, transportation, financial, and insurance services.
- Induced impacts are derived when employees of the aforementioned industries spend their earnings and owners spend their profits. These purchases lead to more employment, wages, income, and tax revenues, and can be felt across a wide range of industries.

Thus, increased demand in a specific industry will not only have direct impacts on the economy but will also spread through the economy through a series of multiplier effects. Indirect effects are first felt on demand in industries that are direct suppliers. Second-round induced effects produce a widespread impact (albeit usually smaller) on all sectors of the economy, largely through a general increase in consumer spending.

It is important to note that the initial dollar value of the project does not result in a one-to-one increase in GDP. This is because the purchase of goods and services associated with the refurbishment of the Darlington

12 Value-added, or net output, is the difference between total revenue (or gross output) and the sum of expenses for parts, materials, and services used in the production process. Summing the value-added across all industries in a region will yield the GDP in that region.

Ontario's manufacturing base allows it to gain a relatively larger share of the benefits associated with induced increases in consumer spending and business investment.

Station is a measure of gross output and not net value-added. For example, demand for manufactured goods will require intermediate inputs purchased from suppliers that may be outside regional and national boundaries. The dependence of the supply chain on imported components will determine the level of leakages and the extent to which the overall economic multiplier is reduced. Depending on the import content of the inputs of each industry, the economic multipliers can vary significantly. Because Ontario is an important supplier of manufactured components and engineering and architectural services, the province has a larger multiplier associated with the refurbishment of nuclear reactors than other regions in Canada. Moreover, Ontario's manufacturing base allows it to gain a relatively larger share of the benefits associated with induced increases in consumer spending and business investment.

Methodology

The economic impact analysis was conducted using a two-step process. Statistics Canada's provincial input-output (I-O) model simulations were first used to identify detailed supply chain impacts of the investment. Results from these simulations were then used to simulate the Conference Board's provincial forecasting model to estimate the full range of economic impacts from the investment.

The Conference Board's provincial forecasting model captures the sum of direct, indirect, and induced impacts on Ontario's economy, based on estimated historical relationships. The model incorporates a detailed modelling of prices, households, and businesses, and provides economic impact results for a wide range of economic indicators. The simulations were produced over both the Definition and Execution phases of the project, spanning from 2010 to 2026, using the Conference Board's latest long-term economic forecast of Ontario's economy as the backdrop.

Given the complex nature of this refurbishment project, the research relied on the use of Statistics Canada's detailed model of Ontario's industrial structure to assess the direct and indirect effects associated

with the expenditures and activities related to the refurbishment investment. The Statistics Canada interprovincial I-O model finely details the industrial structure within an industry and the linkages of input commodities to other industries.[13] As many of these links are unpublished (due to confidentiality), Statistics Canada has the advantage of being able to assess much more accurately both the direct and indirect effects of the specific investment profiles provided on a national and regional basis.

However, while the input-output analysis is important in measuring detailed supply chain effects, the economic impact results of Statistics Canada's model are static and limited to industrial and employment impacts. In order to generate impacts over time and quantify induced impacts, additional simulations were performed using the Conference Board's provincial economic model. This model contains a less-detailed industrial sector but has the benefit of assessing the impact of additional income (through changes in employment, labour income, and profits) on the regional economies. Moreover, it incorporates a dynamic modelling of prices, the government sector, households, and businesses, providing economic impact results over time and for a wider range of economic indicators.

Results

Refurbishment

GDP and Multipliers

Table 2 presents the economic impact results of the investment in the refurbishment of the Darlington Station. The table displays the cumulative sum of investment spending and economic benefits, as well as the annual average impact over the 17-year time frame of the project. More detailed results by year are provided in data tables in Appendix B.

13 Statistics Canada's regional I-O model breaks down close to 300 industries and over 700 commodities. The 2010 I-O model, just completed in November 2014, was used for the analysis. For more information, see Statistics Canada, *Input-Output Model Simulations*.

Table 2
Economic Impact of the Darlington Refurbishment Investment

	Total (sum)	Average (2010–26)
Total core infrastructure investment* (current $ millions)	11,327	666
GDP at market prices ($ millions)	14,891	876
Household income (current $ millions)	8,538	502
Labour force (000s)	108.1	6.4
Employment years (000s)	149,144	8,773
Housing starts	2,195	129
Multiplier	1.3	

*excludes interest payments
Source: The Conference Board of Canada.

Our analysis shows that the refurbishment of the Darlington Station will boost Ontario's nominal GDP by a total of $14.9 billion from 2010 to 2026. Comparing that figure with the total investment of $11.3 billion[14] yields a Total Multiplier of 1.3. This means that every dollar invested in the refurbishment is expected to increase Ontario's GDP by $1.3 as a result of the direct, indirect, and induced effects of the investment. Adjusting for inflation, the project will increase real GDP (in 2014 dollars) by $13.5 billion.[15]

14 This figure consists of the $12.8-billion total investment less interest payments. Interest payments were excluded from the multiplier calculations because they were not included in our economic impact analysis, except as government revenues.

15 Due to inflation, dollar amounts in the future years of the project (2016–26) will be worth less than they are today. The "real GDP" figure cited here converts the impact on GDP into present-day (2014) dollars, which makes it easier to appreciate or interpret the value of the benefits.

The project is estimated to increase employment in Ontario by a total of 149,100 person-years over the 17-year period.

The Type II Multiplier of this project was estimated at 2.1. The Type II Multiplier differs from the Total Multiplier in that it compares the total impact of a project with its direct impact, rather than the size of investment. Since the direct impact is always smaller than the initial investment spending, the Type II Multiplier is always larger than the Total Multiplier. (See "The Four Different Types of Recognized Multipliers.")

The Four Different Types of Recognized Multipliers

Economic impact studies often refer to multiplier effects when describing their results. However, the type of multiplier described is rarely explicitly mentioned. This creates confusion in some cases, because there are four different types of recognized multipliers that can be derived from an economic impact analysis: 1) Simple Multiplier, 2) Total Multiplier, 3) Type I Multiplier, and 4) Type II Multiplier. Furthermore, each of these four can refer to either GDP or jobs, yielding a combination of eight different multipliers.

This project was estimated to have a Total GDP Multiplier of 1.3 and a Type II GDP Multiplier of 2.1. The difference between a Total Multiplier and a Type II Multiplier is the denominator. The Total Multiplier uses the amount of spending (in this case, total investment) as the denominator, whereas Type II multipliers use the direct impact as the denominator. When assessing the impact of additional spending, the direct impact is smaller than total spending, depending on the amount of goods and services purchased through the supply chain and imports. In cases when the direct impact is much smaller than the amount of spending, there will be large variances between the Total Multiplier and Type II Multiplier—however, the real economic impact is unchanged.

The following equations show how each is calculated:

Total Multiplier = (direct + indirect + induced impacts)/investment amount

Type II Multiplier = (direct + indirect + induced impacts)/direct impact

The Simple and Type I multipliers are similar to the Total and Type II multipliers, respectively, and differ only in that they do not include the induced impacts in the numerator.

Source: Statistics Canada.

The multipliers can be considered strong. This is attributable to the relatively low import content of the project; as described earlier, 96 per cent of the expenditures of the refurbishment project occur in Ontario, with just 0.5 per cent in other provinces and only 3.4 per cent outside Canada. Moreover, the multiplier is high because of Ontario's large manufacturing base, which allows the province to capture a relatively elevated share of the production (and income) from both indirect and induced effects.

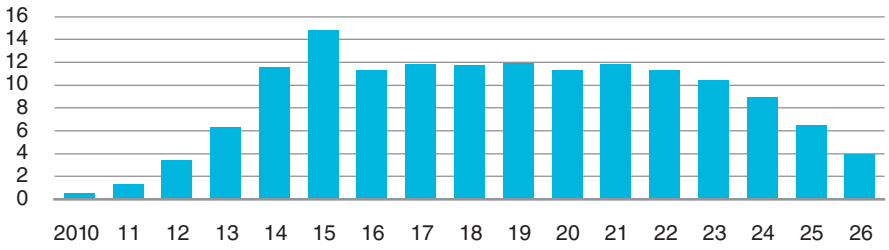
Employment

The project is estimated to increase employment in Ontario by a total of 149,100 person-years over the 17-year period. This means that the refurbishment project will lift the total number of jobs in Ontario by an average of 8,800 jobs from 2010 to 2026. An analysis of the impact over time shows that the largest benefit will occur between 2014 and 2023 (see Chart 3), when the boost to jobs is expected to average 11,800. It is important to note that these figures represent the number of additional jobs present in a given year and not the number of jobs created during a specific year.[16]

Chart 3

Refurbishment Impact on Employment in Ontario

(number of jobs, 000s)



Source: The Conference Board of Canada.

16 The implication of this statement is that it would not be advisable to add the number of additional jobs from two or more years together to create a total. Doing so would give the number of person-years of employment, but not the number of jobs created.

The refurbishment investment will also increase the size of Ontario's labour force, thereby increasing the province's productive capacity. The labour force increases by an average of 6,600 over the investment period. This occurs due to two effects: Ontarians entering (or re-entering) the workforce and interprovincial migration to the province. When demand for labour increases, as is the result in this analysis, job prospects improve, drawing more people into the workforce. The increase in the labour force participation rate can occur among all age groups, but is typical of younger cohorts, who often opt to work when employment prospects improve, sometimes while remaining in school.

Household Income and Corporate Profits

Increased employment and GDP translate into increased income. In fact, the project is expected to boost wages and salaries by $8.1 billion and household income by a total of $8.5 billion, or $502 million per year from 2010 to 2026. Similarly, the project is expected to raise pre-tax corporate profits by $2.8 billion and the pre-tax income of unincorporated businesses by an additional $253 million in this time period.

Household Expenditures and Investment

The increase in wages and salaries will increase household consumption by $7.5 billion, or by an average of $439 million per year. This amount is spent across a broad range of household goods and services, including shelter, food, clothing, and vehicles.

In addition to the direct investment associated with the project, the additional economic activity and job creation will lead to an influx of (largely) interprovincial migrants. This will lift demand for housing in the province. Simulation results suggest that housing starts will be lifted by a cumulative total of 2,200 over the 17-year period, thus boosting residential construction by $1.3 billion. Moreover, the project will increase other non-residential business investment by an additional $1.3 billion, as corporate profits are re-invested into the Ontario economy. This includes structures and purchases of new machinery and equipment.

Local municipalities in Ontario will collect $407 million, consisting mainly of property taxes, developer lot levies, and deed transfer taxes.

Trade

The Darlington Station refurbishment project is projected to lift imports by $7.1 billion and exports by $94 million over its 17-year period. The large increase in imports occurs in part because some project supplies will be imported, but is primarily due to the high import content of machinery and equipment, as well as in household purchases in the "induced effects" described earlier. The small increase in exports occurs due to supply chain transactions that take place internationally or interprovincially.[17]

Government Revenues

Higher labour income, increased corporate profits, and the purchase of raw materials, supplies, and household goods and services contribute to increased government tax revenues. The refurbishment of the Darlington project is projected to result in $183 million per year in additional revenues to the Ontario government, for a total of $3.1 billion. This figure includes $1.5 billion in OPG interest payments to OEFC. Meanwhile, the federal government will collect $111 million per year, for a total of $1.9 billion in revenue over the 17-year period. A slightly larger portion of personal and corporate income taxes accrue to the federal government, since its tax rates are higher. Local municipalities in Ontario will collect $407 million, consisting mainly of property taxes, developer lot levies, and deed transfer taxes. In total, the three levels of government collect $5.4 billion over the entire refurbishment period.

Personal income taxes are projected to constitute about 39 per cent of total taxes collected, while taxes on corporate profits contribute an additional 10 per cent of the total. (See Table 3.) In relation to the total capital cost of the project, for each dollar of capital investment, $0.15 accrues to federal coffers and $0.24 to the Ontario government's coffers.

17 For example, the project may require a machine from Quebec. If, in order to produce this machine, the Quebec-based manufacturer purchases steel from Ontario, then Ontario's exports to Quebec increase.

Table 3
Darlington Refurbishment Impact on Government Revenues
($ millions)

Type of government revenue	Amount
Total federal	**1,891**
Taxes on income	1,626
Taxes on personal income	1,282
Taxes on corporate income	344
Taxes on products	261
Taxes on production	4
Total provincial	**3,116**
Taxes on income	1,049
Taxes on personal income	830
Taxes on corporate income	219
Taxes on products	481
Taxes on production	113
Interest payments	1,473
Total municipal	**407**
Total taxes collected	**5,414**

Sources: The Conference Board of Canada; Statistics Canada.

Given the long duration of the project, it was impractical to include data by year in this briefing. The year-by-year impacts of the refurbishment investment on consumer spending, investment, trade, employment by industry, and real GDP by industry can all be found in supplementary data tables in Appendix B.

Continued Operation

While this briefing does not measure the economic impact of operating the Darlington Station, the operations nevertheless play an important role in Ontario's economy. OPG has provided the Conference Board with some details about its Darlington operations, which are highlighted here.

Darlington's annualized operating, yearly capital, and fuel costs are approximately $1.2 billion per year, including labour compensation and purchases of goods and services.[18] The Darlington Station employs about 2,300 to 2,600 workers, including regular staff at the station and those performing various support functions. The majority of the regular station employees (63 per cent) live in the Regional Municipality of Durham, while the remaining reside largely in Northumberland County, the City of Peterborough, and Peterborough County. Supplemental workers are brought in to support scheduled maintenance outages (these can be large, such as the 2015 Vacuum Building Outage, which required 1,800 supplemental staff). Post-refurbishment, it is expected that Darlington's direct station staff, nuclear support staff, and allocated corporate support staff will be equivalent to about 2,600 to 2,800 on a full-time-equivalent basis.

Additionally, OPG contributes annually to government revenues in numerous ways, including $4 million in property taxes to the Municipality of Clarington and an equivalent amount to the Province of Ontario. Through its Corporate Citizenship Program, OPG provides community investment support to over 300 initiatives annually in Durham Region in the program focus areas of environment, education, and community (approximately $600,000 a year, or 25 per cent of the program's total investment). Since 1999, OPG has provided $9.8 million in Corporate Citizenship Program support in Durham Region. It has also provided $15 million in collaborative educational partnerships with the University of Ontario Institute of Technology (UOIT) and Durham College (Phase I and Phase II). Approximately $1 million in support has been provided to UOIT via the Universities Network of Excellence in Nuclear Engineering.

The economic benefits of OPG's annual $1.2-billion spending post-refurbishment warrants further study, which OPG has requested we do in a further briefing.

18 This includes the compensation of staff resident at the Darlington Station, as well as the compensation of OPG's nuclear support staff and corporate support staff, which may be allocated to Darlington on a proportionate basis.

Conclusion

Our economic impact analysis suggests that the investment in the refurbishment of the Darlington Nuclear Generating Station will increase Ontario's nominal GDP by a total of $14.9 billion. Due to the project's low import content and heavy reliance on Ontario-based contractors, the project has a strong Total Multiplier of 1.3. This means that, on average, for every $1 spent on the project, Ontario's GDP will increase by $1.3. In relation to the project's direct economic impact, the Type II Multiplier is estimated at 2.1.

Over the 2010–26 calendar years, the refurbishment investment is projected to lift employment by an average of 8,800 jobs per year. Household income increases by $8.5 billion, while pre-tax corporate profits increase by $2.8 billion. The increase in economic activity, and the resulting increase in labour income and corporate profits, boost federal, provincial, and municipal governments' tax revenues by a total of $5.4 billion over the project's period. Of that total, $1.9 billion accrues to the federal government, $3.1 billion to the Ontario government (including interest payments made by OPG to the province), and $407 million to local municipalities.

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APPENDIX A

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APPENDIX B

Supplemental Data Tables

Table 1

Darlington Refurbishment Investment Values

Indicator	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Engineering services/project management	34	88	151	144	348	557	620	704	688	716	689	672	606	530	534	324	187
Machinery and equipment/manufacturing	0	0	51	156	153	199	104	79	116	135	87	51	65	34	1	34	1
Construction	3	2	25	119	259	271	99	151	147	131	149	268	273	298	163	97	0

Sources: Ontario Power Generation; The Conference Board of Canada.

Table 2

Refurbishment Investment Impact—Ontario Components of GDP, Expenditure-Based

Current $ millions (market prices)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	TOTAL
Final consumption expenditures	13	41	111	229	434	640	601	557	578	608	614	648	673	658	614	519	390	7,929
Household consumption expenditures	12	39	103	209	402	577	522	513	543	586	596	640	654	637	593	485	355	7,467
Government consumption expenditures	0	2	6	14	23	49	65	33	21	8	2	-9	-1	1	1	14	18	248
Non-profit institution consumption expenditures	0	1	2	5	9	14	14	12	13	15	16	17	19	20	20	19	17	215
Gross fixed capital formation	41	103	266	471	872	1,240	1,056	1,151	1,169	1,202	1,147	1,223	1,174	1,080	895	600	266	13,954
Residential investment	2	7	20	40	77	115	109	94	98	104	105	107	107	101	91	72	46	1,294
Investment in machinery and structures	39	97	246	431	795	1,125	946	1,057	1,071	1,098	1,042	1,116	1,066	979	804	528	220	12,660
Exports	0	0	1	1	-1	0	4	10	13	15	14	13	12	9	5	0	-6	94
Imports	9	32	87	187	362	557	585	581	593	604	591	593	590	559	497	395	262	7,086
Net exports	-9	-31	-86	-185	-363	-557	-581	-571	-580	-589	-576	-580	-579	-550	-492	-395	-268	-6,992
Gross domestic product at market prices	**44**	**113**	**291**	**514**	**943**	**1,322**	**1,076**	**1,138**	**1,167**	**1,221**	**1,185**	**1,292**	**1,268**	**1,188**	**1,017**	**724**	**389**	**14,891**

Source: The Conference Board of Canada.

Table 3
Refurbishment Investment Impact—Ontario Components of GDP, Income-Based

Current $ millions	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	TOTAL
Compensation of employees	25	64	167	316	588	775	603	650	663	692	669	723	710	669	588	441	275	8,618
Wages and salaries	24	61	157	296	552	727	566	610	621	649	628	678	666	628	551	413	258	8,083
Employers' social contributions	1	4	10	20	36	48	38	40	41	43	42	45	44	42	37	27	17	535
Gross operating surplus	19	46	116	177	304	455	340	332	322	317	454	483	428	492	432	230	186	5,132
Net operating surplus: corporation	16	38	91	117	186	279	163	159	149	143	281	294	229	294	243	68	64	2,813
Consumption of fixed capital: corporation and government	3	8	25	60	118	175	177	173	173	174	173	189	200	198	190	162	122	2,320
Gross mixed income	-1	-1	-2	2	12	34	75	100	127	154	5	26	69	-32	-58	8	-105	414
Net mixed income	0	-1	-4	-8	-13	-18	-15	-10	-6	0	9	19	31	44	59	75	92	253
Consumption of fixed capital: unincorporated businesses	0	0	2	10	24	52	90	110	133	154	-4	7	39	-76	-117	-67	-196	161
Taxes less subsidies on production	2	4	11	21	39	50	39	41	42	43	42	45	44	42	37	28	18	548
Taxes less subsidies on product and imports	-1	-1	-2	-1	1	8	20	15	14	14	16	14	16	16	17	17	15	178
GDP at market prices	**44**	**113**	**291**	**514**	**943**	**1,322**	**1,076**	**1,138**	**1,167**	**1,221**	**1,185**	**1,292**	**1,268**	**1,188**	**1,017**	**724**	**389**	**14,891**

Source: The Conference Board of Canada.

Table 4

Refurbishment Investment Impact—Ontario. Real (2007 $ millions) GDP, Basic Prices, by Industry

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	TOTAL
Agriculture	0	0	2	4	5	5	1	1	1	2	1	1	2	1	0	0	(0)	27
Forestry	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	6
Support activities for agriculture and forestry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(0)	1
Fishing and trapping	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mining	1	3	7	10	17	21	14	16	17	17	15	16	14	12	10	6	3	200
Manufacturing	5	10	46	108	137	157	60	58	70	77	55	60	64	52	31	31	10	1,031
Construction	3	5	21	69	142	163	94	111	110	104	108	147	145	147	99	69	28	1,565
Utilities	1	2	4	9	15	19	14	14	14	15	14	15	15	13	12	9	5	189
Transportation and warehousing	1	4	10	18	28	35	22	24	25	26	23	25	24	21	17	12	6	320
Information and culture	4	11	21	27	55	79	74	81	79	81	76	76	69	61	57	37	21	909
Wholesale and retail rade	4	10	29	57	93	125	95	94	97	101	93	96	95	86	74	57	33	1,237
Finance, insurance, and real estate	7	19	48	93	170	232	191	187	191	197	189	199	195	180	157	114	66	2,433
Community, business, and personal services	15	37	82	127	237	325	274	294	295	306	288	295	278	250	222	153	89	3,567
Public sector (including education, health, public administration)	2	5	7	1	39	47	37	33	25	22	27	19	20	22	43	44	54	448
Real GDP at basic prices	**42**	**105**	**276**	**524**	**938**	**1,210**	**876**	**913**	**924**	**949**	**890**	**949**	**921**	**847**	**723**	**532**	**314**	**11,933**

Source: The Conference Board of Canada.

Table 5
Refurbishment Investment Impact—Ontario. Employment, by Industry

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	AVERAGE
Agriculture	4	9	35	75	94	101	27	22	27	31	19	24	25	19	8	6	-4	31
Other primary sector	7	12	30	49	68	88	61	68	67	69	59	60	54	45	38	24	11	48
Utilities	3	7	21	39	70	94	72	70	71	73	68	70	68	62	53	40	24	53
Manufacturing	48	105	458	1,072	1,324	1,511	628	574	652	713	520	552	575	469	288	272	93	580
Construction	32	60	258	950	1,972	2,240	1,353	1,589	1,572	1,502	1,559	2,085	2,062	2,094	1,427	998	426	1,305
Wholesale and retail trade	54	138	400	816	1,317	1,740	1,364	1,337	1,366	1,413	1,308	1,336	1,311	1,193	1,022	783	471	1,022
Transportation and warehousing	20	50	133	256	390	488	310	328	334	347	307	321	304	266	219	155	80	253
Finance, insurance, and real estate	28	74	190	352	618	819	659	661	667	683	645	670	643	586	498	358	206	492
Other commercial services	329	842	1,824	2,747	5,193	7,174	6,344	6,793	6,743	6,925	6,506	6,563	6,111	5,454	4,860	3,342	1,970	4,689
Public sector (including education, health, public administration)	16	52	72	1	499	584	444	373	264	214	282	179	190	233	506	531	679	301
Total employment	**541**	**1,346**	**3,421**	**6,358**	**11,545**	**14,839**	**11,262**	**11,815**	**11,764**	**11,970**	**11,273**	**11,858**	**11,344**	**10,420**	**8,920**	**6,511**	**3,956**	**8,773**

Source: The Conference Board of Canada.

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Refurbishment of the Darlington Nuclear Generating Station: An Impact Analysis on Ontario's Economy

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To cite this briefing: Bounajm, Fares, and Pedro Antunes. *Refurbishment of the Darlington Nuclear Generating Station: An Impact Analysis on Ontario's Economy*. Ottawa: The Conference Board of Canada, 2015.

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PUBLICATION 7529
PRICE: Complimentary

CME Interrogatory #13

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2, Tab 1, Schedule 1, pages 5-6

In 2012, OPG entered into Extended Services Mater Services Agreements (ESMSA's) with two vendors to provide engineering, procurement and construction services. OPG indicates that using Extended Services Mater Services Agreements to undertake major Facilities and Infrastructure projects highlighted weaknesses in project oversight and to contractor issues related to planning, scope, cost estimating, subcontractor management and risk management. OPG has work categorized as "Balance of Plant" under OPG's ESMSA.

(a) Please provide a brief summary of any amendments to the ESMSA have been made to address the contractor issues identified in relation to the construction of facilities and infrastructure projects such as the D20 Storage Facility and the Auxiliary Heating System projects?

(b) Are the vendors who are contracted to undertake the "Balance of Plant" work required in connection with the DRP the same vendors who undertook the D20 Storage Facility and the Auxiliary Heating System projects?

(c) Did OPG successfully exercise any of its contractual remedies under the ESMSA against its vendors in response to contractor issues arising in connection with the delivery of the D20 Storage Facility or the Auxiliary Heating System projects. If so, please provide details.

Response

a) Both the D2O Storage Facility (Heavy Water Facility) and the Auxiliary Heating Systems projects were executed under purchase orders to an ESMSA. The ESMSAs themselves were not amended to address the contractor issues identified in relation to the construction of facilities and infrastructure projects such as the Heavy Water Facility and Auxiliary Heating Systems Projects.

For the Heavy Water Facility project, the purchase order under the original ESMSA contractor was ultimately terminated and a new ESMSA contractor was awarded the purchase order to finish the project. For the Auxiliary Heating Systems project, approximately 75% into the project, the pricing model under that particular purchase order was converted from a Performance Fee to a Fixed Price Fee for completion.

b) Both contractors are performing some of the Balance of Plant work under the ESMSA Agreements. Please refer to part d of L-4.3-20 VECC-2 for more information on the Heavy Water Facility contractor.

c) Please see part a of L-4.3-1 Staff-78.

CME Interrogatory #14

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2, Tab 2, Schedule 1, pages 2-3

OPG states that it has a high level of confidence in the DRP Cost Estimate of $12.8 Billion:

a) Is the $12.8 Billion in 2016 dollars? If not, what is the estimated cost of the DRP in 2016 dollars?

b) Please confirm that the DRP cost estimates contained in OPG application use a consistent base year for describing cost estimates. If not, please explain where and why the base year differs.

Response

a) The $12.8B is not in 2016 dollars; it includes interest and escalation and, therefore, represents the total forecast cost at completion. For clarity, OPG's forecasts that when the DRP is completed in 2026, the total amount expended on the DRP, if all annual expenditures were to be summed, would be $12.8B.

   The estimated cost of the DRP in 2016$ is $10.6B. This is obtained by taking the cost of $10.4B in 2015$ quoted in the Darlington Refurbishment Program Execution Phase Business Case Summary (see Ex. D2-2-8, Attachment 1, p. 2 and p. 29, Table C1) and multiplying by an assumed Consumer Price Index of 2% for 2016.

b) With the exception of contingency estimates provided in Ex. D2-2-7, pp. 6-9, which are in 2015$ (i.e., excludes interest and escalation) and several references in the Darlington Refurbishment Program Execution Phase Business Case Summary (Ex. D2-2-8, Attachment 1), OPG has tried to ensure that all costs that are provided are as described in part a), i.e., total expenditures including interest and escalation. OPG's convention is to use $M when costs include interest and escalation and 2015$, when costs do not include interest and escalation (sometimes referred to as "overnight costs" or constant $).

CME Interrogatory #15

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2, Tab 2, Schedule 1, Attachment 5

In Chart A- 1, OPG outlines the actual costs related to the environmental studies, monitoring and adaptive management projects required by the Darlington Refurbishment Program EA and follow-up program:

(a) Please expand the chart to include the projected cost of each of the EA Follow-up Studies and Environmental Monitoring Studies;

(b) Where in the application are the total EA costs for the DRP provided (excluding costs associated with adaptive management programs which we understand are currently not known)? If they are not provided, please provide them.

(c) Is OPG able to provide any estimates as to the potential costs of adaptive monitoring which may be required in connection with the DRP.

Response

a) Please refer to Ex. L-6.4-10 LOW-4.

b) The cost to develop the Environmental Assessment for the Darlington Refurbishment Program was $11M.

c) Please refer to Ex. L-6.4-10 LOW-4.

CME Interrogatory #16

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2, Tab 2, Schedule 3

OPG states that it has developed the DRP in accordance with recommendations from the Project Management Institute. Did OPG refer to specific guidelines or reports prepared by PMI? If so, please provide copies of these guidelines or reports

Response

The Project Management Institute (PMI) is a professional organization which sets standards and offers training and certifications, including the Project Management Professional (PMP) designation. OPG's Darlington Refurbishment Program (DRP) has many employees who hold the PMP designation and, therefore, have access to the many Standards, Guides and Reports available through the PMI.

It is not possible for OPG to list all of the guidelines and reports that its employees consulted as OPG planned the DRP throughout the Definition Phase. However, OPG notes that the main document is the Project Management Body of Knowledge (PMBOK) as well as the Standard for Program Management. Additional standards were used for scheduling, work breakdown structure, and earned value management.

OPG cannot provide copies of these guidelines and reports, as they are made available to members of the Project Management Institute only. Please see the PMI's website for more information.

CME Interrogatory #17

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2, Tab 2, Schedule 8

OPG provides a detailed cost break down of release quality estimate (RQE) components of the DRP. The RQE total cost attributed to "Balance of Plant" is $967 Million. The presentation materials at pg. 12 list a contract value of $783 Million for "Balance of Plant."

(a) Please explain the discrepancy.

(b) Is OPG undertaking $184 Million of work associated with "Balance of Plant" outside of the ESMSA? If so, who is undertaking the work?

Response

a) The $783M for Balance of Plant noted in Ex. D2-2-3, Chart 2 (and in OPG's untranscribed technical conference presentation, p. 12) is the value of the EPC and ESMSA contracts in place for the Balance of Plant work.

The $967M for Balance of Plant noted in Ex. D2-2-8, Chart 3, represents the RQE total cost for Balance of Plant, including EPC and ESMSA contract costs and OPG's oversight costs.

The $184M difference is OPG's oversight costs, including OPG labour and support costs.

b) As noted in answer a) above, the $184M represents OPG's oversight costs, including OPG labour and support costs.

CME Interrogatory #18

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2, Tab 2, Schedule 8. Attachment 1

At page 15 of the power point presentation which OPG provided in advance of the untranscribed Technical Conference which took place in these proceedings on September 23, 2016, OPG notes that it conducted a vetting process to establish the cost of work estimate for the DRP which included "comparisons to benchmarks" and benchmarking "information from other refurbishments." The Appendix C to the Darlington Refurbishment Business Case Summary refers at page 28 to "benchmarking against publicly available costs of other CANDU refurbishment projects at Pt. Lepreau and the Bruce 1 & 2 Units.":

(a) Are Pt. Lepreau and Bruce 1 & 2 the only nuclear refurbishments that OPG benchmarked its cost estimates against? If not, what other refurbishments were considered for this purpose?

(b) Please provide the information that was used to conduct the benchmarking exercise?

(c) Please describe any adjustments which were made to the information in order to effect the costs comparison;

(d) Please provide the results of the benchmarking exercise?

(e) Did the benchmarking exercise cause OPG to increase or decrease any of its costs estimates? If so, please provide particulars. If not, why not?

Response

a) Pt. Lepreau and Bruce Units 1 & 2 are the only other completed CANDU nuclear refurbishments where OPG had sufficient information to benchmark the costs against DRP in aggregate. Given the distinct design of the CANDU stations, and the distinct nature of the CANDU refurbishment (replacement of the fuel channels), other CANDU units are the only units with which it is possible to carry out cost benchmarking at an aggregate level. Please see L-04.3-1 Staff-52 for a discussion of similarities and differences between CANDU stations which have undergone or are planned to undergo

refurbishment. Also, please see Ex. L-04.3-8 GEC-014 for a discussion of cost estimates for the Gentilly station which OPG reviewed.

b) OPG did not classify the information used to do cost benchmarking separately from all of the other information used to derive lessons learned. Please see Ex. L-04.3-2 AMPCO-52, Attachment 3 which provides a summary of the lessons learned library from the Risk Management and Oversight (RMO) tool for 2014-2015.

c) The only major adjustment OPG made in carrying out the cost benchmarking was to recognize the differing sizes of the Pt. Lepreau unit versus the Bruce and Darlington units in the number of fuel channels (380 fuel channels in Pt. Lepreau vs. 480 fuel channels in the Bruce and Darlington units), and to note that Pt. Lepreau is a single unit with a dedicated fueling machine and without interferences from other units.. At a high level, OPG was also aware of scope differences between the Bruce Units 1 and 2 refurbishments and the Darlington refurbishment, specifically in the area of replacement of the steam generators. In addition, OPG was aware that the Bruce Units 1 and 2 refurbishments were begun after the units had already been defueled and “cold” for a number of years, whereas the Darlington refurbishments will commence immediately after shutdown of the units, with other operating units immediately adjacent, and that the defueling exercise would take place with other operating units needing to utilize the shared fuelling machines. Please see Ex. L-04.3-1 Staff-52.

d) There are no reports on the cost benchmarking exercise.

e) The aggregate cost estimate benchmarking was not used directly to drive discussions with its contract partners, however, specific benchmarks were used as direct input into the Re-tube and Feeder Replacement estimate.

CME Interrogatory #19

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2. Tab 2. Schedule 2 at Attachment 1

In September of 2013, Concentric Energy Advisors produced a report titled "Assessment of Commercial Strategies Developed for the Overall Darlington Refurbishment Project and the Retube & Feeder Replacement Work Program. This report was filed in OPG's 2014 - 2015 rates application. Has Concentric provided any update to its report?

Response

The following response has been prepared by Concentric:

Concentric completed an update of its September 2013 assessment of the Retube and Feeder Replacement work package in July 2016. However, this July 2016 assessment is limited in scope to the Retube and Feeder Replacement work package and does not reflect an update to Concentric's assessment to the Darlington Refurbishment Program overall.

Concentric's July 2016 report entitled, "Updated Assessment of Commercial Strategies Developed for the Darlington Refurbishment Program Retube and Feeder Replacement Work Package" is filed at Ex. D2-2-11, Attachment 1.

CME Interrogatory #20

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2, Tab 2, Schedule 2 at Attachment 1, page 8 of 16

According to Concentric, one the significant advantages of the "multi-prime" contracting strategy that OPG has adopted for key aspects of the DRP, including the Retube and Feeder Replacement Project, is that it will provide OPG with the ability to transfer work between major vendors if such a transfer promotes efficiency and value for money.

(a) Do the contracts that OPG has entered into with the SNC/AECON Joint Venture preserve an ability to transfer components of the work to other vendors?

(b) To the extent that the contracts with SNC/AECON preserve the ability to transfer work to another vendor, who would that work be transferred to?

(c) Please provide an example of a scenario where OPG might transfer work.

Response

a) Yes. Under section 4.2 of the agreement provided in Ex. D2-2-3, Attachment 6, OPG has broad rights to make unilateral changes to the work, including transferring components of the work to/from the SNC/AECON Joint Venture to another contractor without invalidating the agreement. The Target Cost would be adjusted accordingly. Also, under the default provisions in section 14.3, OPG could transfer components of the work to other contractors as a remedy for any SNC/AECON Joint Venture event(s) of default. Equivalent provisions are found in the other major Darlington Refurbishment Program agreements.

b) A transfer of the work from the SNC/AECON Joint Venture to another contractor would be considered on a case by case basis based on the needs of the Darlington Refurbishment Program. In making the decision, OPG would consider the cost, schedule, quality and risk impacts related to the transfer of the work. OPG can also transfer the work back to OPG, in order to self-perform the work.

c) As examples, OPG may consider transferring work to another contractor for work-flow optimization or a reduction in risk to critical path work. Additionally, as discussed above, if

the SNC/AECON Joint Venture fails to perform any elements of the work, OPG could transfer the work to a contractor that can meet the performance expectations using either section 4.2 or the default provisions in section 14.3.

CME Interrogatory #21

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2. Tab 2. Schedule 7

This exhibit describes the total DRP contingency of $1.78 and confirms that contingency amounts are expected to be expended because there are risk items and uncertainties that will occur and connect be entirely mitigated or avoided. A contingency amount of $694.1 M is attributed to Unit 2 which is expected to come into service during the test period. OPG proposes that the variance between actual costs and firm commitments and those forecast costs and firm financial commitment underpinning the 2017-2021 annual nuclear revenue requirement be recorded in the Capacity Refurbishment Variance Account (CRVA):

(a) Please confirm that to the extent that the whole of the $694.1 M contingency for Unit 2 is spent, this entire amount will be recorded in the CRVA;

(b) Will detailed explanations for the expenditure of contingency be included in the annual reporting that OPG proposes to provide with respect to the DRP?

Response

(a) OPG confirms that the Capacity Refurbishment Variance Account will record the revenue requirement impact of the full amount of variances between actual and forecast in-service amounts associated with Unit 2, including the impact of any variances related to unspent contingency.

(b) Please see L-4.3-2 AMPCO-154.

CCC Interrogatory #18

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Ex. D2/T2/S11 Attachment 3 p. 8
This testimony from Dr. Patricia D. Galloway asserts at several places that OPG used a "p90" confidence level when setting the contingency amount for the DRP of $1.7B.

a) What is the level of contingency that would result from utilizing a p50 confidence level?

b) Please provide a table that illustrates, for the test period, both the "as filed" in service additions for the DRP and the reduced in service additions for the DRP during the test period based on the lower contingency amount that results from using a p50 confidence level. Please estimate the reduced revenue requirement for each of the test years in relation to the p50 scenario.

c) Please list and describe all of the risks that OPG considered may contribute to increased costs for the DRP where the nature of the risk is such that if manifested the added cost would not be appropriately recovered from either OPG's contractors or from OPG's ratepayers, but rather absorbed by OPG directly.

Response

a) The level of contingency that would result from using a P50 confidence level is $1.4B (2015$) excluding interest and escalation. Please see L-4.3-2 AMPCO-70.

b) The total contingency for Unit 2 is $694.1M (Ex. D2-2-7, p. 7) which includes interest and escalation. This amount is included in the in-service amount of $4.8B for Unit 2 in 2020. As noted in part a), the amount of contingency for the four unit refurbishment at the P50 confidence level is $1.4B (2015$). The contingency amount for Unit 2 at the P50 confidence level is estimated by prorating the P50 and the P90 contingency estimates in the RQE and is therefore estimated to be $578M ($694.1M X ($1.4B/$1.7B)), including interest and escalation. Thus, the estimated revised in-service amount for Unit 2 in 2020 would be reduced by $116M ($694M-$578M) to $4,693M.

Please refer to the chart below for the revised in-service amounts:

Chart 1

	2017 ($M)	2018 ($M)	2019 ($M)	2020 ($M)	2021 ($M)
Filed Evidence – In-Service Additions (1)	374.4	8.9	0.0	4,809.2	0.4
Estimated In-Service Additions with Unit 2 P50 Contingency	374.4	8.9	0.0	4,693	0.4

Note (1) – Please see Ex. D2-2-10, Table 5.

OPG estimates that in-service additions of $4,693M in 2020 and associated reductions in capital expenditures leading up to that point would reduce the 2017-2021 revenue requirement by approximately $18M, as follows: $2M increase in 2019, $9M decrease in 2020 and $11M decrease in 2021. These estimated amounts were derived in the manner shown in L-04.3-2 AMPCO-77.

c) There are no risks that OPG considered at the program or project level that would not appropriately be recoverable through the CRVA.

CCC Interrogatory #19

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Ex. D2/T2/S8 page 3
The evidence asserts that the RQE is a Class 3 estimate, and that Class 3 estimates can be expected to be as much as 20% too high and as much as 30% too low.

a) Please explain how it is that there is no double counting of contingencies within the RQE, when the RQE is to be considered to accurate only to within a band of -20% to +30%, while at the same time a contingency amount of $1.7B to cover unspecified risks was built into the RQE by OPG.

Response

Please see L-4.3-1 Staff-75.

CCC Interrogatory #20

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Ex. D2/T2/S3

a) Please confirm that all of the contracts that OPG has entered into with contractors for the completion of the DRP span the proposed refurbishment of all 4 units that are part of the DRP. If that is not the case please explain how contracts have been split between the different units, including a description of how much of the $12.8B RQE is subject to contracts that span the refurbishment of all 4 units and how much of the $12.8B RQE relates to unit specific aspects of the DRP.

b) Please confirm that the refurbishment of each of the 4 units that make up the DRP are materially identical; to the extent that there are material differences in the scope of the work that is to be (ultimately) completed on one or more of the units as compared to one or more of the other units, please detail those differences including the scope of the work and the cost of the work as a component of the overall $12.8B RQE.

c) Assuming a) is confirmed, please explain whether and how OPG has ensured that to the extent that OPG and its contractors learn from the refurbishment of Unit 2 in the first instance such that the refurbishment of subsequent units can be performed more efficiently and inexpensively, the contracts entered into between OPG and its contractors capture those efficiencies and cost savings to the benefit of ratepayers in the arrangements covering each subsequent unit within the DRP.

Response

a) All major Darlington Refurbishment Program (DRP) contracts span the refurbishment of all four units.

b) There are no material unit-to-unit differences in the refurbishment work on the majority of the work packages with two exceptions:

   1. Turbine Generators - Turbine Controls are only being replaced on Units 1, 3, and 4, and Stator replacements are only occurring on Units 3 and 4. The Turbine Controls on Unit 2 will be replaced at a later date outside of the DRP.

2. Unit 2 includes certain isolation activities that are not required on other units. This is due to the fact that Unit 2 was the first unit constructed at Darlington and carries some systems that are shared with the other units.

c) OPG and its contractors' quality programs require that continuous improvement programs be in place, which includes incorporating lessons learned and operational experience. This will help ensure that efficiencies and cost savings are realized on subsequent units. Lessons learned from other refurbishment projects confirm that this is a reasonable expectation.

In addition, most of the DRP projects (save for the Steam Generator work package) employ a reimbursable target cost model, which provides incentives to the contractors to reduce costs and realize on efficiency gains. Where costs efficiencies are realized, OPG pays actual costs for the work completed by the contractor for target cost work and the costs savings are passed on to rate payers through reduced project costs. The Capacity Refurbishment Variance Account will record the revenue requirement impact of the full amount of variances between actual and forecast capital and non-capital costs.

Please see also L-4.3-15 SEC-023 for more details on efficiency and productivity measures built into the contracts.

Although the contracts are in place, all target price contracts will be negotiated on a unit by unit basis to ensure that any opportunity for cost reductions are applied in each successive unit.

EP Interrogatory #9

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2

Does OPG have any evidence of other nuclear refurbishments that have constructed a mock-up reactor?

Response

Ontario Hydro built a reactor mock-up for training and re-tube of the Pickering Units 1 to 4 reactors in the 1980s. It was not as extensive as the one built for the Darlington Refurbishment Program.

OPG is also aware that each of Bruce, Pt. Lepreau, and Wolsong used partial mock-ups to test their tools; however, none had a full-scale mock-up to perform a full suite of testing. As a result of this, the actual productivity experienced was lower than predicted because those mock-up were used primarily to test the performance of tools, but did not mimic the working conditions on the face of the reactor. OPG learned lessons from this, and for the DRP, has built a full scale mock-up in order to train staff in near real conditions on the face of the reactor. In addition to a mock-up of the reactor face, the mock-up for the DRP attempts to mimic all of the space constraints and access restrictions, in order to test all required logistics for movement of people, equipment and components throughout the reactor vault. Staff have also been trained in reduced lighting conditions in order to simulate the lighting conditions within the reactor.

EP Interrogatory #10

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Can OPG provide a detailed breakdown of the projected and (now) finalized costs of all spending leading up to the shutdown of Unit 2.

Response

The detailed breakdown of the projected life-to-date expenditures at Dec 31, 2015 is shown in Ex. D2-2-8, Attachment 1, p. 29, Table C1. At the time (November, 2015), this was a projection to year-end 2015. The detailed breakdown of the projected expenditures in 2016 up to the October 15 start of Unit 2 refurbishment is shown in Ex. D2-2-8 Attachment 1, p. 40, Appendix D.

To prepare a similar chart to that shown in Ex. D2-2-8, Attachment 1, p. 40, Appendix D, OPG has added projected costs for the first 2 weeks of October of approximately $46M, to the actual costs incurred life-to-date for the DRP to September 30, 2016. This chart is included as Attachment 1.

Attachment to L-04.3-6 EP-010

NR Actual Cost - Inception To-Date thru Breaker Open*

Line #	Description	Cost $
1	NR - Retubing & Feeder Replacement	937,949,240
2	NR - Turbine Generator	160,845,807
3	NR - Balance of Plant	114,376,802
4	NR - Fuel Handling	16,077,766
5	NR - Defueling	32,407,982
6	NR - Steam Generator	19,366,569
7	NR - Specialized Projects	34,504,861
8	NR - Shutdown, Layup and Services	40,945,397
9	NR - Refurbishment Support Facilities	31,990,108
10	NR - Unit Islanding	47,746,244
11	NR - Waste Disposal	-
12	**SubTotal Bundle Projects**	**1,436,210,776**
13	NR - Campus Plan F&IP Projects	622,647,482
14	NR - SIO - Safety Improvement Opportunities	256,978,669
15	**SubTotal Campus Plan Projects**	**879,626,151**
16	NR - Project Office	16,002,968
17	NR - Contract Management	13,123,285
18	NR - Engineering	151,226,535
19	NR - Managed Systems Oversight	17,905,424
20	NR - Planning & Controls	90,628,877
21	NR - Program Fees & Other Support	62,470,071
22	NR - Supply Chain	18,556,229
23	NR - Project Execution / Construction OS	31,353,248
24	NR - Operations and Maintenance	94,892,941
25	NR - Release 3	125,299,260
26	NR - Release 4	9,078,379
27	**SubTotal Functions**	**630,537,217**
28	Escalation **	-
29	Interest **	-
30	**Nuclear Refurbishment Program**	**2,946,374,144**

* Represents AC thru Sept 30,16 and estimated costs Oct 1 - 15, 2016

* Note: escalation and Interest are allocated and reported as against each bundle and function.

EP Interrogatory #11

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2, Tab 2, Schedule 5, page 1

Can OPG provide a detailed breakdown of the "change control process to control scope growth."

Response

Please see L--4.3-1 Staff 48, item 27, for a copy of the Nuclear Refurbishment - Program Change Management (N-MAN-00120-10001-PC-12) process. The change management process is used to control any changes to the DRP, including scope.

Please also refer to L-4.3-1 SEC-38 for more information on the change management process, as well as L-4.3-2 AMPCO-58 with respect to how OPG has managed or avoided scope growth/creep.

EP Interrogatory #12

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2, Tab 2, Schedule 7, page 5

1. Does OPG have a list of other major infrastructure projects that have used the Palisade software to establish their contingency?

2. Is OPG aware of any cost overruns at projects that have used the Palisade software to establish their contingency?

Response

1. No. However, information on the industries and types of applications where Palisade's @Risk software has been used can be found at Palisade's website.

   @Risk is a widely used software in many industries to perform risk analysis including Monte Carlo analysis and decision tree analysis. It is not only used for major infrastructure projects.

   The Palisade website states that they have been in business for over 30 years, have 150,000 users, including 93 Fortune 100 companies.

2. OPG is not aware of cost overruns at projects that have used the Palisade software to establish their contingency.

EP Interrogatory #13

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2, Tab 2, Schedule 7, page 6

Can OPG provide a list of the "low probability, high consequence events" that the company didn't consider in establishing its contingency amount.

Response

The list includes:

- a significant labour disruption
- changes in the political environment
- an international nuclear accident (Fukushima-type event) or incident
- unforeseen changes to financial and other economic factors beyond those assumed in the Program
- an unforeseen natural disaster (e.g., tornado; earthquake, hurricane)
- a world event (e.g., Sept 11. 2001-type event) which causes a significant escalation in security, affecting access to the plant and productivity
- a failure of the information technology infrastructure (outside of OPG)
- societal breakdown/war/civil disruption

OPG provides an elaboration of the financial and other economic factors which fall into this category in Ex. L-04.3-2 AMPCO-071, part c).

EP Interrogatory #14

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2-2-8, Attachment 1, page 16

Does the Levelized Unit Energy Cost (LUEC) include the cost of interest that will be owed due to rate smoothing and deferral? If not, Can OPG calculate what they will add to the LEUC estimate?

Response

The question makes an assumption that the LUEC would be influenced by decisions on OPG's approach to cost recovery through rates. Rates and LUECs are not the same (see below). The deferral of revenue recovery through rate smoothing, which is what generates the interest costs, does not affect the LUEC calculation. Therefore, OPG cannot calculate what amount the inclusion of interest costs associated with rate smoothing would add to the LUEC.

LUEC is an economic measure used to compare the relative economics of alternative generation options. The calculation of the LUEC utilizes present value techniques to ensure full recovery of all investment, operating and post-operation costs (e.g., decommissioning) over the operating life of the option.

While LUEC can provide an indication of the long-term rate of a generation option over the life of that option required to fully recover the costs of that option, it is not the electricity rate. Because LUEC is "levelized", it is one constant number (usually expressed in a particular year's dollars). LUEC escalates at the rate of inflation.

Annual rates reflect annual specifics such as: (1) fluctuations in generation by year; (2) fluctuations in operating costs by year (e.g., costs are higher in years with vacuum building outages); (3) in-service amounts added to the rate base. These impacts are all "smoothed out" in a LUEC calculation, which represents an average over a full life cycle period.

EP Interrogatory #15

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2-2-8, Attachment 4, page 15

OPG states that it had reached an agreement with the Joint Venture (JV) that has eliminated and "Productivity Gains."

Can OPG please explain what is meant by that comment. Does that mean the JV is not required to show productivity gains over the course of the DRP?

Response

OPG notes that the full quote from the Expert Panel Report is as follows:

> "It has been reported that this agreement was reached with some adjustment to contractual requirements, many of which were identified as key "Negotiating Strategy" concepts in the Milestone Report such as the incorporation of an RP protocol, the elimination of the Productivity Gains, and an increase in Neutral Band. The Panel does not have visibility to the final details on these adjustments however assurances were provided by OPG and JV they were both in agreement with the adjustments." (emphasis added)

As part of OPG and the JV's negotiation on the Execution Phase target price and schedule, the JV had sought to eliminate the Productivity Gains provision from the Retube and Feeder Replacement (RFR) contract. The Panel did not, as they acknowledged, have visibility to the final details from the negotiation at the time of the report.

Ultimately, OPG maintained the importance of the Productivity Gains provision. Amendment 4 to the RFR Contract (see: Ex. D2-2-3, Attachments 1 and 6) varied the provision, but did not remove it.

Please refer to L-4.3-15 SEC-23 for further discussions on the efficiency and productivity measures built into the RFR contract.

EP Interrogatory #16

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2-2-8, Attachment 4, page 21

The report states that the JV "has not yet been subjected to the full scope of acceptance testing and reliability cycling. It has also been identified that "Plan B" methods of temporarily managing the retube waste to avoid delays in reactor face work were investigated…however at this point no feasible options have been identified. The impact is there is currently no "buffer" for the waster should significant issues with the retube waste processing system be encountered. It is for these reasons the Panel believe retube waste processing remains a significant risk to the project, at least for the first unit."

Can OPG provide any evidence that it has addressed the Panel's concerns?

Response

Factory Acceptance Testing of the Waste Tooling System was successfully completed in Q2 2016, in advance of the need date. Enhanced reliability testing was then performed to address the documented risks with this "First-of-a Kind" system. Successful testing completed in Q2 to Q3 2016 has reduced the residual risk.

In parallel, a study of an alternative to the End Fitting Severing cell, the one cell on the critical path of the outage, is underway as another risk mitigating action.

EP Interrogatory #17

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2-2-8, Attachment 4, page 22

Can you confirm that the Panel knew very little about the details and rigor applied to the planning of critical path activities in the segments of the outage when OPG activities are on the critical path?

Can you also confirm that these activities account for 20% of the time that Unit 2 is being refurbished?

Response

OPG does not confirm. The Expert Panel was commissioned to look at the Retube and Feeder Replacement project; therefore, the rest of the critical path was out of the scope of their review. However, this does not mean that the Expert Panel knew very little about the rest of the critical path based on their extensive refurbishment experience in other CANDU facilities.

For Unit 2, OPG activities represent approximately 16% of the critical path.

EP Interrogatory #18

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2, Tab 2, Schedule 9, page 9

Has OPG issued any status reports to date? If so, please provide them or a link to those reports.

Response

Please see L-4.3-1 Staff-223 and the Darlington Refurbishment Program Performance Report attached.

A REPORT ON CANADA'S LARGEST CLEAN POWER PROJECT

DARLINGTON REFURBISHMENT

AUGUST 2016

ONTARIO POWER GENERATION

READY TO EXECUTE

The Darlington Nuclear Generating Station has been safely and reliably producing almost 20 per cent of the province's electricity since the early 1990s. After six years of detailed planning and preparations, OPG is now ready to refurbish the station's four nuclear reactors, extending their lifetime for another 30 years of clean power.

This October, OPG will take the Unit 2 nuclear reactor offline to execute Darlington Refurbishment. This three-year (40 month) project will be the first of four such outages as we refurbish the plant's four units over the next 10 years. During this period, OPG will remove, replace and repair critical components in each reactor. With less than two months to go, all necessary materials required to start Refurbishment has been delivered to site; training of workers has begun at our mock-up facility; and the detailed execution plan has been finalized. While there is still a lot of work to be done, there are no major obstacles in our way to start this project as committed, mid-October.

We call this step "Breaker-Open," because we will officially disconnect from Ontario's power grid to start the work.

FOUR PILLARS TO REFURBISHMENT SUCCESS

The project pillars measure our success in maintaining high standards when it comes to safety, quality of work done right the first time, ability to stay on schedule, and adherence to the overall project cost estimate. Here is an overview of our current performance since our last report.

SAFETY

Safety performance has been excellent. The project team has safely worked 2,372 days without a lost-time accident. OPG, with its vendor partners, continues to be rigorous to reduce low level events that, if unmanaged, can lead to lost-time accidents.

QUALITY

There have been no new significant quality events on the Refurbishment project.

SCHEDULE

There are schedule challenges with certain pre-requisite* projects, however, none are expected to impact Breaker-Open. The project remains on track to begin refurbishment of Unit 2 in October.

COST

Cost performance is excellent and has improved since the last reporting period. The work to date is being performed efficiently across many aspects of the project. OPG remains within its $12.8 billion project estimate, with $2.6 billion spent to date.

Excellent ☐ Good Moderate Poor

* **Pre-requisite projects** are numerous critical activities that must be completed in order to execute refurbishment.

Filed: 20
EB-2
Exhibit L, Tab 4.2, Schedule
Ita

A NUMBER OF MOVING PARTS

Darlington Refurbishment comprises over 500 projects, across four refurbishment units and five work bundles or *parts*, operating together toward success.

Re-tube and feeder replacement is core to a successful refurbishment. It involves removing and replacing the fuel channels, calandria tubes and feeders inside each reactor.

No safety issues or quality events have been identified. While some materials are delayed, all are expected to be in place in spring of 2017 following removal of fuel, draining of heavy water and isolation of Unit 2 from the other three operating units at the Darlington Station. Use of the mock-up reactor has shifted from testing to training of staff on tools and procedures. As a result, efficiencies and safety improvements continue to be realized well in advance of the project start date.

One Team Approach
Crucial to the success of this project is our One Team approach. OPG's dedicated employees, construction partners and industry partners from across Ontario are working together to get a quality job done safely, on time and on budget.

The **turbine generators** work bundle consists of inspections and repairs on the four turbine generator sets and replacement of analog control systems with new digital control systems.

No safety issues or quality events have been identified and schedule performance has improved. All of the specialized Original Equipment Manufacturer parts required to refurbish the turbine generator for Unit 2 were delivered on time.

Defueling of the Reactor involves removing used fuel from the reactor and refurbishing the fuel handling equipment.

No safety issues or quality events have been identified. All materials required for execution have been delivered and are ready for staging. All equipment and tooling modifications are complete and on-reactor rehearsals were conducted successfully to defuel 18 fuel channels. The results of these tests were positive and provide confidence that OPG can defuel the reactor within the planned duration.

The **steam generators** work bundle includes mechanical cleaning, water lancing, inspection and maintenance work.

No safety issues or quality events have been identified. The project is ready to proceed. A number of efficiencies have been realized between OPG and vendor project management.

Balance of plant covers a number of smaller projects to replace or repair components on both the nuclear side (such as heavy water and cooling systems) and on the non-nuclear side (such as electrical system, piping and valve work).

No safety issues or quality events have been identified. Two pre-requisite projects - the shutdown cooling heat exchanger replacement project and the adjuster rod shim project – are both on track to be in-service prior to breaker open. Some non-critical pre-requisite projects are delayed but pose no risk to the overall schedule.

POWERED UP FOR REFURBISHMENT

Over the past six years, OPG has been involved in a number of facilities and infrastructure projects and safety improvement opportunities at the station.

FACILITIES AND INFRASTRUCTURE PROJECTS

1. Darlington Energy Complex
2. Operations Support Building Refurbishment
3. Re-tube and Feeder Replacement Island Support Annex
4. Refurbishment Project Office
5. Vehicle Screening Facility
6. Holt Road Interchange Improvements
7. Site Electrical Power Distribution
8. Auxiliary Heating System
9. Domestic Water and Sewer
10. Heavy Water (D2O) Storage and Drum Handling Facility
11. Re-tube Waste Processing Building

SAFETY IMPROVEMENT OPPORTUNITIES AND OTHER PROJECTS

12. Additional (3rd) Emergency Power Generator
13. Containment Filtered Venting System
14. Power House Steam Venting System
15. Shield Tank Overpressure Protection
16. Emergency Service Water Projects

WASTE MANAGEMENT FACILITIES

17. Re-tube Waste Storage Building
18. Used Fuel Dry Storage

■ In-progress and on track ☐ Completed

DARLINGTON REFURBISHMENT

PROJECT READINESS AT A GLANCE

Darlington Refurbishment is a $12.8 billion initiative, the largest clean energy project in Canada. It is expected to generate $14.9 billion in economic benefits to Ontario, and will create 8,800 jobs per year over the course of the project and 11,800 jobs at its peak. Scheduled for completion by 2026, OPG is now ready to execute a plan that will enable the plant to continue providing safe and reliable energy to the province for the next 30 years.

SAFETY

2,372 DAYS WITHOUT A LOST-TIME ACCIDENT

ALL FILTERS ARE IN PLACE FOR THE CONTAINMENT FILTERED VENTING SYSTEM.

ALL REGULATORY **APPROVALS TO COMMENCE REFURBISHMENT** HAVE BEEN **RECEIVED** FROM THE CANADIAN NUCLEAR SAFETY COMMISSION (CNSC).

QUALITY

722 COMPREHENSIVE WORK PACKAGES HAVE BEEN DEVELOPED AND OVER **75,000** TASKS HAVE BEEN SCHEDULED

51 INTEGRATED IMPLEMENTATION PLAN TASKS FOR THE CNSC (SCHEDULED FOR COMPLETION IN 2016) ARE ON TRACK.

30,000: THE NUMBER OF HOURS TRADES HAVE PRACTISED USING TOOLS AT THE MOCK-UP AND TRAINING FACILITY

SCHEDULE

OVER 22,000 CUBIC METRES OF CONCRETE DELIVERED TO DATE - ENOUGH TO PAVE A SIDEWALK FOR **46 KM**

DELIVERED ON TIME:

- PRODUCTION TOOLS REQUIRED TO PERFORM THE REMOVAL AND REPLACEMENT OF FUEL CHANNEL ASSEMBLIES AND FEEDER TUBES IN EACH REACTOR.

COST

$2.6 BILLION SPENT TO DATE

PROJECT IS CURRENTLY **ON BUDGET.**

- SIGNIFICANT IMPACT TO THE LOCAL ECONOMY

The Containment Filtered Venting System under construction at the Darlington Nuclear Generating Station.

Ontario Power Generation produces almost half of the electricity that Ontario homes, schools, hospitals and businesses rely on each day. We are committed to ensuring our energy production is reliable, safe, clean and sustainable for Ontarians today and for the future.

WWW.OPG.COM

ONTARIO POWER GENERATION

EP Interrogatory #19

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2, Tab 2, Schedule 9, page 11

1. Can you please provide any internal audit group reports?

2. Can you please provide any Refurbishment Construction Review Board reports?

3. Can you please provide any Darlington Refurbishment Committee of OPG's Board of Directors reports?

Response

1. Please see Ex. L-4.3-1 Staff-72 (b).

2. Please see Ex. L-4.3-1 Staff-72 (a).

3. There are no Darlington Refurbishment Committee reports. The Darlington Refurbishment Committee acts by reviewing and approving memoranda for submission to the OPG Board of Directors. The memorandum reviewed and approved in support of the Release Quality Estimate is provided in L-4.3-5 CCC-022. The memorandum reviewed and approved in support of the Unit 2 Execution Estimate is provided in L-4.3-1 Staff-055. The memoranda OPG has provided are those that underpin OPG's requested approvals for the Darlington Refurbishment Program in this application.

ED Interrogatory #1

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: "OPG has a high level of confidence in the DRP cost estimate of $12.8B, which includes contingency, capitalized interest and escalation." Ex. D2, Tab 2, Schedule 1, Page 2.

Please provide OPG's estimate of the probability that the cost of the DRP will exceed $12.8 billion.

Response

OPG's estimate of $12.8B for the Darlington Refurbishment Program (DRP) is a high confidence estimate which includes $1.7B (2015$) in contingency based on detailed Monte Carlo modeling of risks as described in Ex. D2-2-7. Based on the results of the Monte Carlo modeling, OPG expects that the $12.8B is a 90% confidence estimate, which implies that the probability of exceeding this estimate is 10%. However, OPG notes the following:

- While Monte Carlo modeling of risks to develop contingency amounts is a best practice, it is only an aid to inform Management decision-making about the appropriate amount of contingency required to achieve a certain level of confidence.

- In determining the amount of contingency required to achieve high confidence, OPG explicitly excluded low probability, high consequence events which are beyond the ability of the project to manage or mitigate. Examples of such events are provided in Ex. D2-2-7, p. 6, lines 20-23, L-4.3-15 SEC-019, and L-4.3-6 EP-013.

ED Interrogatory #2

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: "OPG has a high level of confidence in the DRP cost estimate of $12.8B, which includes contingency, capitalized interest and escalation." Ex. D2, Tab 2, Schedule 1, Page 2.

Please provide OPG's estimate of the probability that the cost of the DRP will exceed $12.8 billion by 10% or greater.

Response

OPG interprets the question to be "provide OPG's estimate of the probability that the cost of the DRP will exceed $12.8B by 10%, i.e., that DRP will exceed $14.08B ($12.8B + $1.28B)."

OPG cannot provide the requested estimate. OPG does its risk analysis and contingency development using a constant dollar estimate (2015$ in the Release Quality Estimate (RQE)) and then adds interest and escalation based on the resulting flow of costs (including contingency) in order to develop the total cost, including interest and escalation. The requested calculation would require OPG to make a number of assumptions and simplifications to go "backwards" from a total cost, to a probability associated with a derived level of contingency.

In L-4.3-15 SEC-027, OPG provides its estimate of contingency at 99% confidence as $2.6B (2015$), excluding escalation and interest, or $0.9B (2015$) greater than the contingency, excluding escalation and interest, included in RQE.

ED Interrogatory #3

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: "OPG has a high level of confidence in the DRP cost estimate of $12.8B, which includes contingency, capitalized interest and escalation." Ex. D2, Tab 2, Schedule 1, Page 2.

Please provide the proportions (%) of the DRP cost overruns that will be passed on to OPG assuming the DRP experiences cost overruns of: a) 25%; b) 50%; c) 75%; d) 100%; e) 125%; f) 150%; g) 175%; h) 200%, and i) 250%. Please assume that the cost overrun percentages are applied equally to each of the program components (e.g. a 25% increase of each work bundle cost, 25% increase of the safety improvement costs, 25% increase of the facility & infrastructure project costs, and so on). See Ex. D2, tab 2, schedule 1, page 3 for a list of program components. Please assume that the cost overruns are in addition to the amounts set aside for contingency (seeing as "contingency refers to amounts that are *expected* to be expended" per Ex. D2, Tab 2, Schedule 7, p. 1)). Please apply the cost overruns both to the contractor costs (i.e. the work bundles) and the cost of the work to be undertaking by OPG itself. Please also account for the consequential increases to interest and escalation.

Response

Please refer to L-04.3-7 ED-004 for OPG's notes and description of limitations regarding this mathematical exercise.

OPG has completed this mathematical exercise for two of the requested scenarios: a) 25% cost overrun; and d) 100% cost overrun. The calculated percentage of these cost overruns that would be passed on to OPG are: a) 82% of the 25% cost overrun; d) 83% of the 100% cost overrun.

The additional scenarios cannot be provided with reasonable effort given the modeling work required to develop the responses.

To re-iterate, OPG has provided the information as requested; however, for the reasons noted L-04.3-7 ED-004, OPG does not deem the scenario results to be a reasonable representation of any likely outcome of the Darlington Refurbishment Program.

ED Interrogatory #4

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Exhibit D2, tab 2, schedule 3, p. 14

Please provide the total cost of the DRP based on cost overrun scenarios of: a) 25%; b) 50%; c) d) 100%; e) 150%; f) 200%, and g) 250%. Please assume that the cost overrun percentages are applied equally to each of the program components (e.g. a 25% increase of each work bundle cost, 25% increase of the safety improvement costs, 25% increase of the facility & infrastructure project costs, and so on). Please apply the cost overruns both to the contractor costs (i.e. the work bundles) and the cost of the work to be undertaking by OPG itself. Please assume that the cost overruns are in addition to the amounts set aside for contingency (seeing as "contingency refers to amounts that are *expected* to be expended" per Ex. D2, Tab 2, Schedule 7, p. 1)). Please also calculate and include the consequential increases to interest and escalation.

Please provide a breakdown of each scenario in a chart similar to chart 4 on page 14 of Ex. D2-2-3 (pasted below). This will require adding rows for the other work bundles, the sub-components of the other work bundles, the remainder of the work components, interest and escalation, and contingency to the chart. The chart will help confirm that all costs are included and how the overrun scenarios have been applied.

Chart 4 - Illustrative Scenarios of RFR Target Pricing (Contractor 10% Cost Overrun)

			% Contractor Cost Overrun = 10%				
#	Category ($ Million)	Contract Costs (from table 3)	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost (Incl RWPB)	185	204	19	0	19	204
2	Definition Phase Fixed Fee	74	81	7	7	0	74
3	Definition Phase Fixed Fee Incentive/ Disincentive	0			0	0	0
4	Execution Phase Target Cost	1,667	1,834	167	0	167	1,834
5	Execution Phase Fixed Fee	492	541	49	49	0	492
6	Execution Phase Fixed Fee Incentive/ Disincentive	0	0	0	18	(18)	(18)
7	Mock-up Fixed Price	38	42	4	4	0	38
8	Non-target Reimbursable Costs	6	7	1	0	1	7
9	Tooling Fixed Price	375	413	38	38	0	375
10	OSM with Fee(estimate)	579	637	58	0	58	637
11	Goods with Fee(estimate)	48	53	5	0	5	53
12	Total	3,464	3,810	346	116	230	3,694

Response

OPG has provided the results of pro-rating OPG's RQE estimate by: a) 25%; and, d) 100%.

a) For the 25% cost overrun scenario, the total cost of the DRP mathematically evaluates to $15.5B.
b) For the 100% cost overrun scenario, the total cost of the DRP mathematically evaluates to $23.5B.

The detailed cost breakdowns for the above two scenarios, in a similar format to Chart 4 in Ex. D2-2-3 p. 14 are provided in Attachment 1. The additional scenarios cannot be provided with reasonable effort given the modeling work required to develop the responses. Development of these scenarios requires detailed assessment of the incentive mechanisms in the contracts in order to assess costs borne by OPG versus costs which would be borne by each contractor. Simplifying assumptions needed to be made to provide the two scenarios in this response.

While OPG has responded to this interrogatory as requested, OPG does not believe that the information provides a reasonable basis to assess the potential future costs that may be expended by OPG in executing the Darlington Refurbishment Program (DRP).

OPG has learned significantly from the experiences of past large complex projects and has executed a robust planning process. Please see Ex. D2-2-4 regarding OPG's planning process, including the application of lessons learned. The Release Quality Estimate (RQE) produced in 2015 is a high confidence estimate with a high degree of certainty for each of the contractors' estimates, and with adequate contingency based on the class of estimate.

There will be risks associated with the execution of the project. OPG is the general contractor and will play an active role in monitoring the work and ensuring that all risks are actively managed. OPG would intervene and take appropriate actions to mitigate the costs and schedule impacts long before the circumstances contemplated in this interrogatory manifested. The contractors are responsible and have incentives to mitigate and recover delays and cost overruns. There are also off-ramps in the contracts that allow OPG to terminate contracts in situations where performance is not meeting expectation. OPG has full transparency on the status of the overall DRP, in terms of safety, quality, schedule, and cost performance, and would take corrective actions very early in the process, if required.

The target price contracts are structured in a way to incent OPG's contract partners to achieve (and beat) the target price and schedule, and contain disincentives for failure to meet these targets. If the contractor exceeds the target price, OPG will pay the direct costs, i.e. actual costs for trades and project management labour; however, the contractors would be unable to recover profit or overheads on the cost overruns, and receive a contract disincentive which would reduce their recovery of overheads.

In order to respond to this undertaking, OPG has adhered to the assumptions requested, but which OPG does not view as reasonable. Specifically:

i. OPG was asked to assume all contingency is spent before applying the cost overrun percentages. OPG does not believe that is appropriate. Contingency would be used to offset risks and cost growth in executing the DRP and should first be reduced to zero before the cost overrun percentages are applied;
ii. OPG has artificially pro-rated all of its functional costs, including project management associated with each major work bundle by the cost overrun percentage. OPG does not believe that this is reasonable as the functional costs would be unlikely to grow at the same proportion as the costs in a major work bundle; and
iii. OPG has applied the cost overrun scenario to all costs, including costs that are already expended, some of which has already been placed in service.

OPG has not pro-rated contingency, as there is no basis for assuming that, should there be a cost overrun, there would also be a need to increase contingency in the estimate.

To re-iterate, OPG has provided the information as requested; however in OPG's view, none of the scenarios are a reasonable representation of any likely outcome of the DRP.

Attachment to L-04.3-7 ED-004 (includes summary calculations for L-04.3-7 ED-003)

Cost Overrun Scenarios

2015$M (except for Interest and Escalation line item)

Major Category	Category/ Contract Type		RQE Base Case	ED-004 1.25 25% Cost Growth: Base cost + % Increase	Cost Variance	Impact to Contractor	Impact to OPG	Actual Cost to OPG	ED-003 Proportion of Increase paid by OPG	ED-004 2 100% Cost Growth: Base cost + % Increase	Cost Variance	Impact to Contractor	Impact to OPG	Actual Cos to OPG	ED-003 Proportion of Increase paid by OPG
Retube Feeder Replacement	OPG Project Management & Oversight Costs		167	209	42		42	209		334	167		167	334	
	Contractor Costs	Definition Phase Target Price (Incl RWPB)	185	231	46	0	46	231		370	185	0	185	370	
		Definition Phase Fixed Fee	74	92	18	18	0	74		147	74	74	0	74	
		Definition Phase Fixed Fee Incentive/ Disincentive				9	(9)	(9)				35	(35)	(35)	
		Execution Phase Target Price	1,667	2,084	417	0	417	2,084		3,334	1,667	0	1,667	3,334	
		Execution Phase Fixed Fee	492	615	123	123	0	492		984	492	492	0	492	
		Execution Phase Fixed Fee Incentive/ Disincentive				68	(68)	(68)				236	(236)	(236)	
		Mock-up Fixed Price	38	48	10	10	0	38		76	38	38	0	38	
		Non-target Reimbursable Costs	6	8	2	0	2	8		12	6	0	6	12	
		Tooling Fixed Price	375	469	94	94	0	375		750	375	375	0	375	
		OSM with Fee(estimate)	579	724	145	0	145	724		1,158	579	0	579	1,158	
		Goods with Fee(estimate)	48	60	12	0	12	60		96	48	0	48	96	
Fuel Handling/ Defueling	OPG Project Management & Oversight Costs		49	61	12		12	61		98	49		49	98	
	Cont. Costs	Defueling - Eng Services (Fixed/Firm Price)	16	20	4	4	0	16		32	16	16	0	16	
		Defueling - Eng Services (Misc Reimbursable)	7	9	2	0	2	9		14	7	0	7	14	
		Fuel Handling (ESMSA - see assumptions)	126	157	31	[redacted]				252	126	[redacted]			
Steam Generators	OPG Project Management & Oversight Costs		13	16	3		3	16		26	13		13	26	
	Contractor Costs	Fixed Price	[redacted]							[redacted]					
		Target Price													
		Target Price Fixed Fee													
		Target Price Fixed Fee Incentive/ Disincentive							67%						68%
		SS&E & Reimbursable													
		SS&E Incentive/Disincentive													
Turbine Generator	OPG Project Management & Oversight Costs		41	51	10		10	51		82	41		41	82	
	Contractor Costs	ESES - Fixed/ Firm Cost - Equipment Supply	257	321	64	64	0	257		513	257	257	0	257	
		ESES - Target Cost Installation & Static Commissioning	38	48	10	0	10	48		77	38	0	38	77	
		ESES - Target Cost - Incentive/ Disincentive				5	(5)	(5)				19	(19)	(19)	
		ESES - Target Cost - Dynamic Commissioning	14	17	3	0	3	17		28	14	0	14	28	
		ESES - Target Cost - Incentive/ Disincentive				2	(2)	(2)				7	(7)	(7)	
		ESES - Reimbursable (no markup)	28	35	7	0	7	35		56	28	0	28	56	
		EPC - Definition Phase Target Cost	21	27	5	0	5	27		43	21	0	21	43	
		EPC - Definition Phase Fixed Fee	13	16	3	3	0	13		26	13	13	0	13	
		EPC - Definition Phase Fixed Fee Incentive/ Disincentive				1	(1)	(1)				4	(4)	(4)	
		EPC - Execution Phase Target Cost	161	202	40	0	40	202		323	161	0	161	323	
		EPC - Execution Phase Fixed Fee	53	66	13	13	0	53		106	53	53	0	53	
		EPC - Execution Phase Fixed Fee Incentive/ Disincentive				7	(7)	(7)				25	(25)	(25)	
		EPC - Dynamic Commissioning Work (Trades)	2	3	1	0	1	3		5	2	0	2	5	
		EPC - Goods	5	6	1	0	1	6		10	5	0	5	10	
		EPC - Reimbursable Costs with no-markup	11	14	3	0	3	14		23	11	0	11	23	
Balance of Plant	OPG Project Management & Oversight Costs		183	229	46		46	229		366	183		183	366	
	Contractor Costs (mainly ESMSA)		784	980	196	[redacted]				1,567	784	[redacted]			
F&IP & SIO Projects	Facility and Infrastructure Projects (mainly ESMSA)		640	800	160					1,280	640				
	Safety Improvement Opportunities (mainly ESMSA)		205	256	51					410	205				
Functions	Project Execution		322	402	80		80	402		643	322		322	643	
	Contract Management		52	65	13		13	65		104	52		52	104	
	Engineering		283	353	71		71	353		565	283		283	565	
	Managed Systems Oversight		41	51	10		10	51		82	41		41	82	
	Planning & Controls		136	170	34		34	170		272	136		136	272	
	Nuclear Safety		83	104	21		21	104	100%	166	83		83	166	100%
	Program Fees & Other Support		341	426	85		85	426		682	341		341	682	
	Supply Chain		86	107	21		21	107		171	86		86	171	
	Work Control		80	99	20		20	99		159	80		80	159	
	Operations and Maintenance		805	1,006	201		201	1,006		1,610	805		805	1,610	
	Early Release 3		102	127	25		25	127		203	102		102	203	
	Early Release 4		7	9	2		2	9		15	7		7	15	
Contingency			1,706	1,706	0		0	1,706	N/A	1,706	0		0	1,706	N/A
Sub Total			**10,429**	**12,611**	**2,181**	**465**	**1,716**	**12,138**		**19,154**	**8,724**	**1,820**	**6,904**	**17,320**	
Interest & Escalation ($M)			2,371	2,866	496		496	2,866	100%	4,354	1,983		1,983	4,354	100%
Total			**12,800**	**15,477**	**2,677**	**465**	**2,212**	**15,004**	**82%**	**23,507**	**10,707**	**1,820**	**8,887**	**21,674**	**83%**

Notes and assumptions:

1. Based on OPG's Release Quality Estimate (RQE). All numbers except interest and escalation are in 2015$.
2. These are illustrative examples; assumption is that all contractor incentives/disincentives and performance fee mechanisms are applicable.
3. Cost overrun factors are also applied to life-to-date actual costs (costs with no risk of overruns).
4. Cost overrun factors are applied to all costs excluding contingency.
5. RFR contract costs are as per Ex. D2-2-3, pp. 10 and 11.
6. De-fuelling contract is mainly fixed/ firm price. Reimbursable fixed fees are capped for certain costs; however, this was not incorporated into the calculations due to lack of materiality.
7. Steam Generator contract includes fixed/ firm component, along with target cost with fixed fee at risk and Support Services and Equipment cost with fee at risk.
8. For work bundles that are mainly under ESMSA contracts (e.g. BOP, FH, FIP, SIO), it was assumed, for simplicity, that the increase is caused by the contractor; therefore, the cost to OPG is [redacted] of the cost overrun (performance fee of [redacted] withheld).
9. For simplicity, for all of the target cost contracts, a 20% cost disincentive was applied above any neutral band specified in the contracts. The actual percentage is calculated using a graded approach.
10. For simplicity, interest and escalation were pro-rated.

ED Interrogatory #5

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Ex. E2, Tab 1, Schedule 1, Table 1

Please provide the output (TWh), installed capacity (MW) and capacity utilization rates for each year of the Darlington Nuclear Station's commercial operation.

Response

Chart 1 below provides the requested information since 2005.

Consistent with OPG's approach in EB-2007-0905, EB-2010-0008 and EB-2013-0321, historical information for the period prior to 2005 is not provided. The information from before 2005 is not relevant as OPG was not regulated prior to April 1, 2005.

In issuing an earlier version of the filing guidelines for OPG's prescribed facilities (EB-2006-0064), the OEB stated:

> *OPG, along with some other stakeholders, submitted that data should not be required for 2004 or earlier years, as proposed in staff's discussion paper. As the current payment regime was implemented in April 2005, these stakeholders questioned the relevance of 2004 and pre-2004 information. OPG, for its part, also indicated that providing the information would be a significant burden for it. The Board has accepted these submissions, and has not included information relating to 2004 or earlier years in the Filing Guidelines.*

OEB Cover Letter re: Setting Payment Amounts for Ontario Power Generation Inc.'s Prescribed Generation Assets, Filing Guidelines, EB-2006-0064, July 27, 2007, p. 3.

The OEB has, therefore, already made a determination that data from before 2005 is not relevant.

Chart 1

Year	Installed Capacity MCR Net (MW)	Net Output (TWh)	Unit Capability Factor (UCF) (%)
2005	3512	27.6	90.6
2006	3512	27.0	88.7
2007	3512	27.2	89.5
2008	3512	28.9	94.5
2009	3512	26.0	85.9
2010	3512	26.5	87.6
2011	3512	29.0	95.2
2012	3512	28.3	93.2
2013	3512	25.1	82.9
2014	3512	28.0	91.9
2015	3512	23.3	76.9

ED Interrogatory #9

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: "OPG plans to issue status reports to the public for the duration of the Program." Ex. D2, Tab 2, Schedule 1, Page 5

Is OPG planning to report its actual cumulative capital expenditures and interest costs with respect to the Unit 2 refurbishment in its quarterly financial reports? If "no", please explain why not.

Response

OPG will continue to report the year-to-date and life-to-date total actual capital expenditures for the Darlington Refurbishment Program ("DRP"), inclusive of interest costs, in its publicly available quarterly and annual Management's Discussion and Analysis ("MD&A") documents. OPG will also be reporting in the MD&A its progress towards the planned in-service addition of $4.8 billion associated with the scheduled return to service of refurbished Unit 2 in February 2020.

ED Interrogatory #10

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: "Management has completed the Definition Phase has high confident that the 4 unit cost estimate is $10.4B (2015$). The $10.4B (2015$) estimate is $12.8B including capitalized interest and future inflation." Ex. D2, Tab 2, Schedule 8, Attachment 1, Page 2

"An average capability factor of 88% continues to be used in this economic assessment with a range of 83% to 93%." Ibid., Page 17

Please provide OPG's Levelized Unit Energy Cost (LUEC) for the Darlington reactors post-refurbishment assuming:

a) A total capital cost of $12.8 billion, an annual average capacity utilization rate of 88% and a 30 year operating life;

b) A total capital cost of $19.2 billion, an annual average capacity utilization rate of 88% and a 30 year operating life;

c) A total capital cost of $25.6 billion, an annual average capacity utilization rate of 88% and a 30 year operating life;

d) A total capital cost of $32 billion, an annual average capacity utilization rate of 88% and a 30 year operating life;

e) A total capital cost of $12.8 billion, an annual average capacity utilization rate of 84.8% and a 30 year operating life;

f) A total capital cost of $19.2 billion, an annual average capacity utilization rate of 84.8% and a 30 year operating life;

g) A total capital cost of $25.6 billion, an annual average capacity utilization rate of 84.8% and a 30 year operating life;

h) A total capital cost of $32 billion, an annual average capacity utilization rate of 84.8% and a 30 year operating life;

Please provide a break-out of your LUEC estimates according to the following categories: a) capital costs; b) operating costs; c) fuel costs; and d) long-term (perpetual) storage of spent fuel.

Response

As requested the components of the total LUEC have been broken out according to the following categories:

i. Refurbishment Project Costs
ii. OM&A Direct, Sustaining Projects and Station Support (operating costs)
iii. Fuel costs
iv. Used Fuel Management costs

a) Scenario (a) (total refurbishment cost of $12.8 billion, average capacity factor of 88% and a 30 year operating life) matches the assumptions in the Darlington Refurbishment Execution Phase Business Case Summary (see: Ex. D2-2-8, Attachment 1), with an overall LUEC of 8.1 ¢/kWh (2015$). The breakdown of this LUEC is given in Ex. D2-2-8 Attachment 1, Figure 4, p. 18. Used Fuel Management accounts for 0.1 ¢/kWh (2015$) of the 0.59 ¢/kWh (2015$) shown for Fuel costs.

b) to h)

The remaining scenarios are summarized in the following two Charts. Columns may not add due to rounding.

Chart 1 – Scenarios b to d

LUEC ¢/kWh (2015$) **88% Average Capacity Factor**	**Total Project Costs ($B)**		
	$19.2B (b)	**$25.6B** (c)	**$32B** (d)
i. Refurbishment Project Costs	5.0	6.6	8.3
ii. OM&A Direct, Sustaining Projects and Station Support	4.1	4.1	4.1
iii. Fuel costs	0.5	0.5	0.5
iv. Used Fuel Management costs	0.1	0.1	0.1
TOTAL	**9.8**	**11.4**	**13.0**

Chart 2 - Scenarios e to h

LUEC ¢/kWh (2015$) **84.8% Average Capacity Factor**	**Total Project Costs ($B)**			
	$12.8B (e)	**$19.2B** (f)	**$25.6B** (g)	**$32B** (h)
i. Refurbishment Project Costs	3.5	5.2	6.9	8.6
ii. OM&A Direct, Sustaining Projects and Station Support	4.3	4.3	4.3	4.3
iii. Fuel costs	0.5	0.5	0.5	0.5
iv. Used Fuel Management costs	0.1	0.1	0.1	0.1
TOTAL	**8.4**	**10.1**	**11.8**	**13.5**

ED Interrogatory #11

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Ex. D2, Tab 2, Schedule 8, Attachment 1, Page 2

Please state the weighted average cost of capital that OPG uses to perform its LUEC estimates and please show its inputs assumptions (e.g., debt/equity ratio, return on equity, interest rate on debt).

Response

OPG uses a 7% discount rate in the evaluation of its LUEC estimates. The basis for the 7% has been provided in past OEB proceedings (e.g. in EB-2010-0008, L-6-002 and L-6-003 and in EB-2013-0321, L-4.7-6 ED-005.

OPG reviews its discount rate calculation periodically, and while debt rates, equity rates and the debt/equity ratio will fluctuate over time, the resulting discount rate has remained at 7%.

The 7% discount rate OPG uses to evaluate projects is intended to reflect OPG's target Weighted Average Cost of Capital (WACC). Because OPG's assets are long-lived, OPG uses its long-term expected cost of debt, its long-term target Return on Equity (ROE) and its long-term target debt/equity ratio to derive this number. There is a significant range of debt/equity ratios, debt rates, and ROEs over which the WACC evaluates to 7%. It is OPG's policy to round the discount rate used to evaluate projects to the nearest whole number.

For greater clarity, the WACC that is currently used in project evaluations is based on OPG's long-term target debt/equity ratio, OPG's projected long-term cost of debt (over the period consistent with the duration of the project) and OPG's long-term target return on equity. Utilizing these numbers yields a 7% WACC:

Debt/Equity Ratio = 51/49
Debt Rate = 5.50%
ROE = 10.0%
Tax Rate = 25%
Result = 7.00%

ED Interrogatory #12

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: "The post-refurbishment costs include $4.4B (2015$) of ongoing sustaining investments to maintain the condition of the plant." Ex. D2, Tab 2, Schedule 8, Attachment 1, Page 21

(a) Please provide OPG's estimate of the LUEC of the above referenced $4.4 billion investment assuming a 30 year operating life and annual average capacity utilization rates of 84.8% and 88%;

(b) Please confirm whether the $4.4 billion of anticipated investment is accounted for in the latest Darlington LUEC estimates in the Business Case Summary at Exhibit D2-2-8, Attachment 1.

Response

OPG notes that the reference provided in this question should have been to p. 18 of Ex. D2-2-8 Attachment 1 and not to p. 21.

a) The post-refurbishment sustaining investments of $4.4B (2015$) contribute 0.60¢/kWh (2015$) to the overall 8.1¢/kWh (2015$) LUEC quoted in the Darlington Refurbishment Execution Phase Business Case Summary (Ex. D2-2-8 Attachment 1, p. 18), based on an average post-refurbishment capacity factor of 88% over a 30-year operating life.

   At an average post-refurbishment capacity factor of 84.8% over a 30-year operating life, the post-refurbishment sustaining investments of $4.4B (2015$) contribute 0.62¢/kWh (2015$) to an overall 8.4¢/kWh (2015$) LUEC.

b) OPG confirms that the $4.4B (2015$) of anticipated investment is accounted for in the 8.1¢/kWh (2015$) LUEC estimate in the Darlington Refurbishment Execution Phase Business Case Summary (Ex. D2-2-8, Attachment 1, p. 18).

ED Interrogatory #13

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: "The refurbishment scope does not include replacement of steam generators." Ex. D2, Tab 2, Schedule 8, Attachment 1, Page 28

a) Please provide your best estimate of the probability that it will be necessary to replace some or all of Darlington's steam generators; and

b) Please provide your best estimate of the cost of replacing Darlington's steam generators. Please include contingency and interest and escalation.

Response

a) OPG believes that the steam generators in the Darlington units will operate reliably until the end of the 30-35 year post-refurbishment life of the units. OPG addressed the decision not to include steam generators in DRP scope in EB-2010-0008 (see: L-7-016 and L-7-028).

b) Since OPG made the decision in 2009 not to replace the steam generators (as detailed in EB-2010-0008 L-7-016 and L-7-028), OPG has not updated its cost estimate for replacing the steam generators.

ED Interrogatory #14

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Ex. D2, Tab 1, Schedule 1, Page 2, Chart 1

If the Government of Ontario were to cancel the Darlington Refurbishment Project in 2016, please quantify the magnitude of the nuclear operations project portfolio expenditures which would no longer be necessary in each year from 2017 to 2021.

Response

Given that the Government has announced its approval of Darlington Refurbishment and amended O.Reg 53/05 to address the issue of need for Darlington Refurbishment, OPG has not considered the potential impacts of an immediate cancelation of Darlington Refurbishment on its project portfolio expenditures, and therefore, does not have the requested information. Moreover, any attempt to develop this information would be completely speculative, depending entirely on assumptions about outages (e.g. scope, timing and duration) and other work programs that have not been developed, let alone planned to the level that would be required to establish meaningful annual estimates of project portfolio expenditures.

ED Interrogatory #15

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Ex. D2-2-8, Attachment 1

For each of the Darlington reactors, please estimate the total incremental cost of replacement power that will be necessary while the reactor will be out of service during the refurbishment (i.e. the difference between the estimated cost of power that would be produced by that reactor during the relevant period and the estimated cost of power from the alternative source of the power that will most likely be utilized). If the estimated cost of the replacement power is not known by OPG, please request the information from the IESO.

Response

OPG declines to provide the requested information on the basis of relevance. As OPG is not seeking to recover the cost of replacement power, this interrogatory seeks information that is not relevant to deciding any issue on the approved Issues List in this Application.

ED Interrogatory #16

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Reference: Ex. D2-2-8, Attachment 1, p. 7
Table 1 shows that the first reactor to be refurbished (unit 2) will be completed two months *after* the start of refurbishment of the next reactor (unit 3). Unit 2 is to be complete by February 15, 2020 and Unit 3 is to start on December 15, 2019. These questions relate to anticipated overlap between the first two reactor refurbishments and the Long-Term Energy Plan's requirement to have off-ramps for future reactor refurbishments, and to take smaller initial steps to ensure there is opportunity to incorporate lessons learned."

(a) Assuming that OPG's payment amounts application is approved, please discuss what approvals will be required to proceed with the unit 3 refurbishment (e.g. from the OPG Board of Directors, the Ministry of Energy, and from the Ontario Energy Board)? Please indicate the target dates for OPG to submit documents to receive those approvals and for the approvals to be granted.

(b) What information will OPG make available to (i) the Ministry of Energy, (ii) the Ontario Energy Board, and (iii) the public about whether the unit 2 refurbishment is on or off budget and schedule before a decision to proceed with unit 3 is made?

(c) Would OPG be better able to learn lessons from the unit 2 refurbishment to incorporate into the unit 3 refurbishment if there was a buffer of time between the two? Please discuss.

(d) Please discuss the pros and cons of completely "unlapping" the refurbishment of the first two reactors so that there would be a buffer of time (months or at least weeks) between the end of one and the start of the other.

(e) Is there any reason why the start of the unit 3 refurbishment *technically cannot* be pushed back by 5 months to put a 3 month buffer of time after the end of unit 2 refurbishment? Please make best efforts to estimate the cost consequences of doing so. Please assume that this would be done in the most cost-effective and safe manner. Please make and state assumptions as necessary. Please include your calculations. Please also estimate the cost of pushing back the unit 3 refurbishment by 8 months to provide a 6 month buffer of time.

(f) Figure 14 on page 30 of the Long Term Energy Plan shows a gap between the end of the first reactor refurbishment and the beginning of the second reactor refurbishment. Please explain why OPG's plan is inconsistent with this.

(g) What is the percentage probability that the unit 2 refurbishment will be completed (i) at least 2 weeks, (ii) at least 4 weeks, (iii) at least 8 weeks, or (iv) at least 12 weeks beyond the scheduled date of February 15, 2020.

Response

The high confidence schedule for the Darlington Refurbishment Program at the Release Quality Estimate as referenced in the interrogatory was revised with the Unit 2 execution estimate (see Ex. L-4.3-1 Staff-055). The only significant change was the un-lapping of the beginning of the Unit 3 refurbishment from the end of the Unit 2 refurbishment, to be consistent with the Province's requirement to complete Unit 2 prior to commencing any subsequent units.

a) Please see Ex. D-2-2.8 Attachment 1 p. 23 for an overview of OPG's Release Strategy regarding the DRP. Management will commence formal planning of Unit 3 in early 2017, and at that time will request funds from OPG's Board to start planning work. Additional funding for detailed planning will likely be requested in early 2018; however, final plans for Unit 3 are not yet finalized. Formal approval to commence the execution of Unit 3 will be requested approximately 3 to 6 months prior to the start of Unit 3, which will vary depending on the timing of the completion of the Unit 2 refurbishment. Please also see Ex L-04.3-1 Staff 44 for a discussion on OPG's views on approval processes.

b) Please see Ex. L-10.4-1 Staff-223, Ex. L-10.4-5 CCC-41, and Ex D2-2-9 section 7 regarding DRP reporting commitments (including public reporting).

c) Please see to Ex. L-04.3-1 Staff-60 for an explanation on how lessons learned from Unit 2 will be applied to Unit 3. Because each unit's refurbishment has many phases, it is possible to apply the lessons learned from the early phases of one refurbishment to the early phases of the next refurbishment. As each phase is completed, the lessons learned will be used to finalize plans for the same phase for Unit 3. OPG does not believe that adding a buffer between Units 2 and 3 would significantly enhance the ability to apply lessons learned to Unit 3.

d) Please refer to Ex. L-04.3-8 GEC-10, Ex. L-04.3-1 Staff-55 and Ex. L-04.3-1 Staff-60. OPG believes that there is sufficient time between activities for Unit 2 and the start of similar activities on Unit 3 for lessons learned to be incorporated into the planning for Unit 3.

e) There is no technical reason why the Unit 3 start could not be pushed back from the dates provided in D-2-2-8 Attachment 1, p.7. Please see Ex L-04.3-8 GEC-10 and Ex. L-04.3-1 Staff-55.

However, there are tighter technical limits on the operation of Unit 3, which result in OPG's high confidence end-of-life date for this unit being early-to-mid 2020 (please see Ex. L-04.3-8 GEC-009). Pushing back the start of Unit 3 much further than when it is currently planned to start (February 2020) would need to be carefully assessed, as the risk of idling the unit prior to the start of refurbishment would increase.

The cost consequences of doing so would include potentially increased DRP costs because of the extended schedule, potentially increased costs for retaining skilled resources because of a longer gap between the units, search costs to replace staff and trades who may move to other projects (e.g. Bruce refurbishment), training/retraining costs, potential for increased costs from OPG's contract partners because the current contracts were negotiated based on current planned start dates, e.g. demobilization and remobilization costs (contracts would need to be re-negotiated based on the revised schedule). In addition, there would be lost production if the unit were idled (incurring operating costs, but not producing). The longer the duration of the gap between units, the more costs would be expected. The delay would also impact the extent of overlaps of the refurbishment for Units 3, 1 and 4 and the associated costs mentioned above.

OPG does not have estimates of the costs of pushing back Unit 3 by 8 months (or any duration) and to develop these costs would require an extensive reassessment of the entire DRP. OPG is not providing these estimates as they cannot be provided with reasonable effort.

f) Figure 14 on page 30 of the Long Term Energy Plan (2013) is a high level representation of the nuclear refurbishment sequence by quarters. It does not show a gap between the first and second refurbishments; it shows the refurbishment of the first unit (Unit 2) ending in Q3 2019 and the refurbishment of the second unit (Unit 3) starting in Q4 2019. As stated above, OPG has unlapped Unit 2 and Unit 3 refurbishments.

g) Based on the results of the Monte Carlo simulation modeling, the Unit 2 refurbishment completion date of February 15, 2020 is a 90% confidence estimate, which implies that the probability of exceeding this estimate is 10%.

The following are the confidence levels for completion dates beyond February 15, 2020

Extension Beyond Feb 15, 2020	Confidence Level
2 weeks	94%
4 weeks	96%
8 weeks	98%
12 weeks	99%

However, OPG notes that while Monte Carlo modeling of risks to develop contingency amounts is a best practice, it is only an aid to inform Management decision-making about the appropriate amount of contingency required to achieve a certain level of confidence. Please see Ex. L-04.3-7 ED-001.

GEC Interrogatory #2

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Please provide illustrative examples for the portion of each part of the DRP budget that is avoidable if the project is cancelled or curtailed at various stages. Please break this out to indicate the portion avoidable that falls within the amounts included in the current application. Please ensure that one scenario provided indicates what financial commitments would be avoidable if the project was cancelled today and what proportion of those avoidable commitments are included in the approvals sought in this case.

Response

OPG began refurbishment of Unit 2 on October 15, 2016 and has no plans to cancel or curtail the refurbishment at this stage or at future stages. OPG is unable to provide the requested illustrative examples. Any attempt to do so would be speculative, as it would be entirely dependent on assumptions that have no basis in fact. If OPG were to cancel or curtail DRP during the period covered by this application, OPG would inform the OEB and seek direction.

If the DRP were to be cancelled, the costs incurred to the date of cancellation, including accruals for work completed but not invoiced, would not be avoidable. Additionally, certain costs related to procurement commitments and demobilization costs, including costs to place the work in a safe state would not be avoidable.

The project spend to August 2016 was $2.6B (L-4.3-6 EP-18, Attachment 1, p. 2). In addition, as of September 30, 2016, accruals and commitments related to DRP were estimated at $478M (see L-4.3-13 PWU-8).

GEC Interrogatory #3

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

During its September 23rd presentation OPG indicated that it considered the price impact of alternate contracting approaches. Please provide the percentage impacts that were found to be associated with differing approaches for each major contract or work grouping included in the DRP.

Response

OPG cannot provide the requested analysis. In OPG's September 23, 2016 presentation to the Untranscribed Technical Conference, it was not OPG's intention to imply that, for each major work bundle or grouping, bids were received under differing pricing models.

OPG's presentation stated that "In contracting the various work packages, OPG implemented different pricing models to optimize risk transfer and value-for-money". OPG's presentation also stated that, "Different procurement methods, contracting strategies and pricing models apply to the major work packages to address varying degrees of complexity, uncertainty and need for collaboration". The risk transfer model referenced in OPG's presentation is also included in Ex. D2-2-3 p. 5, Figure 1.

What OPG intended to convey was that its contracting process was designed to ensure that the appropriate risk transfer was achieved for each work package, and that the appropriate party (OPG or the contractor) retained the risks that it was in the best position to manage, thereby achieving an appropriate price.

In preparing for the DRP, and particularly for the larger work packages (e.g. RFR and T/G), OPG first canvassed the market through Expressions of Interest or Requests for Information to determine the contractors' ability to perform the work under different pricing models. Having canvassed the market, OPG then made a determination of which was the most appropriate pricing model for each work package grouping, and issued a Request for Proposal (RFP) inviting bids under the specified pricing model. In certain RFPs, OPG also encouraged bids under alternative pricing models; however, OPG did not stipulate that bids must be submitted under alternative pricing models.

An example of where OPG adjusted its strategy to achieve an appropriate price is in the Turbine Generator work bundle. OPG's initial strategy was to attempt to achieve an

Engineer, Procure, Construct (EPC) agreement with the Original Equipment Manufacturer (OEM) for the entire T/G scope of work, partly driven by the fact that the OEM owned the intellectual property rights on the Turbine Generator sets and also by the desire not to have a different entity performing engineering for the T/G sets. However, the bid OPG received from the OEM was not acceptable, and OPG re-evaluated its approach. The outcome was that the Turbine Generator work was split into two components: a) an Engineering Support and Equipment Supply Agreement (ESES) which was sole-sourced to the OEM under a Fixed/Firm Price model with a limited target price component; and b) a competitively bid EPC contract for the remainder of the work, primarily field work, which was won by a joint venture of SNC/Aecon, under a target price model.

GEC Interrogatory #5

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Pegasus Report D-2-2-11 att. 3

a) How many nuclear projects has Pegasus been retained to review?

b) How many times has Pegasus given evidence or provided analysis in regard to a nuclear project where Pegasus was retained by a project proponent or its counsel? How many times for parties opposing a nuclear project?

c) How many times have you found a nuclear project plan, planning approach or cost estimate to be largely reasonable, and how many times unreasonable?

d) Where you have found a nuclear project plan, planning approach or cost estimate to be generally reasonable, how many of the projects have ultimately been able to adhere to the cost estimate and plan timetable in place at the time of your review?

e) For each nuclear project that Pegasus has reviewed, please list the deviations from budget and completion time compared to the estimates in place at the time of the Pegasus review.

Response

The following responses have been prepared by Pegasus-Global Holdings:

a) Approximately 55 nuclear projects (includes multiple units at specific nuclear stations).

b) Pegasus-Global does not maintain its records via “project proponent” or “parties opposing.” Pegasus-Global has been retained by City/Attorney Generals, Public Utility Commissions, and Utility Companies for work on previous engagements.

c) Pegasus-Global does not evaluate project planning approaches or cost estimates relative to specifics of the interrogatory question asked. Rather, Pegasus-Global provides an independent assessment of the prudent decision-making processes and so conducts its audit work per U.S. Generally Accepted Government Auditing Standards (GAGAS). Cost estimating and the evaluation of cost estimates is typically reviewed on all prudence audits. However, Pegasus-Global does not have copies of all the reports and/or

testimony that have been prepared over the past 30-plus years. The volume of the prudence reports prepared over the prior 30-plus years contains thousands of pages and would take weeks to review to ascertain the information sought. The considerations, assessments and analyses requested in this interrogatory were not part of Pegasus-Global's engagement and study respecting the DRP.

d) Pegasus-Global does not maintain such records. See response to part c above. In any event, OPG does not see the relevance of this request to the DRP, given the different facts and circumstances unique to each project.

e) Pegasus-Global does not maintain such records. See response to part c above. In any event, OPG does not see the relevance of this request to the DRP, given the different facts and circumstances unique to each project.

GEC Interrogatory #7

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Please provide all documents from the province describing the offramp mechanisms for the Darlington life-extension.

Response

OPG has no documents from the Province describing the offramp mechanisms for the Darlington life-extension.

GEC Interrogatory #8

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Please describe what differences exist between off ramp mechanisms for the Darlington life-extension and the life extension of the Bruce reactors.

Response

The 2013 LTEP refurbishment principles included establishment of realistic off-ramps and applied to both Darlington and the Bruce station.

For OPG's Darlington Station:

The Ontario Government can request OPG to stop the Darlington Refurbishment Program (DRP) at any time. OPG's contracts have built in off ramps with specific criteria, including paying out certain costs associated with accruals, demobilizations, and materials. The appropriate clauses are embedded into the contracts developed between OPG and its contract partners.

For the Bruce Station:

OPG has no access to information on off ramps for the Bruce station other than what is available publicly in the Amended Bruce Power Refurbishment Implementation Agreement (December 2015). Based on the Agreement posted on the IESO's website, OPG provides this summary:

- Both Bruce Power and the IESO have back out provisions, or "off-ramps", which can be leveraged in the agreement. The off ramp provisions govern situations where the parties may disagree as to whether refurbishment of a given unit should go ahead in light of predicted cost or schedule overruns.

- Where the cost of refurbishing any given unit exceeds either the price or duration thresholds set by the IESO, IESO may elect to proceed, or halt the refurbishment of a given unit, or of that unit and all yet to be refurbished units.

- IESO may also make such election where any given refurbishment is predicted to take more than six months longer than the locked-in planned refurbishment durations.

- Where the cost exceeds Bruce Power's cost thresholds (which are 50% over the unit threshold base amounts), IESO still elects whether to proceed with the project, but following that election, Bruce Power may elect whether or not it will refurbish the unit in question, or to cease refurbishing any further units. Bruce Power would have to demonstrate that the economics of the project are “significantly impaired” to evoke this clause and can only do so at certain key junctures.

- In general, where one party elects not to proceed with the work, but the other overrides that decision, the party that overrides shall compensate the other for any cost overages.

GEC Interrogatory #9

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

If an offramp is exercised after unit 2 completion, how long does OPG estimate the remaining units would continue operating without refurbishment? What would be the annual revenue requirement impact of such a scenario?

Response

In the event that an off-ramp is exercised after the refurbishment of Unit 2 and the remaining three units were not to be refurbished, OPG would operate the remaining Darlington units for as long as they can continue to be safely operated and licensed to operate by the CNSC. This would require that all life-limiting components, in particular the fuel channels, continue to meet prescribed technical fitness-for-service requirements. Based on current assessments, the following would be the approximate shutdown dates:

Unit 3	early to mid- 2020
Unit 1	mid-to-late 2022
Unit 4	late 2023 to early 2024

The technical fitness-for-service assessments process is an on-going process and dates are subject to change.

OPG cannot provide the annual revenue requirement impact of this scenario. Such an exercise would be completely speculative and require OPG to make a large number of assumptions in many areas of its business, in addition to utilizing the nominal shutdown dates shown above. For example, the shutdown of the majority of the Darlington units in this time period, given the planned timing of the shutdown of the Pickering units, would require OPG to shrink its nuclear program from 10 operating units to 1 operating unit over a period of only a few years. The resultant major downsizing of the company would create fundamental changes to OPG's business. Downsizing costs, decommissioning plan changes, changes to labour strategies, potential changes in regulatory requirements, and changes in financing and cash flow needs, as examples, would all have to be understood and be factored into a revised revenue requirement calculation.

GEC Interrogatory #10

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Please provide a table showing the refurbishment schedules for the Bruce and Darlington nuclear stations from the 2010 and 2013 Long Term Energy Plan directives and the current refurbishment schedule for the Bruce and Darlington nuclear stations. Please explain the differences and rationale for changes between the current and past refurbishment schedules.

Response

OPG does not have Bruce Power's current refurbishment schedule other than information that is publicly available.

The Darlington Refurbishment schedule used in LTEP 2010 was based on the schedule used in the November 2009 Preliminary Release (originally produced in EB-2010-0008 at Ex. D2-2-1, Attachment 4) and reproduced below:

Chart 1

Unit	Start of Refurbishment Outage	Finish of Refurbishment Outage	Duration (months)	Overlap on Previous Unit
1st	**October, 2016**	September, 2019	36	
2nd	February, 2018	January, 2021	36	19
3rd	September, 2019	September, 2022	36	16
4th	January, 2021	**January, 2024**	36	19
		Unit Outage Months	144	
		Refurbishment Window	88	

The Darlington Refurbishment schedule used in LTEP 2013 was based on the November 2013 Business Case Update (originally produced in EB-2013-0321 at Ex. D2-2-1, Attachment 5):

Chart 2

Unit	Start of Refurbishment Outage	Finish of Refurbishment Outage	Duration (months)	Overlap on Previous Unit
D2	**October 2016**	September 2019	36	
D1	October 2019	September 2022	36	0
D3	March 2021	February 2024	36	19
D4	October 2022	**September 2025**	36	17
Total Unit Outage Months (4 units)			144	
Refurbishment Window			108	

An explanation for the change in the Darlington refurbishment schedule between the 2010 LTEP and 2013 LTEP was filed with the Ontario Energy Board in EB-2013-0321 at Ex.D2-2-1, Attachment 5 on page 3:

> "As a result of OPG's improving confidence in the life of critical components at Darlington and the resulting opportunity this creates to maximize the value of the asset and to smooth overall rate impact while mitigating execution risk of the DRP, Management recommended the removal of the overlap of the first and second refurbishment units in June, 2013, effectively delaying the beginning of the refurbishment outages on the 2nd, 3rd and 4th units by nominally 18 months each. This schedule change was approved by the CEO and forms the base schedule planning assumption for this November 2013 updated Business Case."

And on page 7:

> "OPG has pursued increased fuel channel life for both Pickering and Darlington through the Fuel Channel Life Management Project with the aim of developing high confidence in the fuel channel service lives. Recent developments indicate that there may be an opportunity to extend the lives of the fuel channels at Darlington beyond the nominal life of 210,000 EFPH. This opportunity is being explored through a Fuel Channel Life Extension project, which builds on the work accomplished in the Fuel Channel Life Management project. The Fuel Channel Life Extension (FCLE) project is scheduled to be launched in early 2014 and has, as one of its objectives, the achievement of high confidence in 235,000 EFPH on the fuel channels at Darlington.
>
> In June 2013, based on improving confidence in the life of critical components at Darlington and the expectation of positive results from the FCLE project and the resulting opportunity this creates to maximize the value of the asset and to smooth overall rate impact while mitigating execution risk of the DRP, Management recommended the removal of the overlap of the first and second refurbishment units. This was approved by the CEO and forms the base planning assumption for this Business Case."

The high confidence schedule for the Darlington Refurbishment Program at the time of the completion of the Release Quality Estimate was filed with at Ex.D2-2-8, Attachment 1. Also shown in the Chart 3 below is the current high confidence schedule at the time of completion of the Unit 2 Execution Estimate (see L-4.3-1 Staff-055):

Chart 3

Unit	High Confidence at RQE			High Confidence (U2EE)			Variance From RQE
	Start	Finish	Duration (Months)	Start	Finish	Duration (Months)	
Unit 2	15-Oct-16	15-Feb-20	40	15-Oct-16	15-Feb-20	40	0
Unit 3	15-Dec-19	15-Apr-23	40	15-Feb-20	15-June-23	40	0
Unit 1	15-Apr-21	15-Jun-24	38	15-Jul-21	15-Sep-24	38	0
Unit 4	15-Jan-23	15-Feb-26	37	15-Jan-23	15-Feb-26	37	0
4 Units	**15-Oct-16**	**15-Feb-26**	**112**	**15-Oct-16**	**15-Feb-26**	**112**	

The reason for the change between November 2013 and the Release Quality Estimate is that, as OPG completed the Release Quality Estimate, durations were refined and appropriate risks and contingencies were developed, which resulted in the high confidence dates and durations in the Release Quality Estimate.

The only significant change to the high confidence 4-unit schedule since Release Quality Estimate was the un-lapping of the beginning of the Unit 3 refurbishment from the end of the Unit 2 refurbishment, to be consistent with the Province's requirement to complete Unit 2 prior to commencing any subsequent units. The overall 4-unit high confidence schedule duration remained at 112 months. The updated schedule was reflected in OPG's 2016-2018 Business Plan based on Release Quality Estimate cost flows.

GEC Interrogatory #11

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
GEC wishes to examine the historical accuracy and trends in OPG's (and Ontario Hydro's) cost estimates as reflected in LUEC estimates:

a) In 2016, the Office of the Information Commissioner ordered OPG to release the 2009 Levelized Unit Energy Cost spreadsheet for the Darlington refurbishment that was provided to its board of directors in 2009. (See: PA-12-394 attached.) Please provide the most recently updated comparable LUEC spreadsheet for the Darlington station post refurbishment. Please explain any differences.

b) Please provide all available past LUEC estimates for Darlington and the equivalent value in 2016 dollars (see for e.g. the NB Power undertaking attached). In each case please indicate whether the LUEC includes the stranded debt that OPG was relieved of. In each case please indicate whether the LUEC includes the DRP.

c) Please indicate and what similar historical analyses have been presented to OPG's Board and to the various review entities that OPG has retained for the DRP and provide these.

d) Please provide the LUEC cost for the Darlington nuclear station in 2016 dollars as actually experienced (without avoidable DRP costs). Please include costs with and without the applicable stranded debt.

Response

This interrogatory seeks current and historical details about the Levelized Unit Energy Cost (LUEC) of the DRP. This information is not relevant to deciding any issue on the approved Issues List in this application. LUEC is one of the factors used in the determination of the appropriate generation options to meet the electricity demand in Ontario. This accountability lies with the Ministry of Energy, supported by the IESO. LUEC is used as an economic comparator. Please see Ex. D2-2-1, p. 9 section 4.1 where OPG notes that Ontario Regulation 53/05 was amended on January 1, 2016 to include additional provisions that deal with nuclear refurbishment costs and establish the need for the DRP. The OEB has previously ruled that consideration of the need for the DRP is outside its mandate. In the Decision with Reasons, EB-2013-0321, p. 60, the Board re-iterated the following:

> "The Board indicated in an earlier ruling in this proceeding that it will not consider, as a threshold issue, whether the Darlington Refurbishment Project should proceed. The Board maintains that the decision to refurbish Darlington is a decision that has been made by the provincial government and forms a key component of the Long-Term Energy Plan. As such, at this time the Board needs only to focus on the test period capital expenditures."

OPG does not believe that the LUEC analysis is relevant to the consideration of the prudence of the overall DRP cost and the effectiveness of how the project will be executed.

Without agreeing that this information is relevant, OPG provides the responses below.

a) The LUEC spreadsheet consistent with the Release Quality Estimate is provided in Attachment 1. It shows the RQE LUEC result of 8.1 ¢/kWh (2015$). LUEC escalates each year at the rate of inflation. OPG uses the Ontario Consumer Price Index to escalate LUEC. For comparison purposes, OPG has also provided the LUEC spreadsheet OPG provided in response to PA-12-394, but converted to 2015$. That spreadsheet is provided in Attachment 2; it shows the 2009 LUEC result as 6.1 ¢/kWh (2015$).

   The major differences are as follows:

   - The Darlington Refurbishment Program (DRP) estimate used to calculate the LUEC in 2009 was the point estimate (slightly less than a 50% confidence estimate), which was $8.7B (including interest and escalation) at the time. OPG moved to using a 90% confidence estimate for the DRP in both its 2013 LUEC estimate, shown in EB-2013-0321, Ex. D2-2-1, Attachment 5, and in the RQE LUEC estimate. Had the 90% confidence estimate been used in 2009, the estimated DRP costs would have been $10.3B (including interest and escalation) versus $12.8B used at RQE. As OPG has noted, a major purpose of the Definition Phase planning was to put more rigor and detail into the cost estimates. The earlier 2009 estimates were feasibility level estimates without the benefit of detailed Definition Phase planning and, as a result, OPG publicly communicated a range estimate of $6B to $10B (2009$) in February 2010. The upper end of that range, $10B (2009$) translates to $14B, when interest and escalation is included. Please see L-4.3-2 AMPCO-78 and also OPG's response to J15.2 in EB-2013-0321. The impact on LUEC of the change from $8.7B in 2009 to $12.8B in 2015 is estimated to be 1.1 ¢/kWh (2015$).

   - The preliminary DRP schedule used in the 2009 LUEC calculation was a uniform 36 months per unit, with an overlap of the first two units of 19 months. By the time of RQE, OPG had refined its high confidence schedule to 40, 40, 38, 37 months for Units 2, 3, 1 and 4 respectively and the overlap between the first two units had been removed. The impact on LUEC of the schedule change is estimated to be 0.1 ¢/kWh (2015$).

- The 2009 DRP business case was prepared under the assumption of a continued minimum 10-unit OPG nuclear program and potential growth of that program. That is, refurbishment of Pickering Units 5 to 8 was assumed and also the potential for New Nuclear. The decision not to refurbish Pickering Units 5 to 8, but to pursue continued operations instead, was made in 2009. OPG adjusted its assumptions in the DRP business cases: (1) to reflect losses of economies of scale in Nuclear and Corporate Support costs in the post-refurbishment period given no cost sharing with Pickering and potentially New Nuclear; and (2) to use costs that were more consistent with the "fully allocated" Nuclear Support costs and Corporate Support Costs versus the incremental costs view used in the November 2009 business case. Fully allocated versus incremental costs and the losses of economies of scale regarding Darlington's support costs are explained in OPG's 2013 DRP business case (see: Ex. D2-2-1 Attachment 5, p. 41).

b) The question appears to contemplate providing LUECs for the original Darlington plant built in the 1980s and placed in-service in the late 1980s and early 1990s. The question also contemplates calculating LUEC without the stranded debt of Ontario Hydro. Firstly, stranded debt cannot be allocated to specific assets and secondly, consistent with OPG's approach in EB-2007-0905, EB-2010-0008 and EB-2013-0321, historical information for the period prior to 2005 is not provided. The information from before 2005 is not relevant as OPG was not regulated prior to April 1, 2005.

Please see the table below for the LUEC of the DRP prepared during the period 2009 to 2015. LUECs were updated in each year except 2010, consistent with the release of further funding throughout the Definition Phase of the DRP.

LUECs are provided in both the year's dollars in which the LUEC was originally prepared and in 2016$ in Charts 1 and 2 below. After 2013, OPG did not carry out Monte Carlo analysis of the LUEC. Please see note 2 in Table 2. In every case, the LUEC includes the DRP.

Chart 1 - Point Estimate LUECs for 2009 to 2013 and High Confidence LUECs using Monte Carlo Simulation

Year	Pt. Estimate of LUECs ($ of the year shown)	90% Conf. Estimate of LUEC ($ of the year shown)	90% Conf. LUECs converted to 2016$
2009	5.4(1)	6.6	7.6
2010	N/A(2)	N/A(2)	N/A(2)
2011	6.7	7.4	8.1
2012	7.2	7.7	8.3
2013	7.3	8.1	8.6

Notes:

1. As noted in the answer to part a) this LUEC was based on a very preliminary point estimate for the DRP, medium confidence estimates of post-refurbishment costs and a uniform 36 months per unit DRP duration.
2. No updates to the LUEC were completed in 2010.

Chart 2 - Going forward and Economic LUEC Using High Confidence Estimates

	Going Forward(2) High Confidence Pt. Estimate of LUEC ($ of the year shown)	High Confidence Pt. Estimate of Economic LUEC(2) ($ of the year shown)	Going Forward(2) Pt. Estimate of LUEC (2016$)	High Confidence Pt. Estimate of Economic LUEC(2) (2016$)
2014(1)	7.1	7.7(3)	7.4	7.9
2015(1)	7.2	8.1(3)	7.4	8.3

Notes:

1. The 2014 and 2015 high confidence LUEC estimate is not the result of a Monte Carlo simulation, but relies on the high confidence point estimates of the DRP (RQE in 2015), high confidence point estimates of post-refurbishment costs and medium confidence post-refurbishment estimates of fuel costs and performance.
2. Please see Ex. D2-2-8, Attachment 1, p. 17 for a discussion of going-forward LUECs and high-confidence economic LUECs. Going-forward LUECs exclude “sunk” DRP costs; i.e. costs-to-date.

c) OPG did not provide the assumptions underlying LUEC to any external entities other than Ministries of the Government of Ontario, the OPA and the IESO. In 2016, in response to a request, OPG provided its LUEC spreadsheet for the RQE to the Financial Accountability Office of the Ontario Government.

d) There is no “LUEC cost for the Darlington nuclear station in 2016 dollars as actually experienced (without avoidable DRP costs)”. Please see L-04.3-6 ED-014 for a discussion of the differences between LUEC and rates. However, OPG interprets this question to be “Please provide the historical total generating cost of the Darlington Station”. Please see Ex. F2-1-1, Attachment 1, p. 88, which shows the 3-year average total generation cost to 2014 for the Darlington station to be $37.73/MWh.

GEC ATTACHMENT #1

Chairman Nicholson at page 1473 of June 13 Transcript:

"Okay. I guess I will go back and follow up with what Commissioner Dumont has asked and ask you if you could undertake to provide the Board with the – a net present value of the cost per kilowatt hour of electricity that has been produced by Point Lepreau since it was commissioned? And I would say up to and including...

or levelized cost, right up and including, if you are able to do this as well, when you will either refurbishment it or shut it down in 2006, 2007 based on your estimate?

Response:

The levelized cost of power from Point Lepreau from 1983 up to 2006 based on actual costs until March 2002 and budgeted costs until March 2006 is 6.06 cents/kWh in 1983$. Escalating that cost forward using actual and projected CPI the estimated levelized power cost in 2006$ would be 10.97 cents/kWh.

ONTARIO POWER GENERATION

INPUT

Input fields are coloured **blue**

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Capacity MW/unit		878	878	878	878	878	878	878	878	878	878	878	878	878	878	878	878	878	878	878	878
Days in year		365	365	365	366	365	365	365	366	365	365	365	366	365	365	365	366	365	365	365	366
Outage Start																					
D2	10/15/2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D3	12/15/2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D1	4/15/2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D4	1/15/2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.96	1.00	1.00	1.00	1.00	1.00
Return to Service																					
D2	2/15/2020	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D3	4/15/2023	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	1.00	1.00	1.00	1.00	1.00
D1	6/15/2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55	1.00	1.00	1.00	1.00
D4	2/15/2026	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	1.00	1.00
Out-ofService Date																					
D2	2/15/2050	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D3	4/15/2053	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D1	6/15/2054	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D4	2/15/2056	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Operational Unit-Years																					
D2	30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
D3	30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	1.00	1.00	1.00	1.00	1.00
D1	30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55	1.00	1.00	1.00	1.00
D4	30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	1.00	1.00
Total Operational Unit-Years	120	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	1.00	1.00	1.72	2.55	3.00	3.88	4.00	4.00
Perfect production GWh	923586	0	0	0	0	0	0	0	0	0	0	0	6764	7691	7691	13191	19639	23074	29817	30765	30849
Energy GWh	812755	0	0	0	0	0	0	0	0	0	0	0	6005	6828	6828	11711	17436	20485	26471	24694	27388
Annual Capacity Factor	88.00%																				

Economic Indices & Tax

Discount Rate	7%																				
PV factor at 2015-01-01		1.451	1.356	1.267	1.184	1.107	1.034	0.967	0.903	0.844	0.789	0.738	0.689	0.644	0.602	0.563	0.526	0.491	0.459	0.429	0.401
Inflation (CPI)																					
Escalation rate	Ontario CPI	0.4%	2.5%	3.1%	1.4%	1.0%	2.4%	1.6%	2.1%	2.0%	2.0%	1.9%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Escalation factor 2015$->esc$		0.889	0.911	0.939	0.952	0.961	0.984	1.000	1.021	1.042	1.063	1.083	1.105	1.127	1.150	1.173	1.196	1.220	1.245	1.269	1.295
Tax Schedule																					
provincial + federal		31.0%	29.0%	26.5%	25.0%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%

ONTARIO POWER GENERATION

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Option Costs																					
Refurbishment Project Expenditures (esc$)																					
Total cost	12800		35	91	233	416	701	732	1232	1136	1135	983	907	1215	1372	1196	807	521	90	0	0
Interest During Construction (IDC)	1461		1	3	10	22	45	78	93	141	195	203	58	108	179	135	103	87	0	0	0
Total excl IDC	11339		35	87	223	394	655	654	1139	995	940	780	849	1107	1193	1061	704	434	90	0	0
OM&A portion	247		0	1	3	6	6	4	1	42	14	4	48	20	31	41	9	14	4	0	0
Capital portion excl IDC	11092		34	87	220	388	649	650	1138	953	926	776	800	1087	1162	1020	695	420	86	0	0
Other costs (esc$)																					
Radioactive waste containers	170						1	9	19	32	28	32	28	15	5						
Initial fuel charge	80								0	0	0	17	0	0	20	0	21	22			
Post-refurbishment Costs (2015 $M)																					
Base Operations, Maintenance & Admin ((	9314	0	0	0	0	0	0	0	0	0	0	0	62	70	70	120	179	210	272	281	281
Outage OM&A	4230	0	0	0	0	0	0	0	0	0	0	0	31	35	35	60	90	106	137	141	141
OM&A Projects	1114	0	0	0	0	0	0	0	0	0	0	0	8	9	9	15	23	27	35	36	36
Property Tax	349	0	0	0	0	0	0	0	0	0	0	0	2	3	3	5	7	8	10	11	11
Nuclear & Corp Overhead	14296	0	0	0	0	0	0	0	0	0	0	0	101	115	115	197	292	344	445	459	459
Sustaining Capital	3264	0	0	0	0	0	0	0	0	0	0	0	14	19	22	36	55	70	91	102	111
Minor Fixed Assets	302	0	0	0	0	0	0	0	0	0	0	0	2	2	2	4	6	7	9	10	10
Fuel & Used Fuel Management	4781	0	0	0	0	0	0	0	0	0	0	0	35	40	40	69	102	120	156	145	161
Total Annual Costs	37650	0	0	0	0	0	0	0	0	0	0	0	255	293	296	507	754	893	1154	1184	1209
Annual Operating Costs																					
Annual Costs (esc $M)																					
Base Operations, Maintenance & Admin ((	15664	0	0	0	0	0	0	0	0	0	0	0	69	80	82	143	217	261	344	362	369
Outage OM&A	6892	0	0	0	0	0	0	0	0	0	0	0	35	40	41	72	109	131	173	182	186
OM&A Projects	1806	0	0	0	0	0	0	0	0	0	0	0	9	10	10	18	27	33	43	45	46
Property Tax	584	0	0	0	0	0	0	0	0	0	0	0	3	3	3	5	8	10	13	14	14
Nuclear & Corp Overhead	23566	0	0	0	0	0	0	0	0	0	0	0	113	132	134	235	355	427	563	593	604
Sustaining Capital	5148	0	0	0	0	0	0	0	0	0	0	0	15	21	25	42	65	85	113	129	144
Minor Fixed Assets	489	0	0	0	0	0	0	0	0	0	0	0	2	3	3	5	7	9	12	12	13
Fuel & Used Fuel Management	7659	0	0	0	0	0	0	0	0	0	0	0	39	45	46	81	122	147	193	184	208
Total Annual Costs	61807	0	0	0	0	0	0	0	0	0	0	0	285	334	345	602	913	1103	1454	1521	1584
Total Annual Lifetime Cost																					
Total Cashflows ($ million)																					
Refurbishment OM&A Portion	247	0	0	1	3	6	6	4	1	42	14	4	48	20	31	41	9	14	4	0	0
Refurbishment Capital Portion	11092	0	34	87	220	388	649	650	1138	953	926	776	800	1087	1162	1020	695	420	86	0	0
Radioactive waste containers	170	0	0	0	0	0	1	9	19	32	28	32	28	15	5	0	0	0	0	0	0
Initial fuel charge	80	0	0	0	0	0	0	0	0	0	0	17	0	0	20	0	21	22	0	0	0
Base Operations, Maintenance & Admin ((	15664	0	0	0	0	0	0	0	0	0	0	0	69	80	82	143	217	261	344	362	369
Outage OM&A	6892	0	0	0	0	0	0	0	0	0	0	0	35	40	41	72	109	131	173	182	186
OM&A Projects	1806	0	0	0	0	0	0	0	0	0	0	0	9	10	10	18	27	33	43	45	46
Property Tax	584	0	0	0	0	0	0	0	0	0	0	0	3	3	3	5	8	10	13	14	14
Nuclear & Corp Overhead	23566	0	0	0	0	0	0	0	0	0	0	0	113	132	134	235	355	427	563	593	604
Sustaining Capital	5148	0	0	0	0	0	0	0	0	0	0	0	15	21	25	42	65	85	113	129	144
Minor Fixed Assets	489	0	0	0	0	0	0	0	0	0	0	0	2	3	3	5	7	9	12	12	13
Fuel & Used Fuel Management	7659	0	0	0	0	0	0	0	0	0	0	0	39	45	46	81	122	147	193	184	208
TOTAL	73396	0	35	87	223	394	657	663	1158	1027	968	829	1162	1456	1562	1663	1637	1558	1544	1521	1584

ONTARIO POWER GENERATION

Simplified Levelized Unit Energy Cost (LUEC)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Costs (including tax impact)																				
Refurbishment OM&A Portion	0	0	0	2	5	5	3	1	31	10	3	36	15	23	31	6	10	3	0	0
Refurbishment Capital Portion	0	34	87	220	388	649	650	1138	953	926	776	800	1087	1162	1020	695	420	86	0	0
Radioactive waste containers	0	0	0	0	0	1	7	14	24	21	24	21	11	3	0	0	0	0	0	0
Initial fuel charge	0	0	0	0	0	0	0	0	0	0	17	0	0	20	0	21	22	0	0	0
Base Operations, Maintenance & Admin (OM&A)	0	0	0	0	0	0	0	0	0	0	0	52	60	61	108	163	196	258	272	277
Outage OM&A	0	0	0	0	0	0	0	0	0	0	0	26	30	31	54	82	98	130	136	139
OM&A Projects	0	0	0	0	0	0	0	0	0	0	0	6	8	8	13	20	25	32	34	35
Property Tax	0	0	0	0	0	0	0	0	0	0	0	2	2	2	4	6	7	10	10	11
Nuclear & Corp Overhead	0	0	0	0	0	0	0	0	0	0	0	85	99	101	176	267	320	422	444	453
Sustaining Capital	0	0	0	0	0	0	0	0	0	0	0	15	21	25	42	65	85	113	129	144
Minor Fixed Assets	0	0	0	0	0	0	0	0	0	0	0	2	3	3	5	7	9	12	12	13
Fuel & Used Fuel Management	0	0	0	0	0	0	0	0	0	0	0	29	34	35	60	92	110	145	138	156
Tax shields: CCA & IDC	0	0	-1	-4	-10	-21	-40	-60	-86	-120	-142	-114	-144	-170	-178	-171	-173	-143	-135	-127
Changes in Working Capital	0	0	0	0	0	0	0	0	-2	3	1	60	14	2	56	70	39	75	-22	46
PV = 17467	0	34	87	219	383	634	620	1093	921	841	680	1021	1240	1306	1392	1324	1169	1143	1019	1147
LUEC denominator																				
PV = 214.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.98	5.77	5.89	10.30	15.64	18.75	24.71	23.51	26.60

LUEC 2015 $/MWh	**81**
LUEC 2015 ¢/kWh	**8.1**

NOTICE
The attached model and information contained in the model is confidential, a trade secret and otherwise proprietary to Ontario Power Generation Inc. (OPG) and is, at all times, the exclusive property of OPG.

Users of this model will treat the model and the information contained therein as confidential information and take such measures to protect such information as it uses to protect its own confidential and proprietary information. Unauthorized disclosure of this information could reasonably be expected to prejudice significantly the competitive position or interfere significantly with the contractual or other negotiations of OPG.

ONTARIO POWER GENERATION

INPUT

Input fields are coloured **blue**

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Capacity MW/unit		878	878	878	878	878	878	878	878	878	878	878	878	878	878	878	878	878	878
Outage Start																			
u1	10/1/2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u2	3/1/2018	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u3	11/1/2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u4	4/1/2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	1.00	1.00	1.00	1.00	1.00
Return to Service																			
u1	10/1/2019	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u2	3/1/2021	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	1.00	1.00	1.00	1.00	1.00
u3	11/1/2022	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	1.00	1.00	1.00	1.00
u4	4/1/2024	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	1.00	1.00
Out-ofService Date																			
u1	10/1/2049	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u2	3/1/2051	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u3	11/1/2052	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u4	4/1/2054	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Operational Unit-Years																			
u1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	1.00	1.00	1.00	1.00	1.00
u3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	1.00	1.00	1.00	1.00
u4		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	1.00	1.00
Total Operational Unit-Years		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.00	1.84	2.17	3.00	3.75	4.00	4.00
Lifetime Unit-Years																			
u1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u3		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	1.00	1.00	1.00	1.00	1.00	1.00	1.00
u4		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	1.00	1.00	1.00	1.00	1.00
Total Lifetime Unit-Years		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	1.00	1.84	2.17	3.00	3.75	4.00	4.00	4.00	4.00	4.00
Perfect production GWh		0	0	0	0	0	0	0	0	0	0	1939	7691	14139	16668	23074	28869	30765	30765
Annual Capacity Factor		87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%	87%
Energy GWh		0	0	0	0	0	0	0	0	0	0	1687	6691	12301	14501	20074	25116	26766	26766

ONTARIO POWER GENERATION

		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Economic Indices																			
Discount Rate		7%																	
Interest Capitalization Rate		6%																	
Capital Escalation																			
Escalation rate	Ontario CPI	0.4%	2.5%	3.1%	1.4%	1.0%	2.4%	1.6%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Escalation factor		0.889	0.911	0.939	0.952	0.961	0.984	1.000	1.020	1.040	1.061	1.082	1.104	1.126	1.149	1.172	1.195	1.219	1.243
Operations, Maintenance & Admin Escalation																			
Escalation rate	Ontario CPI	0.4%	2.5%	3.1%	1.4%	1.0%	2.4%	1.6%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Escalation factor		0.889	0.911	0.939	0.952	0.961	0.984	1.000	1.020	1.040	1.061	1.082	1.104	1.126	1.149	1.172	1.195	1.219	1.243
Fuel Escalation																			
Escalation rate	Ontario CPI	0.4%	2.5%	3.1%	1.4%	1.0%	2.4%	1.6%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Escalation factor		0.889	0.911	0.939	0.952	0.961	0.984	1.000	1.020	1.040	1.061	1.082	1.104	1.126	1.149	1.172	1.195	1.219	1.243
Used Fuel Management Escalation																			
Escalation rate	Ontario CPI	0.4%	2.5%	3.1%	1.4%	1.0%	2.4%	1.6%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Escalation factor		0.889	0.911	0.939	0.952	0.961	0.984	1.000	1.020	1.040	1.061	1.082	1.104	1.126	1.149	1.172	1.195	1.219	1.243
Inflation (CPI)																			
Escalation rate	Ontario CPI	0.4%	2.5%	3.1%	1.4%	1.0%	2.4%	1.6%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Inflation factor 2015$		0.889	0.911	0.939	0.952	0.961	0.984	1.000	1.020	1.040	1.061	1.082	1.104	1.126	1.149	1.172	1.195	1.219	1.243
Inflation factor 2009$		1.000	1.025	1.056	1.071	1.082	1.107	**1.125**											
Option Costs																			
Project Expenditures (2015 $M)																			
u1	2645	0	74	111	227	245	295	217	267	570	448	181	10	0	0	0	0	0	0
u2	1458	0	0	0	0	0	0	0	0	17	457	608	336	38	2	0	0	0	0
u3	1432	1	0	0	0	0	0	0	0	0	4	111	550	526	216	24	0	0	0
u4	1456	0	0	0	0	0	0	0	0	0	0	0	15	358	636	387	57	3	0
Total Project Cost Flow	6991	1	74	111	227	245	295	217	267	588	909	899	911	923	853	411	57	3	0
Project Expenditures (esc $M)																			
u1	2678	0	68	105	216	235	290	217	273	593	475	196	11	0	0	0	0	0	0
u2	1577	0	0	0	0	0	0	0	0	18	485	658	371	43	2	0	0	0	0
u3	1601	1	0	0	0	0	0	0	0	0	5	120	607	593	248	28	0	0	0
u4	1676	0	0	0	0	0	0	0	0	0	0	0	17	403	730	453	68	4	0
Total Project Cost Flow	7531	1	68	105	216	235	290	217	273	611	964	974	1006	1039	980	481	68	4	0
Interest During Construction (esc $M)																			
u1	677	0	2	7	17	32	50	68	87	118	157	139	0	0	0	0	0	0	0
u2	168	0	0	0	0	0	0	0	0	1	16	51	85	17	0	0	0	0	0
u3	171	0	0	0	0	0	0	0	0	0	0	4	26	64	77	0	0	0	0
u4	174	0	0	0	0	0	0	0	0	0	0	0	1	13	48	86	26	0	0
Total Interest During Construction	1191	0	2	7	17	32	50	68	87	118	173	194	111	93	125	86	26	0	0

ONTARIO POWER GENERATION

Annual Operating Costs

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Annual Costs (2015 $M)																		
Base Operations, Maintenance & Admin (OM&A)	343	343	343	343	343	343	343	317	317	317	317	317	317	317	317	317	365	365
Outage OM&A & OM&A Projects	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161	161
Nuclear & Corp Overhead	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214	214
Sustaining Capital	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57
Total Annual Costs	775	775	775	775	775	775	775	749	749	749	749	749	749	749	749	749	797	797
Fuel Costs (2009$/MWh)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Used Fuel Management Costs (2009$/MWh)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Annual Costs (esc $M)																		
Base Operations, Maintenance & Admin (OM&A)	0	0	0	0	0	0	0	20	83	155	186	263	335	364	372	379	444	453
Outage OM&A & OM&A Projects	0	0	0	0	0	0	0	0	0	0	11	44	83	100	141	180	196	200
Nuclear & Corp Overhead	0	0	0	0	0	0	0	14	56	104	125	177	226	246	250	255	261	266
Sustaining Capital	0	0	0	0	0	0	0	0	0	0	4	16	30	36	50	64	70	71
Fuel & Used Fuel Management	0	0	0	0	0	0	0	0	0	0	9	37	69	82	116	149	162	165
Total Annual Costs	0	0	0	0	0	0	0	34	138	259	335	537	743	828	930	1028	1133	1155

Total Annual Lifetime Cost

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Total Costs ($ million)																		
Project Expenditures	1	68	105	216	235	290	217	273	611	964	974	1006	1039	980	481	68	4	0
Interest During Construction	0	2	7	17	32	50	68	87	118	173	194	111	93	125	86	26	0	0
Base Operations, Maintenance & Admin (OM&A)	0	0	0	0	0	0	0	20	83	155	186	263	335	364	372	379	444	453
Outage OM&A & OM&A Projects	0	0	0	0	0	0	0	0	0	0	11	44	83	100	141	180	196	200
Nuclear & Corp Overhead	0	0	0	0	0	0	0	14	56	104	125	177	226	246	250	255	261	266
Sustaining Capital	0	0	0	0	0	0	0	0	0	0	4	16	30	36	50	64	70	71
Fuel & Used Fuel Management	0	0	0	0	0	0	0	0	0	0	9	37	69	82	116	149	162	165
TOTAL	1	70	112	233	267	340	284	394	868	1396	1503	1654	1875	1934	1498	1122	1137	1155

ONTARIO POWER GENERATION

Capital Cost Allowance (CCA) and Tax

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Tax Depreciation Schedule	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Undepreciated Capital Cost opening	0	0	0	0	0	0	0	0	0	0	0	3220	2962	4399	5747	5285	6636	6102
In-Service additions- Project											3355		1745	1772		1850		
In-Service additions- Sustaining	0	0	0	0	0	0	0	0	0	0	4	16	30	36	50	64	70	71
Capital Cost Allowance (CCA)	0	0	0	0	0	0	0	0	0	0	134	258	308	424	462	499	534	491
Undepreciated Capital Cost closing	0	0	0	0	0	0	0	0	0	0	3220	2962	4399	5747	5285	6636	6102	5611
Tax Schedule																		
Current provincial + federal	31.0%	29.0%	26.5%	25.0%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%

Simplified Levelized Unit Energy Cost (LUEC)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Costs (including tax impact)																		
Base Operations, Maintenance & Admin (OM&A)	0	0	0	0	0	0	0	15	62	116	140	197	251	273	279	284	333	340
Outage OM&A & OM&A Projects	0	0	0	0	0	0	0	0	0	0	8	33	62	75	106	135	147	150
Nuclear & Corp Overhead	0	0	0	0	0	0	0	10	42	78	94	133	169	184	188	192	195	199
Fuel & Used Fuel Management	0	0	0	0	0	0	0	0	0	0	7	27	51	62	87	111	121	124
Project Capital	1	68	105	216	235	290	217	273	611	964	974	1006	1039	980	481	68	4	0
Sustaining Capital	0	0	0	0	0	0	0	0	0	0	4	16	30	36	50	64	70	71
CCA tax shield	0	0	0	0	0	0	0	0	0	0	-34	-65	-77	-106	-115	-125	-133	-123
PV = 8931	1	68	105	216	235	290	217	298	715	1159	1193	1348	1527	1504	1076	730	737	761
LUEC denominator																		
PV = 146.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.37	5.54	10.39	12.49	17.64	22.51	24.47	24.96

LUEC 2015 $/MWh **61.0** 61.0 check

LUEC 2015 ¢/kWh **6.1**

NOTICE

The attached model and information contained in the model is confidential, a trade secret and otherwise proprietary to Ontario Power Generation Inc. (OPG) and is, at all times, the exclusive property of OPG.

Users of this model will treat the model and the information contained therein as confidential information and take such measures to protect such information as it uses to protect its own confidential and proprietary information. Unauthorized disclosure of this information could reasonably be expected to prejudice significantly the competitive position or interfere significantly

Simplifications:
1. Simplified tax calculation
2. No calculation of working capital
3. Simplified Operations, Maintenance & Admin allocation during partial station operation
4. Standby generator fuel cost included with Base Operations, Maintenance & Admin
5. Base OM&A is lower during project execution due to some staff being assigned to the project.

GEC Interrogatory #12

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

In past submissions to the board, OPG has provided cost comparisons of the Darlington life-extension to alternatives, such as combined cycle natural gas. (see for e.g. EB-2010-0008, Exhibit D2-2-1, Attachment 4; EB-2013-0321, D2-2-1, Attachment 5, Updated 2014-02-06) No updated alternative comparisons were provided in the current application. Among other considerations, GEC expects that trends in such comparisons could inform a consideration of the likelihood of the government exercising the off-ramps.

Please provide updated cost comparisons to the Darlington life-extension.

Response

OPG objects to the question on the basis of relevance. An investigation into alternatives to Darlington Refurbishment is not within the scope of this proceeding because section 12(v) of O. Reg. 53/05 states: “the Board shall accept the need for the Darlington Refurbishment Project in light of the Plan of the Ministry of Energy known as the 2013 Long-Term Energy Plan and the related policy of the Minister endorsing the need for nuclear refurbishment.”

Without waiving this objection, OPG notes that material responsive to this interrogatory is provided in Ex. L-4.3-5 CCC-022.

GEC Interrogatory #14

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Exhibit D2-2-8 Attachment 1, page 28

OPG states it has benchmarked the Darlington life-extension against CANDU projects at Point Lepreau and Bruce units 1 & 2. Has OPG reviewed and assessed Hydro-Quebec's cost estimates for rebuilding the Gentilly-2 reactor? Please provide cost estimates for the Gentilly-2 life-extension that OPG reviewed.

Response

Please refer to Ex. L-04.3-1 Staff-53 for a summary of the information OPG reviewed from other CANDU projects. OPG has not performed a detailed review of the cost estimates for the refurbishment of the Gentilly 2 nuclear unit. However, OPG did perform high-level cost comparisons of the Gentilly-2 cost estimates, based on publicly available information as part of its planning during the Definition Phase of the DRP.

In 2012, Hydro Quebec's announced that it would no longer pursue the refurbishment of the Gentilly nuclear unit. At that time, the company published a number of reports which OPG did assess to understand the reasons for the Hydro Quebec decision and to compare to DRP. The Executive Summary of the Gentilly cost estimate which OPG reviewed is provided in Attachment 1. This Executive Summary and other documents published by Hydro Quebec at the time are available from Hydro Quebec's website at:

http://www.hydroquebec.com/generation/centrale-nucleaire/pdf/executive-summary.pdf

EXECUTIVE SUMMARY

Gentilly-2 nuclear generating station was commissioned in October 1983. It was designed to have a useful life of 30 years, given the inevitable aging of several major components. The facility's current operating licence, issued by the Canadian Nuclear Safety Commission (CNSC), requires that the facility be shut down at the end of 2012 and prohibits any extension of operations beyond that time without major refurbishment.

Hydro-Québec initiated draft-design studies at the beginning of the last decade to determine whether it would be feasible and advisable to refurbish Gentilly-2 in order to extend its useful life for an additional 30 years.

In August 2008, upon completion of these studies, Hydro-Québec announced its decision to proceed with the refurbishment. The anticipated cost of a second life cycle was $3.5 billion, plus operating expenses. Refurbishment was estimated at $1.9 billion for a unit cost of 8.6¢ per kilowatthour (kWh) of output, taking into account the required investment and future costs of $1.6 billion related to spent fuel and long-term facility dismantlement. On an incremental basis compared to the total costs associated with the short-term closure alternative, the unit cost of electricity produced under the refurbishment scenario amounted to 7.2¢/kWh. At that time, electricity market conditions were favorable, with prices exceeding 8¢ US per kWh as a result of high natural gas prices and anticipated future increases. Under these circumstances, the project was justified from a financial standpoint.

Several factors led to the postponement of the refurbishment project. Major problems were encountered by Atomic Energy of Canada Limited (AECL) in the refurbishment of similar nuclear plants in New Brunswick and South Korea, and the federal government's decision to sell AECL, announced in 2009, caused further uncertainties. Then came the nuclear incidents in Fukushima, Japan, in 2011. In light of these events, Hydro-Québec decided to slow down preparations for the refurbishment of Gentilly-2.

Feedback obtained from the projects in South Korea and New Brunswick now enable us to better assess the full refurbishment cycle of a nuclear facility such as Gentilly-2. Based on the new data, the cost of a second life cycle would amount to $6.3 billion, plus operating expenses. The refurbishment of Gentilly-2 would cost $4.3 billion and extend from January 2014 to September 2016. Such an investment would yield energy output at 12.3¢/kWh, taking into account the required investment and $2 billion in future costs associated with spent fuel and long-term facility dismantlement. On an incremental basis compared to the total cost associated with the short-term closure alternative, the refurbishment scenario would yield electricity at 9.7¢/kWh as of 2017. The refurbishment project would require a financial commitment of nearly $3.4 billion over and above the $965 million invested to date. This translates into a unit cost of 10.8¢/kWh, or 8.3¢/kWh on an incremental basis compared to the cost of a 2012 closure. In other words, project costs have increased.

Market conditions have also changed since 2008. Potential export revenue from the sale of energy produced at Gentilly-2 would be on the order of 4¢/kWh in 2017, given the spectacular drop in natural gas and electricity prices stemming mainly from the development of the US shale gas industry. Given the total anticipated volume of Hydro-Québec exports in the medium term, the closure of Gentilly-2 will mostly result in a reduction of sales in daily and seasonal off-peak periods on markets outside Québec, which explains the 4¢/kWh figure. It should also be mentioned that the Québec market presents electricity surpluses throughout the current decade.

The increase in project costs, combined with the decrease in accessible market revenue, has led Hydro-Québec to conclude that **the project is no longer justified from a financial standpoint.** The financial analysis on which this conclusion is based is summarized in the following table.

Financial Analysis Summary

GENTILLY-2 NUCLEAR GENERATING STATION	2008 analysis REFURBISHMENT ($ 2008)	2012 analysis ($ 2012)		
		REFURBISHMENT Total cost	REFURBISHMENT Future cost only	DECOMMISSIONING
Shutdown	March 2011	December 2012	December 2012	December 2012
Start of refurbishment	March 2011	January 2014	January 2014	–
Commissioning	November 2012	September 2016	September 2016	–
Projected cost of refurbishment	$1.9 billion	$4.3 billion	$3.4 billion	–
Cost of decommissioning	$1.6 billion	$2.0 billion	$2.0 billion	$1.8 billion
TOTAL COST	**$3.5 billion**	**$6.3 billion**	**$5.4 billion**	**$1.8 billion**
Total unit cost of refurbishment (¢2012/kWh)	**8.6**	**12.3**	**10.8**	**–**
Incremental unit cost of refurbishment (¢2012/kWh)	**7.2**	**9.7**	**8.3**	**–**

Closure of Gentilly-2 at the end of 2012 will cost $1.8 billion over a period exceeding 50 years. It will yield better financial results for Hydro-Québec in the future than would the refurbishment of the facility. The company's net annual income will be about $215 million higher in 2017 and subsequent years than it would be under a refurbishment scenario. This variance is based on the difference between the incremental refurbishment cost of 8.3¢/kWh and the marginal export revenue on the order of 4¢/kWh. The resulting 4.3¢/kWh variance, which will remain quite stable over time, multiplied by Gentilly-2's annual output of 5 billion kWh, amounts to $215 million per year. In other words,

refurbishment would lead to a decrease of $215 million in Hydro-Québec's annual earnings as of 2017.

This analysis factors in all costs associated with the closing of Gentilly-2, including the cost of spent fuel disposal in a definitive repository site and that of completely dismantling the generating station several decades from now. Closing the facility in the short term represents a major advantage in terms of future fuel disposal costs, since the volume of spent fuel will be about half of what it would be if the facility were to be refurbished and operated for an additional 30 years. It also translates into reduced risk.

The closure of Gentilly-2 will affect the 736 permanent and temporary employees currently working at the facility. Hydro-Québec will implement a gradual relocation plan for permanent employees based on staffing requirements for the preparations preceeding the station dormancy phase, which will last several decades. This phase will be followed by station dismantling and site restoration. All collective agreements and work standards will be respected. Unionized employees whose services will no longer be required at the facility will be paid until they are relocated.

Finally, the closure of Gentilly-2 **will have no impact on electricity rates for Québec consumers**, nor will it affect Hydro-Québec's obligation to provide 165 billion kWh of heritage pool electricity to the Québec market at 2.79¢/kWh.

In conclusion, the permanent shutdown of Gentilly-2 generating station at the end of 2012 is clearly more advantageous for Hydro-Québec in today's context, and the company recommends this course of action to its shareholder, the Québec government.

GEC Interrogatory #15

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

Did the contracts Bruce Power and New Brunswick Power signed with Atomic Energy of Canada Limited transfer more or less risk away from the utilities than OPG has obtained? Please explain.

Response

OPG does not have the contracts Bruce Power and New Brunswick Power signed with Atomic Energy of Canada Limited ("AECL").

However, based on publicly available information, OPG does know that the New Brunswick Power contract with AECL was for fixed price work, but that AECL is currently seeking reimbursement for losses it incurred under this contract.

OAPPA Interrogatory #2

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Item 1: Have ratepayers been sufficiently informed and to what extend does the DRP create financial obligations for future ratepayers beyond the Test Period.

1-OAPPA-2

Reference:

Re: Exhibit D2-2-9, Program Execution, Page 9

Annual public status reports will be published via OPG's website, for the duration of the DRP. With Unit 2 outage imminently, pending:

a) Please confirm what quality compliances metrics are to be used?

b) When will the first annual reports be available and will future reports be available by the same anniversary date?

Response

a) With respect to quality compliance, OPG plans to report on the number of significant field rework events over the reporting period.

b) Please refer to part a) of L-4.3-1 Staff-223.

OAPPA Interrogatory #7

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Item 5: Does the DRP have sufficient contingencies.

5-OAPPA-1

Reference:

Re: Exhibit D2-2-3, Major Work Bundle Structure and Contracts, Page 16, lines 5 to 12 and 22

One of the major cost 'extras' and unanticipated schedule delays during Darlington's initial construction was caused by a failed turbine shaft, which if contemplated in the DRP would represent a physically monolithic and expensive component of the Generator Turbine Work Bundle. We note that the equipment component cost estimate of $333M is unlikely to include sufficient funds for any replacement of the turbine shaft. We further note that other consistently strained components of the generating process (e.g. PHT) are being replaced during the Test Period.

a) Can you confirm that none of the Turbine shafts is being replaced?

b) What is your confidence level that the shafts will not need to be replaced and what is the expected EOL for each of the shafts?

c) If during the outage(s), a turbine shaft is found to be in need of replacement, please advise:
   i. What is the estimated replacement cost of a turbine shaft?
   ii. Is there a Canadian manufacturer (still) that could construct the shaft?
   iii. How quickly would a new shaft be manufactured and/or how much delay would be invoked in the schedule on a best/worst case scenario basis?

d) Please confirm if the $333M cost for equipment supply component and $284M cost for the fieldwork (Turbine Generator Work Bundle) for each unit, or for all 4 units combined?

Response

a) None of the turbine shafts are planned to be replaced.

b) The likelihood that a turbine shaft will be found to be in need of replacement during the outage is considered very low.

A Component Condition Assessment was completed by the Original Equipment Manufacturer (OEM) - Alstom in 2009. This included a lifetime assessment calculation for turbine High Pressure (HP) and Low Pressure (LP) rotors, which was performed by drawing an analogy between a lifetime assessment for a pressurized heavy-water reactor (PHWR) in Europe and Darlington Units 1-4. The result of the analogy as summarized below is that the Darlington turbine rotors have low lifetime consumption:

- For the HP rotors the calculated Life Expenditure was L=0.1%.
- For the LP rotors the calculated Life Expenditure was L=4.5%

OPG's assessment, based on the OEM's Component Condition Assessment and OPG's inspection data, is that the rotors are likely to last until the end of Darlington's post-refurbishment life (nominally 30-35 years).

OPG performs periodic outage inspections of turbine rotors. No significant findings have been discovered during these inspections:

- The HP rotor is inspected in-situ every 9 years (visual and magnetic particle inspection).
- The LP rotors are inspected in situ every 6 years. OPG has developed and implemented its proprietary phased array ultrasonic testing (PAUT) technique for inspecting the last 2 rows of blades which are the most susceptible to stress corrosion cracking. This technique allows detection of cracks in turbine blade roots and disk steeples without having to remove the blades for inspection.

c)

i. OPG does not have a recent budgetary estimate for the replacement of a turbine rotor. However, for an indicative cost, in 2010 a US plant received a budgetary estimate from GE for a similar turbine LP rotor replacement. The estimated cost was approximately $22,000,000 USD. The Darlington Refurbishment Program Release Quality Estimate includes contingency that covers the aggregate of the key low risk, high economic impact discovery items, including a turbine shaft / rotor replacement.

ii. The shafts were originally manufactured by BBC - Alstom (currently GE). Turbine shaft manufacturing would not be in Canada, but likely in Europe.

iii. The turbine shafts have a typical lead time of 2-3 years; however, these items can be expedited to an 18 month schedule. The schedule risk would be challenging but may be manageable with expediting.

d) The $333M cost for the equipment supply component and $284M cost for the fieldwork (Turbine Generator Work Bundle) are for all 4 units combined.

OAPPA Interrogatory #8

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Item 5: Does the DRP have sufficient contingencies.

5-OAPPA-2

Reference:

RE: Exhibit D2-2-9, Attachment 2, "*Modus Strategic Solutions & Burns McDonnell Report to Darlington Refurbishment Committee Board of Directors Darlington Nuclear Refurbishment Project*", Page 20.

This November 12, 2015 Report to OPG Board Committee, recommended a total contingency amount of $2.506 B as based on a P90 confidence analysis.

a) Please provide the underlying reasons and approximate cost differential (by reason), as to why the Application has a lower contingency amount of $1.7B?

The report suggested that the P50 & P70 values also be considered.

b) Was a P70 (70% confidence) analysis done?

c) What is the P70 contingency amount?

Response

a) The figure referred to in the referenced Modus report was submitted early in the process of finalizing the contingency estimate. This figure included a consideration of $800 M of contingency for low probability high impact risks which were later removed from the estimate as they were deemed to be Management Reserve items, i.e., items that the project could not effectively assess nor control. Please refer to Ex. D2-2-7 p. 6 for the basis of exclusion of these types of risks from the contingency estimate.

b) Yes, a 70% confidence analysis was performed.

c) The amount of contingency required to provide 70% confidence is $1.53B. Please refer to Ex. L-4.3-2 AMPCO-070 and Ex. L-4.3-15 SEC-027.

OAPPA Interrogatory #9

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Item 5: Does the DRP have sufficient contingencies.

5-OAPPA-3

Reference:
RE: Exhibit D2-2-11, Independent Studies, Attachment 3, Testimony of Dr. Patricia Galloway, Pegasus Global Holdings Inc., Page 8.

Dr. Galloway suggests that a P90 confidence value on the contingency amount was reasonable for the DRP, however also suggested that there was no industry best practice for mega-projects. Specifically, based upon OPG's recently completed Sir Adam Beck Tunnel project:

a) What was the confidence level used and what was the original contingency amount?

b) What were the underlying reasons for using this original confidence level?

c) What was the final contingency amount spent upon project completion?

d) What were the lessons learned (from Beck) that would allow for the use of a P90 on the DRP?

Response

a) – c)
These parts of the interrogatory seek details about the Niagara Tunnel Project that are not relevant to deciding any issue on the approved Issues List in this application. The OEB has determined that only adjustments to the previously approved hydroelectric revenue requirement will be considered in this proceeding and OPG is not proposing any revenue requirement adjustment related to the Niagara Tunnel. (Decision on Issues List, September 23, 2016, page 13). Without agreeing that this information is relevant, OPG provides the responses below.

a) The contingency amount incorporated into OPG's initial business case summary dated July 28, 2005 for the Niagara Tunnel Project was at the high confidence (P90) level and the original contingency amount was $112M.

The contingency amount incorporated into OPG's superseding business case summary dated May 2009 for the Niagara Tunnel Project was at the high confidence (P90) level and the contingency amount was $164M.

b) Given the size, complexity and importance of the project; the nature of the identified risks; and the amount and distribution of the potential cost consequences associated with these risks, management recommended and the OPG Board of Directors approved the use of a P90 Confidence Level.

c) Approximately $160M of contingency was spent upon project completion.

.

d) The premise of the question is incorrect. OPG did not determine to use a P90 confidence level for the Darlington Refurbishment Program (DRP) contingency solely based on lessons learned from the Niagara Tunnel Project. Given the size, complexity, nature of the risks, potential cost consequences, and compounded by the nature of the DRP being a megaprogram it was prudent for management to recommend a P90 contingency amount for the DRP. Please refer to Ex. L-4.3-2 AMPCO-52, Attachment 4 for the lessons learned from the Niagara Tunnel Project for the DRP. Specifically, please note items 15 through 19 regarding risk.

PWU Interrogatory #7

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit D2-2-8, Page 8

The reference states that OPG will complete the Unit 2 refurbishments within the total budget envelope of $4.8B. The Reference also indicates that the Unit 2 refurbishment cost includes all Definition Phase costs ($2.2 B to date) and common costs that are needed to complete common work required for 2 or more units.

a) Please provide a breakdown of the total refurbishment cost of $12.8B by unit (the cost of each of the four units) by apportioning the cost of the Definition Phase as well as the above cited common costs across the four units as appropriate.

b) Has OPG done analysis of the sunk cost (including cost incurred so far, cost that will be incurred until the completion of Unit 2, and any liability costs) that would result from the cancellation of the refurbishment of the remaining three units? If so please provide the analysis.

Response

a) Please refer to Ex. L-04.5-5 CCC-22 where OPG has filed the documents provided to OPG's Board of Directors in seeking approval of the Darlington Refurbishment Program (DRP) in November 2015. These documents provide details of the individual units' cost estimates as of November 2015. It is not appropriate to apportion the cost of the Definition Phase and common costs to all four units as this mechanical, mathematical exercise does not appropriately allocate costs to the units causing the costs to be incurred. OPG provides its rationale for including the Definition Phase costs and common costs with the Unit 2 in-service amounts in Ex. D2-2-10, pp. 1 to 2, as well as Ex. L-4.3-1 Staff-054.

b) OPG has not conducted the requested analysis. However, OPG can provide the following:

- The DRP costs forecast to be incurred to the end of 2019 (near the completion of Unit 2) are estimated at $6.7B (including interest and escalation). Please see the attachment to Ex. L-4.3-1 Staff-055. These costs include: a) expenditures to almost complete Unit 2, including Definition Phase expenditures to be placed in-service with

Unit 2, b) expenditures on Facility and Infrastructure Projects (F&IP) and Safety Improvement Opportunities (SIO), c) expenditures on the Early In-service Projects, and d) DRP OM&A expenditures to the end of 2019.

- Exhibit D2-2-10, Table 1 shows the actual capital expenditures on the DRP for 2013 to 2015 and the planned capital expenditures on the DRP for the period 2016 to 2021. Exhibit F2-7-1, Table 1 shows the actual OM&A expenditures on the DRP for 2013 to 2015 and the planned OM&A expenditures on the DRP for the period 2016 to 2021.

The above costs do not include any costs that would be incurred if the DRP were cancelled after the completion of Unit 2. OPG has not estimated these costs.

PWU Interrogatory #8

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref (a): Exhibit A2-1-1, Attachment 5, Page 55

The portions of OPG's contractual obligations and other significant commercial commitments related to the Prescribed Facilities as at December 31, 2015 were determined primarily using specific identification, and are as follows:

(millions of dollars)	2016	2017	2018	2019	2020	Thereafter	Total
Contractual obligations:							
Fuel supply agreements	153	154	144	78	47	54	630
Contributions under the ONFA [1]	177	156	175	266	35	1,162	1,971
Contributions to the OPG registered pension plan [2]	327	-	-	-	-	-	327
Operating lease obligations	15	15	15	14	14	47	120
Commitments related to Darlington Refurbishment [3]	284	-	-	-	-	-	284
Operating licence	41	43	37	23	24	142	310
Unconditional purchase obligations	60	54	51	50	49	4	268
Accounts payable and accrued charges	783	2	6	-	-	2	793
Other	38	14	5	2	2	69	130
Total	1,878	438	433	433	171	1,480	4,833

[1] Contributions under the ONFA are based on the 2012 ONFA Reference Plan contribution schedule approved in 2012. The updated ONFA Reference Plan is expected to be effective January 1, 2017.

[2] The pension contributions reflect current ongoing funding requirements and additional funding requirements towards the deficit, in accordance with the actuarial valuation of the OPG registered pension plan as at January 1, 2014. The next actuarial valuation of the OPG registered pension plan must have an effective date no later than January 1, 2017. The pension contributions are affected by various factors including market performance, changes in actuarial assumptions, plan experience, changes in the pension regulatory environment, and the timing of funding valuations. Funding requirements after 2016 are excluded due to significant variability in the assumptions required to project the timing of future cash flows. The amount of OPG's additional, voluntary contribution, if any, is revisited from time to time.

[3] Estimated currently committed costs to close the project, including demobilization of project staff and cancellation of existing contracts and material orders.

a) Please provide an updated figure for commitments related to Darlington Refurbishment for 2016, and any additional commitments in future years.

b) Are all commitments related to Darlington Refurbishment attributable to Unit 2? If not, please explain.

Response

a) As noted in the response to L-4.3-1 Staff-049, the $284M total commitments related to the Darlington Refurbishment Program (DRP) includes $134M in accruals as at December 31, 2015, and an estimate of $150M as at December 31, 2015 for commitments not recorded as project costs. These include procurement commitments, costs to place the work in a safe state, as well as the costs of demobilizing the contractors from the DRP.

As of September 30, 2016, the accruals have increased to $178M and the additional commitments estimate has increased to $300M.

b) The DRP commitments are not all attributable to Unit 2. The $300M additional commitments estimate noted above includes $250M for Unit 2 and $50M for subsequent units, which would include procurement commitments for Units 3, 1 or 4 related to the Retube and Feeder Replacement, Turbine Generator, and Fuel Handling projects.

PWU Interrogatory #9

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: Exhibit A2-1-1, Attachment 5, Page 55

The reference indicates the total commitments related to the DRP, should OPG close the project, as $284M. OPG explains that the $284M represents estimated currently committed costs to close the project, including demobilization of project staff and cancellation of existing contracts and material orders.

a) Please explain how the $284M liability would be triggered in terms of the timeline of the DRP and under different scenarios-i.e., if the entire project closes now, if the refurbishment of the subsequent units is cancelled, etc. Will the $284M figure change (increase or decrease) depending on the stage of the DRP?

b) Please confirm if the contracts relating to the DRP are entered for the entire project (the refurbishment of all four units) or unit by unit?

Response

a) The $284M liability represents an estimate of the amount that OPG would need to pay to vendors due to commitments made on the project, and/or for reasonable demobilization costs, at the time of the referenced OPG financial statements. The amount is recalculated quarterly to reflect the latest commitments that OPG would be accountable for if the DRP was cancelled. As noted in Ex. L-4.3-13 PWU-008, the value has increased in September 2016.

b) The major contracts for the DRP are for all four units.

SEC Interrogatory #10

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/2, p.5]

Please provide further details explaining what specific services each of the Owner Support Services contractors are providing.

Response

As noted in Ex. D2-2-2, p. 5, Owners Support Services (OSS) contracts are in place to provide support to the owner, the OPG Darlington Refurbishment Program Management team, in executing their oversight function of the vendors working on the project and/or performing activities that are to be completed by the owner, such as the development of plans.

Work performed by OSS contractors includes:

- Assistance with the preparation of design requirements, as well as provision of minor design modifications.
- Performing oversight of Factory Acceptance Tests of Retube and Feeder Replacement tooling and/or reactor mockup setup and testing.
- Performing reviews of engineering products submitted by the contractors, in support of OPG's Design Authority whom must authorize all design changes.
- Oversight of contractors in executing their Quality Assurance functions.
- Support OPG in preparation of work plans.
- Provision of project management support including development of project plans, supporting management deliverables, and providing engineering assessments as required.

See L-4.3-2 AMPCO-36 for additional detail on the different work performed by the OSS contractors.

SEC Interrogatory #11

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/2; EB-2013-0321]

Please file all confidential pre-filed evidence, updated evidence, interrogatory responses, technical conference undertakings, and oral hearing undertakings regarding the DRP project filed in EB-2013-0321.

Response

OPG declines to answer this question. The question does not recognize proportionality considerations which underlie the interrogatory process, in that it is overly broad and all encompassing.

The question contemplates a review of all confidential pre-filed and updated evidence, interrogatory responses, technical conference undertakings, and oral hearing undertakings filed in EB-2013-0321. Given the advancement of the Darlington Refurbishment Program, this request would require a significant amount of work for OPG to re-consider whether each redaction and the corresponding reason for confidential treatment claimed during EB-2013-0321 continues to apply in this Application. Moreover, where relevant, OPG has re-filed materials from EB-2013-0321 in its pre-filed evidence in this Application. Finally, OPG has also responded to specific requests for confidential documents from EB-2013-0321 (see: EB-2016-0152, Procedural Order No. 2).

If the question was refined to reference specific materials relating to an issue on the approved issues list, OPG could undertake to review the relevant confidential materials.

SEC Interrogatory #12

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/2, Attach 2, p.11]

Please provide a copy of the most recent version of all listed Program Management Plans (PgMPs). Please also provide copies of all other DRP related PgMPs that are not listed.

Response

A copy of all most recent versions of the Program Management Plans listed on in Ex. D2-2-2, Attachment 2, p. 11 were filed as attachments to L-4.3-1 Staff-048a (Attachments 7, 55-74). The specific attachment numbers are provided below:

Chart 1

Title	Attachment to L-4.3-1 Staff-48
Darlington Refurbishment Program Structure (referred to as the Darlington Refurbishment Program Management Plan Structure)	55
Planning and Controls PgMP	56
Return to Service Program PgMP	57
Environmental PgMP	58
Health and Safety PgMP	59
Chemistry PgMP	60
Licensing PgMP	61
Engineering PgMP	62
Maintenance PgMP	63
Management System Oversight PgMP (referred to as the Management Systems And Performance Improvement)	64
Program Assurance PgMP	65
Construction PgMP	66
Contract Management PgMP	7
Communications PgMP	67
Supply Chain PgMP	68
Staffing PgMP	69
Operations PgMP	70
Radiation Protection PgMP	71
Training PgMP	72
Human Performance PgMP	73
Quality PgMP	74

Witness Panel: Darlington Refurbishment Program.

SEC Interrogatory #13

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/2, Attach 2, p.23]

Please provide a copy of the most recent version of all DRP related Project Management Plans (PMPs).

Response

Copies of the most recent versions of the Darlington Refurbishment Program Project Management Plans are filed as attachments to L-4.3-1 Staff-48 (Attachments 1, 8, 15 and 40-43). The specific attachment numbers are provided below:

Chart 1

Title	Attachment to L-4.3-1 Staff-48
Balance of Plant PMP	1
Defueling PMP	8
Islanding PMP	15
Retube and Feeder Replacement PMP	40
Shutdown & Layup / Services / Refurbishment Support Facilities PMP	41
Steam Generator PMP	42
Turbine Generator PMP	43

SEC Interrogatory #14

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:

[D2/2/3, p.7-8] Please provide copies of all reports, analysis, opinion, evaluations and/or assessments undertaken by or for OPG regarding the RFR contracting process, strategies, and contract structure, undertaken either before, during, and/or after the issuance of the RFR and negotiating the final contract.

Response

OPG declines to answer this question. The question does not recognize proportionality considerations which underlie the interrogatory process, in that it is overly broad and all encompassing. The production of every document relating to the contracting process for the Retube and Feeder Replacement ("RFR") contract would capture thousands of pages of documents. If the question was refined to reference specific materials relating to an issue on the approved issues list, OPG could undertake to find relevant materials.

Notwithstanding the above objection, OPG believes the below and attached key documents with respect to the request for the RFR contracting process documents are responsive to the question. Together with what OPG has already filed in evidence, OPG believes a set of key documents in response to the question has been provided.

Attachment 1 is filed confidential in its entirety. It is comprised of a proprietary report from Faithful+Gould dated November 17, 2010, which provides OPG with a benchmark analysis across a number of large-scale international projects. The analysis identifies key trends and developments in contracting strategies employed in the energy sector, and confirms that OPG's RFR contracting strategy generally aligns with the overall contracting approach adopted on complex long term projects. The confidential information also includes benchmark findings on overhead and profit levels as well as protection and incentive mechanisms that have been implemented by owners on such projects.

Attachment 2 does not include the appendices to the report as they are voluminous and contain sensitive information relating to the proponents, including banking account numbers of the proponents.

	Document Title	Location
1.	Faithful+Gould Benchmarking Report on Contracts Strategy and Overhead & Profit levels for Large	Attachment 1 (confidential in its entirety)

	Scale International Projects	
2.	RFR Contract Strategy	L-4.3-15 SEC-31, Attachment 2
3.	RFR Evaluation and Negotiation Process Summary Report	Attachment 2
4.	Darlington RFR Class II Estimate Review Report	L-4.3-15 SEC-29, Attachment 1
5.	RFR Class II Estimate Monte Carlo Model Report	L-4.3-2 AMPCO-44, Attachment 1
6.	Expert Panel Report on RFR	Ex. D2-2-8, Attachment 4
7.	Concentric Energy Advisors: Assessment of Commercial Strategies Developed for the Overall Darlington Refurbishment Project and the Retube & Feeder Replacement Work Package	Ex. D2-2-2, Attachment 1
8.	Concentric Energy Advisors: Updated Assessment of Commercial Strategies Developed for the Darlington Refurbishment Program Retube & Feeder Replacement Work Package	Ex. D2-2-11, Attachment 1

ONTARIO POWER GENERATION

Benchmarking Report on Contracts Strategy and Overhead & Profit Levels for Large-Scale International Projects

17 Nov 2010

Prepared for
OPG – Darlington Nuclear Refurbishment Program
Re-Tube & Feeder Replacement Project

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FAITHFUL GOULD
CONSTRUCTIVE EXPERTISE

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Disclaimer

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Project ID: C3144-11.2							
REV	**DESCRIPTION**	**ORIGINATOR**	**REVIEWER**	**F+G APPROVAL**	**DATE**	**CLIENT APPROVAL**	**DATE**
0	Survey Results	CJ	JH	TG	11/05/10		
1	Survey Results	CJ	JH	TG	11/15/10		
B	Survey Results	CJ	JH	TG	11/16/10		
C	Survey Results	CJ	JH	TG	11/17/10		

Benchmarking Report on Contracts Strategy and Overhead & Profit levels for Large-Scale International Projects

1 Background

As part of the investment strategy announced by OPG on February 16, 2010 for its nuclear assets in the Durham Region in Ontario, Canada, OPG has proceeded with the definition phase for the mid-life refurbishment of the Darlington Nuclear Generating Station (DNGS) located on the shore of Lake Ontario in the Municipality of Clarington, Ontario, Canada.

The Darlington Refurbishment Program will consist of a number of large and small projects and OPG is in the early stages (Definition Phase – Preliminary Planning) of assessing the feasibility of refurbishing the Darlington facility in order to operate the facility beyond the current predicted end of life.

The Reactor Re-Tube & Feeder Replacement Project is one of the main elements of the Darlington Nuclear Refurbishment program. The scale of the Contract Scope & Value and associated complexity and difficulty represent a considerable challenge for both OPG and the capabilities of the Contractors.

OPG had already made significant progress in the development of the overall Contract Strategy and in particular for the R&FR Project, prior to Faithful+Gould's involvement, based on previous studies that had been commissioned for other OPG projects and the market knowledge of the project supply chain team assembled from both within and outside of OPG. The initial strategy is summarized below.

1.1 Refurb Preliminary Contracting Strategy – December 17th, 2009

The Refurb Program Team developed an overall preliminary procurement and contracting strategy that was published on December 17th, 2009. The overall Refurbishment Program was broken down into several work packages to facilitate contracting with third parties.

A Scope of Work Study was commissioned for each package and R&FR Study was completed in December, 2009. The Contract Strategy is also based on OPG providing oversight of the Contractors who would be required to be in place to support the development of the Release Quality Estimate in December, 2014.

The initial Contract Strategy for the R&FR project, due to the nature and complexity of the work and the uncertain nature of scope, cost and schedule, followed the recently popular "partnering" approach where the right partner with the most appropriate skill set would be engaged in a collaborative approach rather than via a procurement process.

Other options were considered and the reason for these options not being selected are stated below:

- Self-Perform – OPG does not have all the required capability in-house
- Traditional EPCM – Loss of benefit of early contractor involvement
- EPC Design / Build – Loss of OPG control of project
- Turnkey – Work cannot be isolated, Scope will be flexible due to discovery

The initial partnering approach assumed an single overall Target Cost, under which, there were various pricing mechanisms and, against which, the Contractor would share pain / gain for actual under-spend or over-spend.

1.2 Current Development of RF&F Strategy & Key Term Sheet

The above strategy has since been modified to adopt a "Hybrid" Type Contract where risks are allocated as appropriate through various pricing mechanisms and objectives are aligned through the Contractor being responsible for performance as a whole and sharing pain / gain against that performance.

The contract pricing mechanisms are essentially as per the initial strategy, the Target Cost. However, this has now been limited to the separate Definition and Execution phases.

Contractor capability remains an important issue and Contractors have formed various Consortia to enable the provision of all required capability in a single contracting entity. Contractor capability is also planned to be the criteria for reducing the number of proponents to two for the RFP Stage. This will result in the RFP being a commercial decision between two competent and qualified proponents.

The RF&R Procurement Team has therefore developed a Key Term Sheet that summarizes the hybrid approach and all key commercial issues and the pricing and incentive mechanisms OPG would prefer to see implemented as part of the R&FR Contract. The intent of the Key Term Sheet is to establish the capability and willingness of the Contractors to engage in this type of contract prior to formal issue of the RFP and avoid possible lost time.

OPG was also concerned that they needed to be aware of market levels of Overhead & Profit prior to negotiation of these issues with Contractors in the development of this contract. Faithful+Gould has, therefore, been commissioned to provide support in the development of the Contracts Strategy for this element of the project. As part of this role, Faithful+Gould has been requested to provide a Benchmarking Report which provides a peer review or sense check for the strategy adopted to date.

Faithful+Gould has, therefore, developed this Benchmarking Report based on what contracting strategies have been employed by major programs facing similar challenges and the typical levels of Contractor Overhead & Profit experienced when these Contracting Strategies have been employed.

2 Purpose

The purpose of this Study and Report is to provide the OPG Darlington Nuclear Refurbishment Program with a benchmark across multiple energy sectors and geographical regions on:

- The Contracting Strategies being adopted with most success by large international programs
- The applicable level of Overhead & Profit payable to Contractors where these Contracting Strategies have been adopted

It is intended for the above findings to be used as a guide for the OPG Darlington Nuclear Refurbishment Program Team in both establishing the overall Contract Strategy for the Reactor and negotiating the applicable levels of Overhead & Profit with the Contractors.

3 Benchmark Conclusions

The Study Conclusions below are based on analysis of 40 Major Programs and Portfolios of projects with particular emphasis on the Nuclear and Utility industries. The sample of projects was based on:

- International Programs and Contracts where Faithful+Gould have direct involvement
- Canadian Programs and Projects obtained via a Commission with Deloitte
- Local Framework Contracts obtained via OPG
- OPG Fossil & Hydro – although certain confidential information was not available.

3.1 Summary Benchmark against other Major Projects

In summary, the Benchmarking Analysis has confirmed that the strategy that R&FR Procurement Team is currently progressing is broadly in line with the overall contracting approach being adopted on complex long term projects:

- Contractors are being asked to manage risk where appropriate. e.g. Fixed lump sum prices are obtained where the scope is well defined and risks are known; e.g. Tooling for the RF&R Contract.
- There is a recognition from Owners that Contractors can add value to the process if they are involved early in the project process and objectives are aligned. e.g. The Definition Phase (early involvement) and Incentives for Execution Cost & Schedule Performance for the RF&R Contract.
- Recent contracts have recognized that multiple pricing mechanisms can be used for various elements with differing levels of definition and risk profiles in lieu of one pricing mechanism being force-fit for the overall contract scope. e.g. Fixed price for Tooling, Target Cost for Execution Phase, Reimbursable Cost for Commissioning in the R&FR Contract.

3.2 Variances from Benchmark

The only significant variance that the Benchmarking Study identified is that other projects surveyed have employed the practice of moving to a Fixed Price scenario for Construction once the project scope was sufficiently well defined and the Engineering and Procurement was substantially complete. The concerns associated with this approach are:

- If the Fixed Price is negotiated with the incumbent Contractor, it may well be high and still subject to Change Orders.
- If the Fixed Price is obtained from an additional Contractor there could be significant issues with coordination between Contractors and mitigation of cost and schedule, Rework and identification of source of Rework and Warranty.

With a project as complex as the Retube & Feeder Replacement, the current strategy is more appropriate as it would be a considerable challenge to move to a Fixed Price later in the project and maintain the benefits of the current strategy such as continued warranty and alignment of objectives.

3.3 Risks

The following are the main risks identified with the current strategy based on feedback from other projects that were surveyed in the benchmark Study:

- The initial risk with the current strategy is that the Scope of Work for the Fixed Price elements need to be clearly defined to avoid excessive Change Orders.
- Similarly, the Scope of Work for the Definition Phase Target Costs requires the same level of definition.
- Recent Opex from previous projects and market performance may be factors in driving the Target Cost to the upper end of the cost range.
- The agreement of the Execution Phase Target Cost at the appropriate level is crucial to the success of the RF&R Contract and will need considerable effort to establish an achievable but realistic target with the required level of accuracy and certainty.
- The Target Cost may be vulnerable to change based on previous Contractor history with OPG and the approach to change control.
- The Contractors may not provide sufficient Fee at Risk to provide an adequate pain / gain share. Similarly, OPG may not want to provide the equivalent as further funding for an incentive.
- An ill-defined scope for the Target Cost may result in the Contractor seeking Change Orders to adjust the Target Scope and cover over-spends.
- There is the possibility that the loss of Fee and other damages may result in the loss of any reason or cause for the Contractor to continue performance of the project.

The majority of these risks should be mitigated by the development of a robust Scope of Work and Target Cost and close post-contract change control of the scope and target cost.

3.4 Benchmark Findings – Contracts Strategy

For projects of this size and complexity, Owners and Contractors are generally entering into the following arrangements:

- Where there is significant risk, Owners and Contractors have sought to share risk where appropriate or Owners have accepted risks that cannot be controlled by the Contractors
- Where scope and risk were well known, Owners have sought fixed lump sum prices

Many of the surveyed projects identified the same concerns as those identified by OPG regarding the availability and capability of the workforce and it is important that these issues are addressed through the contract and incentive mechanisms.

Although there is some variation within the sample projects to suit the particular project requirements it is clear that the procurement strategy being adopted by OPG is broadly in line with the majority of the sampled projects

The Benchmark analysis also showed that:

- As projects become more complex and challenging, the Owner project team has endeavored to enter into collaborative arrangements, where objectives are aligned and risks are shared, with those Contractors who can offer meaningful benefits to the project. Refer referenced article from the UK's main Construction Magazine, Procurement: Target Price Contracts" published November 5th, 2010, and RICS "Contracts in Use Survey" published March 2010, (Refer pages 32 & 40 for levels of use at Target Cost) included as Appendices A.1 and A.2
- As resources and capability have become scarce and the ability to successfully perform projects has become a challenge, Contractors are unwilling to accept any unnecessary

risk. Where Contractors have absorbed Productivity Risk the Fee premium has been significant.

- Continuous Contracts, where Contractors are incentivized to improve, have been assessed as most beneficial over a program of multiple projects carried out over a number of years when the benefits of knowledge transfer can be realized.
- As collaborative contracts have progressed, Owner Project Teams have sometimes chosen to follow the more traditional fixed price contracting route once the scope and risk profile have been firmed up.

The above has resulted in Performance Contracting (e.g. Target Cost) and "Hybrid Contracts" (a mix of pricing mechanisms required to allocate risk where best placed for different project elements) now being adopted by most of the large complex projects or portfolios of programs addressed by this study. These types of contracts have been particularly prevalent in:

- ***US & UK Nuclear Industry – Over 75% of the New Build Projects or Contracts reviewed, the only exceptions being the New Brunswick and Quebec Power Contracts***
- ***UK Utility Industry & USA Infrastructure Industries have also readily adopted Target Cost Contracts to encourage performance improvement and cost predictability across portfolios of similar projects.***

The above conclusions are discussed in greater detail in Section 4 – Summary of Contract Strategy Findings

3.5 Benchmark Findings - Levels of Corporate Overhead & Profit

For the purposes of this study:

- **Corporate Overhead** - is the level of contribution each of the Contractor's business Unit is required to make to cover Corporate Costs such as Corporate Marketing, Offices, Investment and Business Development.
- **Profit** – is the profit contribution each of the Contractor's Business Units is required to make to meet the profit requirements of the overall Business and Shareholders.
- **Overall Mark-Up** – is the combination of the above 2 cost elements.

Overhead or Indirect Costs attributable to the Contractor's individual Business Units such as Offices & Supplies, Computers, Software and Communication and Small Tools and Consumables are not included in this analysis.

The overall ranges of Overhead, Profit, Overall Mark-Up, Material Mark-Up and Fee at Risk and the associated mean average and mode (highest frequency) for each category are shown in the following chart:

[redacted]

3.5.1 Overall Mark-UP, Corporate Overhead & Profit

The above chart shows the range for Overall Mark-Up is wide due to heavy high-end influence from local engineering contractors. However, the corresponding ranges of Corporate Overhead & Profit are relatively close and the average of each of these categories tends to support the average of the overall Mark-Up:

Cost Element	Mode	Mean
Overall Mark-Up	[redacted]	
Overall Profit		
Overall Corporate Overhead		

3.5.2 Material Mark-Up

The range for Material Mark-Up is relatively high and is weighted by Engineering Contractor's Mark-Up on general materials. The Mark-Up for general construction materials can be stated as two different levels:

- Mark-Up for Materials procured by Contractor [redacted]
- Mark-Up for Materials procured by Contractor acting as Owner's Agent [redacted]

The reduced Material Mark-Up is obtained by the Contractor acting as an Agent for the Owner and the Owner paying costs directly, thereby avoiding the profit that would be attracted by routing though the Contractor's Financial System. Where this approach is adopted, Owners should ensure that the appropriate warranty and liability protection is maintained.

3.5.3 Variances by Project Element

The Benchmark Study showed that each of the project elements such as Engineering and Construction may be carried out by different partners in a consortium or by different business

units of a company and that as work becomes more specialized, a greater proportion is being sub-contracted to specialist sub-contractors.

Different levels of Overhead & Profit therefore may be established for each project element. These can be broken down into the following elements for which the mean average values of Overall Mark-Up are stated below:

Project Element	Overall Mark-Up
Professional Services	[redacted]
Supply and Sub-Contracts	
Direct Construction Labor	

It should be noted that the "Supply & Sub-Contract" Mark-Up of [redacted] above is skewed by local data and the Nuclear Industry's application of Overhead across all revenue. Faithful+Gould's general experience is that this particular mark-up should be at a level of [redacted]

The above summary benchmark information is discussed in greater in Section 5 – Analysis of Overhead & Profit Levels.

3.6 Protection & Incentives

Where Owners have performed large and complex projects, they have generally been required to establish greater protection to meet requirements of Financing Organizations. This has been achieved via:

- Maximizing the Fixed Price elements of the Project where possible
- Risk Sharing for issues such as Productivity – Target Cost and Fee at Risk

The above has resulted in the "Hybrid" type Contracts discussed in Section 4.3 below. These Contracts have also included several protection and incentive mechanisms designed to drive performance, for which benchmarks are shown below.

It should also be noted that the study has established that increased levels of Protection sought by the Owner, although possibly accommodated by the Contractor, will result in higher cost being passed on to the Owner.

3.6.1 Fee at Risk

Fee at Risk is generally used to provide protection against cost overruns beyond the Target Cost, to the extent that all of the Fee at Risk can be eroded. This is generally balanced with an incentive where the Contractor can earn additional fee (usually equal to the Fee at Risk Value) for under-running the Target Cost

The chart included in Section 3.5 above shows that Contracts have previously accepted approximately [redacted] in Nuclear and Utility projects.

Faithful+Gould's direct experience is that Contractor's generally require to be guaranteed a Profit Level of [redacted] and some Owners have also stated or prescribed this level in major framework contracts.

The above benchmark of [redacted] profit in Section 3.5, coupled with the above-identified required minimum profit level of [redacted] supports the view that the acceptable level of Fee at Risk is [redacted]

3.6.2 Liquidated Damages and Incentives for Schedule Performance

Liquidated Damages have generally been established to offset only a portion of the losses that the Owner would incur due to a delayed completion. These losses are generally significant and Contracts generally only include a level of Liquidated Damages that contribute a portion of the total loss or at least cover Financing Charges.

Liquidated Damages for Schedule have taken the form of an agreed $ amount per day for the loss of production of an individual unit, with the overall Liquidated Damages being a stated % of the Contract Value for the same individual unit.

- The $ Amount / Day has ranged from $250,000 to $500,000 for Major Programs
- The % Cap for Liquidated Damages has ranged from 3.33% to 10%
- The 3.33% referenced above is an outlier and the % cap has generally been based on the duration required to be covered, resulting in a range of 10 to 20% of Contract Price.
- Where Schedule Incentives have been put in place for early completion, this has usually been at a level of 50% of the $Damages / Day Value and up to a cap of 2% of the Contract Price for the relevant Unit.

3.6.3 Performance Guarantees

This is one of the key Protection elements sought by Financing Organizations from Owners. For New Build Nuclear Facilities, Performance Guarantees have been established at $3 Million / MW. The Cap for Performance Guarantees is generally in the range of 15 to 20%.

3.6.4 Parental Indemnity

For Nuclear and Major Programs that have the above forms of protection, Owners have regularly sought and Contractors have provided a Parental Indemnity or Guarantee. The Contracts reviewed do not state a value or cap, they request that a Parental Indemnity or Guarantee is provided to cover the liabilities that the Contractor is assuming.

Where Contractors have no “Parent”, the Parent Company of the major consortium member has also been requested to provide Parental indemnity for the liabilities of the Contractor with no “Parent”. This has been obtained, but at a significant additional cost.

3.6.5 Letter of Credit

The Projects & Contracts reviewed as part of this study have generally included a Performance Bond and a Retention Bond in lieu of a Letter of credit. The Performance bonds are generally “on-demand” Performance Bonds that can be called on in case of Contractor Insolvency or in the case of not renewing a Bond. For other events, the Owner would need to submit an authorized legal decision to support the call on the bond.

- Performance Bonds were in the range of 5% of Contract Price
- Retention Bonds were in the range of 2.5% of Contract Price

3.6.6 Warranty

General Warranty Terms have been applied for 2 years after Commercial Operation or Grid Synchronization or to first re-fuel, whichever is the shorter. Where replacement or correction has required a further 1 year Warranty has generally been made available for those affected elements.

Extended Warranties have also been made for available for Critical Equipment or Elements for durations as long as 10 years or for the life of the plant. Where these warranties have been made available, Contractors have stated the additional cost required.

3.6.7 Limit of Liability

Contractors often require their overall liability to be capped so that they are nor vulnerable to all the contract protection issues impacting them together to a level that could well approach the overall Contract Price

Limits of Liability are generally stated as a % of the Contract value for an individual unit. The levels of limit of Liability have ranged from 10 to 40% of Contract Price for an Individual Unit. A premium was paid to obtain the 40% Limit. A more typical range would be 20 to 25%.

The % applied is also affected by the overall project value and most of the examples were at a higher value being new build nuclear projects. It should also be noted that all the benchmark examples were also designed to be high to accommodate performance guarantees within the limit. This level may not be required where the Contractor is unable or unwilling to guarantee performance or where performance cannot be measured.

The above Protection and Incentives Mechanism are discussed in greater detail in Section 6 – Analysis of Protection and Incentives in Contracts.

4 Summary of Contracts Strategy Findings

The review of current programs has identified the following general trends and developments in Contracting Strategies employed in the Energy Sector.

4.1 Fixed Price

The conventional power industry has traditionally employed a Turnkey EPIC Firm-Fixed Price approach for major projects where:

- The Contractor is responsible for Engineering, Procurement, Installation and Commissioning
- This scope is carried out for a Fixed Lump Sum Price

The main drivers for the above contract strategy were:

- The projects were relatively straightforward “cookie-cutter” type projects that Contractors had carried out repeatedly in the past.
- The Utilities need to establish the required electricity selling rate with the public in advance of the project drove the requirement to obtain cost certainty by placing all of the risk with the Contractor and covering it with a Fixed Lump Sum Price.
- Review of the Fee Structure for these types of Contracts has indicated that Contractors incorporate significantly increased fees to provide contingency required by the Contractor to absorb the risks passed to them via the Contract.

There have been recent projects such as the $2.3 Billion Oak Creek project, which incurred a $500 Million dispute between Owner Wisconsin Energy Corp and Constructor Bechtel that was the result of permitting delays, labor productivity and associated increased costs. This dispute was settled for $72 Million and an Extension of Time.

Disputes such as these are causing Owners to be concerned that they continue to be exposed to risks they anticipated were covered by the original Fixed-Price Agreement. This is common where scope is not well defined, or when these risks become too great for the Contractor to absorb.

There have also been recent attempts in the Canada Nuclear and Power Generation (generally) Industries to utilize Lump Sum or Fixed Price Contracts at New Brunswick Power and for OPG – Both the Niagara Tunnel project and Darlington Nuclear New Build. The New Brunswick Power and Niagara Tunnel Projects are significantly over budget and the Darlington New Build Project found that the market could not accommodate a Fixed Lump Sum approach for a $Multi-Billion Multi-Year Program and the inherent risks and uncertainties.

4.2 Reimbursable – “Time & Material”

Other elements of the Energy Sector such as Upstream Oil & Gas Exploration and Production and Downstream Refining & Chemicals have been engaged on more complex and challenging projects. The Upstream industry has faced more remote and challenging extraction locations and the refining industry has been required to both comply with environmental requirements and develop products that meet higher environmental standards.

The complexity of these projects has lead to the development of a Contracting Strategy where:

- Owners have formed alliances with certain Contractors in order to benefit from knowledge transfer and lessons learned.

- Contractors are reimbursed on a Time and Material basis for all aspects of the Project and therefore do not carry any risk or protection in return for a lower level of profit.
- A collaborative integrated team approach has been adopted in order to mitigate the risk faced by the Owner.

Although this strategy has lead to predictable performance, benchmarking of productivity in capital and maintenance / shutdown activities has established that actual performance has decreased significantly over a number of years. This has been highlighted in recent Canadian Oil Sands Projects and USA Refinery Revamp Projects for Canadian Oil, where budgeted costs and actual costs increased considerably as a result of the high demand on resources and the unexpected reduced productivity.

4.3 "Hybrid" Contracts

The Nuclear Sector has recently seen a significant increase in project activity as both new-build nuclear projects and nuclear refurbishment projects have become necessary on a global basis to prolong the life or replace the current ageing nuclear facilities.

The industry is facing the following challenges:

- Nuclear Projects have not been executed in the relevant markets / economies for a number of years and there is a shortage of experience and skill-set and a general lack of confidence in the ability to perform these projects successfully.
- Multiple projects are being progressed concurrently placing increasing pressure on the capability of Suppliers.
- Financing Organizations, due to current economic climate and regulatory nature of market, are seeking cost certainty.
- Governmental pressure to complete projects on schedule via the award of production tax credits.

The above has resulted in Owner and Project Teams adopting the following project execution and contracting strategies in the USA:

- Unistar is a Joint Venture comprising traditional Owners Constellation Energy and EDF, Technology Providers Areva, Designers & Constructors Bechtel. This has now been deferred due to the Financing Cost associated with the project
- The South Texas Power project is owned / funded by NRG and has contracted with Toshiba who have taken some equity stake and entered into a Firm Price (subject to escalation) contract in order to enter the USA Nuclear Market. The Construction Contractor Fluor is on a reimbursable type basis.
- Other approved Nuclear New Builds - Southern Company's Vogtle and the Scana Project are both with Shaw (including Westinghouse) where Shaw has been appointed as EPC Contractor on a Target Cost basis.
- Exelon also negotiated a Hybrid Contract for a Nuclear New Build in Texas and have just secured environmental permits.

The Firm Price project has already been highlighted as incurring $ 4 Billion Cost Overruns http://www.powermag.com/POWERnews/2409.html ***and the project is on hold.***

The Vogtle Target Cost Contract is progressing and the Exelon project is in "ready" state with a committed contract but awaits further funding opportunities.

The above highlights the challenges of long term Nuclear Programs and how a Firm / Fixed price approach can burden the project to the point that it is no longer viable. The Target Cost projects have allocated risks to the Owner where appropriate, such as Escalation and Currency Exchange, and continue to progress.

4.4 Division of Responsibilities

4.4.1 Client Role

On most of the projects surveyed the client took responsibility for oversight, obtaining regulatory approvals and general stakeholder communication across all phases of the project. During the design phase the client performed the role of Project Manager on 83% of projects. However, they performed this role on only 20% of projects during the construction phase.

The client generally undertook an oversight and approval role for major equipment and bulk materials procurement and on only one project was the client identified as the procurer of these services. However two of these project utilized framework agreements already in place with the client for major items.

4.4.2 Contractor Role

The contractor undertook an overall EPC role, including the development phase on 50% of projects. However this increased to 83% of projects during the detailed design and engineering phase. During both of these phases the contractor was typically paid on a reimbursable basis with one project also incorporating an incentive mechanism.

The contractor was responsible for procurement of major equipment on 50% of projects and for procuring items through pre-existing framework agreements on a further 33% of projects.

4.5 Analysis of Risk Sharing in Contracts

Further detailed analysis of Section 5.2 below shows that Contractors generally require significantly higher levels of Overhead and Profit when requested to absorb all risk. Contractors have also often declined to accept responsibility for Risk when requested by Owners, particularly in the Nuclear Sector.

Owners and Contractors have therefore, in several recent agreements, attempted to allocate risks to the party which has the greatest ability to manage that risk. Owners have also recently recognized that there may be more value in Owners accepting risks that are outside the controls of both the Owner and Contractor, than in paying the Contractor a premium to absorb those risks.

Risks that Owners are typically absorbing include:

- Escalation – Managed via published Escalation Indices for the relevant industry
- Currency Risk – Offset by Currency Hedging
- Regulatory Risk – Impacts of revised Government Legislation affecting Project Scope or Contractor Costs
- Insurances – Owners are increasingly using “Owner Controlled Insurance Policies” on major projects where justified by economics

Risks that Owners are typically requesting Contractors to absorb include:

- Productivity
- Design Errors & Omissions and Construction Rework

- Overhead Cost Variances

The level of Overhead & Profit varies with the level of risk allocated to the Contractor. For larger long term programs, Escalation and Regulatory risk in particular are outside the control of the Contractor, and Owners have generally absorbed these risks in order to avoid excessive levels of Overhead & Profit.

5 Analysis of Overhead & Profit Elements

Levels of Overhead & Profit were established from a sample of 36 projects or finalized contracts which were grouped in the following categories:

- Nuclear
- Local – Engineering and Construction
- Other Major Programs – Power, Oil & Gas, Pharmaceutical, Utilities, Infrastructure

5.1 Overall Mark-Up Levels

The most available data was for Overall Mark-Up (Overhead & Profit combined) and ranges and averages for each of the above-referenced groups are shown below:

[redacted]

The above Chart shows that the average overall Mark-Up for Nuclear and Other Major Programs is approximately [redacted]. However, the both Local Construction and Engineering Contractors appear to require much higher Mark-Ups at [redacted] and [redacted] respectively.

5.2 Corporate Overhead Levels

The Corporate Overhead levels were the most challenging to establish due to Contractors often stating profit only and varying definitions from contract to contract on what Corporate Overheads comprised. The range of established Corporate Overhead levels are shown in the Chart below:

[redacted]

The above chart shows that Corporate Overhead may fall in the range of [redacted] to [redacted] generally and that [redacted] to [redacted] may be more applicable for the area local to the project.

The analysis also identified that Contractors were becoming more familiar with an “Open-Book” approach to levels of Overhead and Profit and re-calculated their Corporate Overhead as a % of Total Cost on an annual basis and were open to the same adjustments being incorporated in the contract. Contractors were also open to annual adjustments to corporate overhead being subject to audit.

5.3 Profit Levels

The profit information was the most available as this is often stated separately in most contracts. The ranges and of profit and associated average profits for each of the study groupings are shown below:

[redacted]

Although there was a high availability of data, the study has not identified a consistent trend across all study groups. The above chart shows that Nuclear Projects / Contracts demand a greater level of profitability than Other Major Programs and that Local Contactors require an even higher level of profitability.

The local profit levels are generally applicable for smaller projects. A more appropriate benchmark for major programs would therefore be the Mean Average Nuclear Profit Level at approximately [redacted].

5.4 Material Mark-Up

The following chart shows that that Mark-Ups for material is [redacted] to [redacted] higher in the Engineering & Installation Framework Contracts in the local market.

Analysis of the Mode shows that the range for Materials Mark-Up is between [redacted] even when local Construction framework contracts are taken into account.

[redacted]

The low end of the range [redacted] to [redacted] indicates that a lower level of mark can be obtained. The low mark-up levels are dependent on:

- Size of program
- Protection required from Owner – e.g. Warranty
- Payment Methodology – avoiding funds routed through Contractor

The above Material Mark-Ups were also generally used to determine Mark-Up Levels for Sub-Contracts.

6 Analysis of Protection and Incentives in Contracts

As Programs and Projects have become larger or more expensive, the requirements for both Cost Certainty and Protection from Financing Organizations and Government Regulators such as the USA DOE have increased. Contractors have generally been able to respond to these increased requirements, however, the cost of these increased protection measures are generally passed onto the Client via increased fees or even pass-through reimbursable charges.

6.1 Fee at Risk

The Chart below displays the range of Fee at Risk that has been identified in the Target Cost Contracts contained within the Sample Study

[redacted]

The Fee at Risk has generally been obtained on the Installation / Construction element of the project and Contractors are reluctant to place any Fee at Risk on Engineering or Material Supply. Additionally, Contractors have been reluctant to accept certain risks such as productivity in Nuclear islands.

This could result in the Fee at Risk being a much lower percentage of the overall contract value.

Owners generally view the Fee at Risk as a fund that the Contractor is providing to develop a buffer of protection against cost overruns. However, Contractors also generally seek a balanced approach which would mean the Owner may need to fund a further amount equivalent to the Fee at Risk as a reward for Savings opposite the Target Cost.

Contracts therefore also included relatively complex methodologies that were designed to ensure an accurate and fair Target Cost, and a sharing of Cost Overruns and Under-runs to protect against the Contractor benefiting excessively from the Fee at Risk Mechanism.

6.2 Liquidated Damages and Incentives for Schedule Performance

The Nuclear Industry has generally accepted that the Damages in terms of Revenue Loss and other Consequential losses would be too great for Contractors to cover to full, in the event they were responsible for a delay to the overall Commercial Operation Date. e.g. The Replacement Power Cost for New Brunswick Power has been reported as $1 Million / Day. Owners, therefore generally seek to recover Interest or Finance Charges at least and a contribution to the Revenue Loss.

The review of the Point Lepreau project stated that caps for Liquidated Damages for Schedule have traditionally been in the range of 25 to 50%. However, historically, these % cap levels would have been applied to projects in the Hundreds of Millions range (as per new Brunswick Power) rather than $Multi-Billion programs of work.

Benchmarking of $Multi-Billion Nuclear Programs has identified a Liquidated Damages range of $250,000 to $500,000 per Day for each Unit being accepted by Contractors. The Maximum Cap accepted by Contractors for these damages have generally been in the range of 5% to 20% of the Contract Value of each Unit,

Application of a Percentage Cap at the higher end of the range would result in Damages continuing for multiple years. I.e. If a Liquidated Damage of $500,000 / day is assumed with a Maximum Cap of 10% of Unit Contract Price, this would result in Liquidated Damages being applied for a duration of over 1,000 Days, i.e. 3 Years.

Nuclear Contracts also generally allow a gradual introduction of Liquidated damages as the schedule is generally long and uncertain and a delay of say 2 weeks on an overall schedule of 3 years represents a 1.33% error.

For a maximum of $500,000 / Day, the typical incremental increase would be:

- $300,000/Day for first 30 Days
- $4000,000/Day for 31 to 60 Days
- $500,000 /Day over 60 Days

Liquidated Damages have therefore typically been set at a level that will provide some contribution to damages incurred by the Owner, with a maximum of $500,000/Day. The cap has then generally been established by assessing the number of required days coverage at the $ Damages / Day. The maximum limit being established as 10%, or 3 years coverage.

6.3 Performance Guarantees

Performance Guarantees were included in New Build Nuclear Contracts at a high level where the Owner required protection against the Technology Performance or the capability of the Contractor to deliver a reliable product.

Performance Guarantees for these Contracts were established generally at a level of $3 Million / MW, with the Cap for liability for Performance Guarantees being as high as 20%. The cost for provision of a Performance Guarantee for this level of coverage and for this type of technology challenge would be significant and would be passed on to the Owner via the overall fee.

Where the technology is very well known, Contractors have no difficulty providing Performance Guarantees. Similarly, where Performance Guarantees are set at the above high level for a relatively new or complex technology, Contractors are also reluctant to guarantee Performance at a level above what they believe to be a conservative estimate.

6.4 Limit of Liability

The levels of limit of Liability for Nuclear New Build Contracts have ranged from 20 to 40% of Contract Price for an Individual Unit, with the majority of Contracts having a range of 20 to 25%. The above ranges appear to be set a level that is raised enough to cover both Schedule Liquidated damages and Performance Guarantees.

Where other Non-Nuclear Contracts have Limits of Liability these have been as high as 50%. This high level is again due to high performance Guarantee requirements and Schedule Liquidated damages for a much lower range of project values.

The sample does not include a Limit of Liability that is not required to cover Performance Guarantees. It is anticipated that the Limits present in the sample would be reduced by approximately 30% if a Performance Guarantee was not required.

This would result in a typical range of limit of Liability of between 15% and 20%.

6.5 Other Protection Items

There was no further statistical data for the following Protection Issues and therefore the relevant information for these issues has been included in Benchmark Summary Conclusions Section 3.3 Protection & Incentives.

- Parental Indemnity
- Letter of Credit

7 Approach / Methodology

7.1 Survey Methodology

The Survey Sample originally employed for the Major Programs comprised:

- Major international programs which Faithful+Gould have direct involvement with.
- Canadian Major Programs obtained via Deloitte
- Local Contract Information obtained via OPG
- OPG Major Fossil and Hydro Projects – although some information was confidential

7.2 Major Programs

Each Faithful+Gould Program Team was issued with a questionnaire – Attachment B.1 requesting details on:

- Program Value and Schedule
- Program Drivers, Constraints, Risks and Mitigation Plans
- Owner & Contractor Role
- Compensation Mechanism & Associated Overhead & Profit Levels

Examples of applicable contracts were also provided to support analysis and the development of the Term Sheet.

7.3 Profile of Major Programs Surveyed

The survey results produced eight samples from programs covering four major industry sectors; Nuclear, Oil & Gas, Utilities and Manufacturing and from the geographical regions of the UK, Africa, North America and South America. The range of projects was as follows:

- Values between $15M and $12Bn with an average project value of $3.8Bn.
- Planned project durations ranged from 43 months to 120 months, averaging 68 months.
- Key project drivers as being replacement, upgrade and expansion.
- All are ongoing or recent programs with three of the projects planned to commence in 2009, one in 2007 and two in 2005.

7.4 Deloitte – Overhead & Profit

In addition, Faithful+Gould contracted with Deloitte & Touche to obtain Project Performance and Overhead & Profit information for a further eight major projects. Faithful+Gould also reviewed the information provided with Deloitte & Touche to ensure understanding of the basis of information.

The Deloitte Survey was more focused on cost elements such as Overhead and Profit. Deloitte were also asked to complete a consistent template an example of which is attached as Appendix B.2. Definitions for the categories of cost in this form were also developed and are included as Appendix B.3.

7.5 OPG Project & Contract Information

Contract information was provided on a confidential basis by OPG Nuclear Procurement via the provision of extracts of each contract. Contracts were selected for applicability, as some were for minor services.

Information from other OPG Fossil and Hydro projects, to the extent that it was available, was provided by OPG's capital investment group. However, this information was very limited due to confidentiality concerns.

7.6 Analysis and Report

Once the Surveys were returned, the Survey Team reviewed the information with the relevant Program Team to ensure full understanding.

Information was then collated into similar project cost categories and statistically analyzed to develop ranges and trends for information obtained.

The results were also incorporated in an overall comparison report detailing Contracts Strategy, Cost Elements and Protection Measures.

Trends and variances were also studied in order to provide understanding and reasons and for variances and further support for conclusions.

This report was then developed detailing the statistical analysis for cost elements, and providing benchmarks for Contract Strategies, Cost Elements and Protection Issues.

8 Appendix A – External Contract Articles / Surveys

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Procurement: Target Price Contracts

In today's overheated market, clients need all the help they can get to deliver good-value, low-risk projects. Some clients are turning to collaborative working – and contracts such as the NEC – to provide an extra incentive. Simon Rawlinson of Davis Langdon examines the issues

A target price contract has helped control costs on the £4.2bn Heathrow Terminal 5

The high-speed rail link to St Pancras also benefited from a target price contract

01 Introduction

Construction is a high-risk activity and much effort has been focused over the years on eliminating this risk. Studies, such as Improving Public Services Through Better Construction by the National Audit Office, suggest that many of these initiatives, which are often focused on transferring rather than managing risk, reduce contractors' motivation and performance.

Even so, many clients continue to transfer risk to contractors through design-and-build contracts, arguably giving contractors greater control over projects. The latest RICS Contracts in Use survey indicates design-and-build procurement accounts for more than 43% of the market.

As risk transfer to the contractor does not necessarily improve the project outcome, there are many initiatives focused on business improvement, particularly on enabling participants to collaborate effectively. These include:

- The development of information exchange standards and processes to help project teams to promote effective, information-enabled collaborative working
- Financial arrangements such as insurance liabilities. Single project insurance policies, covering all project risks, are intended in part to help eliminate sources of unproductive and risk-averse working practice by project participants motivated by the need to manage their design-related insurance liabilities on an individual basis
- Contractual arrangements, including standard partnering contracts such as PPC2000 and the recently launched JCT Constructing Excellence contract.

Procurement policy is especially important for public sector clients, who must set high standards as employers, be accountable to the public and deliver best value.

02 NEC contracts and co-operative working

The NEC exemplifies many aspects of co-operative working. The target cost options allow public sector clients to provide off-the-shelf incentives, and back this up with systems that allow for performance payments within a framework of accountability.

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The NEC promotes many aspects of co-operative working, including:

Focusing the whole team on delivery
Equal sharing of risk
Managing risk rather than transferring it
Continually assessing cost, time and quality.
Focusing the team on achieving these goals is important if the full benefits of the NEC are to be secured. However, a number of ways of circumventing its processes have emerged, through contract amendments or variable commitment to sound administrative practice.

03 Target contracts

The most widely used variants of the NEC are options C and D, both target contracts. The main difference between a target contract and a conventional contract is the mechanism for sharing risk and opportunity. While the client retains the cost and time risk linked to contractual changes, the financial effects of cost overruns can be shared between the client, contractor and supply chain. This is often termed the gain/pain share mechanism.

Target contracts are best used on well-defined projects, where the contractor has a motivation to reduce costs, rather than on projects that are loosely defined, as changes in project definition are likely to change the value of the target price.

Using this approach, equitable risk transfer is often adopted to encourage positive behaviour. That said, as contractual share of risk and gain/pain mechanism are set by the client, it can modulate its exposure to risk.

Used effectively, target contract options should give the incentive to deliver a project on time and to budget. However, if costs fall out of control, the contractor may seek to increase the target via compensation events. In this case, a greater burden of cost overrun risk may transfer to the client than intended.

As such, effective administration by the project manager and contractor is vital.

04 How a target cost contract works

Under a target contract, a contractor is reimbursed for the cost of the works, including those of subcontractors, some elements of establishing the site and the fee for the items listed in the contract as actual or defined costs. These include management costs, overheads and profit.

The contractor is contractually committed to meeting the target cost, which comprises the cost of the works described in the works information, activity schedule or bill of quantity, plus a fixed percentage fee.

The target cost and the contractor's reimbursement are not linked until the end of the project, when the gain/pain share mechanism is applied. What the contractor recovers through regular payments is the actual cost incurred, along with the percentage fee.

While the contractor is paid in accordance with a combination of lump-sum and actual costs incurred, the incentive mechanism and commitment to deliver the project on time are fixed. However, should any allowable compensation events occur that result in a change to cost or programme, the target will be adjusted by the actual cost incurred or by a lump sum, depending on how the contractor and project manager agree them.

After the project is completed, payments made to the contractor are compared to the revised target cost. Depending on the outcome, the gain/pain share mechanism agreed in the contract will come in to play.

Typically, the gain share involves splitting the amount of money saved, that is, the difference between the target cost and the actual expenditure, between the client, contractor and possibly some subcontractors.

If the project's costs exceed the target cost, the pain option is exercised. This could involve the contractor taking 100% of the liability and, as such, suffering the loss. Alternatively, the client may shoulder part of the loss.

The contractor would ideally meet the target cost, in which case it would receive full remuneration. Savings against the target would be shared with the client. The worst outcome for the client is the contractor being paid more than the revised target cost.

The difference between the target cost and the actual cost is, of course, fundamental to the incentive model. However, the lack of a direct link during construction means there is a risk that the project team could lose sight of its target and incentive. Therefore:

- The target cost should be realistic, based on a fully set of works information. Target cost contracts are sometimes misunderstood as being incentivised develop-and-construct approaches, where a project team is encouraged to work from an outline concept to deliver a solution focused on a client's needs. Unfortunately, a project let without well-defined works information resulting from incomplete design development is highly likely to require substantial changes and result in compensation events and amendments to the target cost. In reality, the documentation required to support the contract will be as detailed as a lump-sum contract.

- It should be set at a level that acts as an incentive. Too low, and the contractor will recover costs by other means. Too high, and inefficient working may be rewarded.

- It should be based on a detailed programme. The target cost mechanism cannot be properly administered without considering the impact of compensation events. Without this, it is not possible to assess the responsibility for delay.

- The client must understand that it is not a lump-sum contract and should co-operate with the project manager in administering the contract. Failing to comply with timescales can lead to a client creating liabilities for itself under the NEC.

- It is important for the contractor to keep track of costs incurred relative to the adjusted cost, so its own commercial position is protected. In some cases, where subcontractors are also incentivised, this may involve the project manager and contractor in the audit of material supply invoices and labour returns, to confirm levels of expenditure.

05 Effective management and maintenance of incentives on target cost contracts

Target contracts operate by encouraging good purchasing and contract management so long as the incentive is understood by the contractor and the target remains visible.

Given the administrative demands of the NEC contract, there is a risk that the link between target and actual cost entitlements could be lost, and the client could be exposed to a significant transfer of cost risk. This exposure can be managed by the gain/pain mechanism.

There are a number of characteristics of target contracts that clients and their project managers need to manage to maintain the incentive. These include:

- Management of the information flow. The NEC workflow is extensive and complex, so a management system should be in place to support the project manager and contractor in meeting timescales and updating reports. On projects worth more than £10m, web-based extranet systems designed to support the NEC workflow are invaluable.

- Dealing with the learning curve. The cultural changes associated with incentivised contracts and the NEC are substantial. Many parties may not fully appreciate the benefits to innovation or project management.

- Use of the contract. On a JCT-based project the contract stays in the drawer unless there is a problem; under NEC the opposite applies. If the contract is not referred to regularly, problems are likely to build up.

- Rebalancing risk transfer. Some of the compensation events under NEC can expose the client to risk. Examples include the prevention event, which transfers risk of many remote events to the employer. A common but less equitable amendment deals with the impacts of poor project management performance linked to the issue of notices.

- Effective use of the contract's risk management provisions.

- Maintaining the programme. Assessment of the programme in real time is an essential element of the NEC philosophy. It is essential that the programme is kept up to date. Under the target cost option, adjustments should be based on a pre-assessment of the impact of specific compensation events. Under a typical post-hoc assessment extension of time, the pressure is to recover all the delay costs, even if some result from aspects of the contractor's management. In practice, programme impacts are often managed imperfectly under NEC with, for example, a series of compensation events being grouped together for assessment. However, as long as the assessment is kept up to date, the contractor and client will understand their position.

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Other challenges include:

- Managing alternative financial motivations, such as:

Chasing turnover. As contractors are compensated, in part, by a fee, there may be pressure to increase recovery through defined costs during the contract rather than secure gain share at the close.

Optimism with regard to cost recovery. Owing to the disconnect between the contractor's costs and their entitlement under the adjusted target cost, it is essential contractors appreciate what their entitlement is likely to be and what their costs are.

Assessing compensation events in advance. The NEC gives the option for the target cost to be amended by means of agreed quotations, addressing both future cost and programme. Many clients and project managers do not feel comfortable agreeing these impacts in advance as the contractor may on some occasions secure an upside. Early assessment does, however, facilitate good decision-making. A degree of risk sharing is also built into the assessment.

If impacts are assessed retrospectively once costs are known, they are more likely to be awarded on the basis of cost and time rather than as a target.

Where the employer has a well-defined scheme that presents opportunities for cost saving via effective procurement and management, a co-operative approach based on risk sharing may be an incentive. The employer must appreciate, however, that the project has to be sufficiently well defined to enable a realistic target to be set and that the contractor and project manager must understand the relationship between target and actual costs.

06 Case Study

The case study is based on a commercial project using NEC2 with both the main contractor and some subcontractor packages being subject to target cost incentives. The employer adopted a target cost approach to achieve a balance between risk transfer and demand on in-house administration.

The agreed gain/pain share was based on a combination of fixed-sum preliminaries, overheads and profits. It rewarded early completion and provided some cushion for cost overruns. The gains would be divided 50:25:25, between the client, main contractor and subcontractors respectively.

The target cost was established using a well-developed design produced after a two-stage procurement process. In stage one, specialist contractors competed on overhead, profit, preliminaries and schedules of rates.

In stage two, the specialist either agreed a lump sum or, where there were genuine opportunities for performance improvement, a target cost approach was adopted.

The target cost was settled from quotations and guaranteed lump-sum payments for preliminaries, overheads and profits.

The actual cost was assessed through guaranteed payment and audited costs. There was no pain share mechanism, which meant the only allowable upward increase in costs came from the assessment of compensation events. These could trigger an increase in the value of the target costs related to the value of the work, together with an uplift for overhead, profit and preliminaries related to duration.

In practice, not all subcontractors were able to buy into the opportunities represented by the gain share. Reasons included:

Wondering why it was needed. Guaranteed preliminaries helped to gain their confidence
In the late stages of design, cost-saving opportunities related to buying power only
Contractors' control of their own costs. Some specialists were ineffective in controlling costs and accounting and could not track target and actual costs accurately.
The administration processes used on the contract took some time to settle down, emphasising the need for a familiarity with procedures. The compensation system also came under pressure owing to the volume of changes required. That said, specialists quickly understood the importance of the process, although it was difficult to agree "upfront" adjustments to the target costs.

In the final analysis, the project was a considerable success, delivered below budget and ahead of programme. Most specialists did well out of the project, although some lost control of their own administration and costs.

Some specialists introduced real innovation in their procurement and management to secure maximum savings and to maintain control over their own costs.

In general, cost control was heavily incentivised and the project was sufficiently well defined for the inducement to make an impact, even though there continued to be significant commercial issues affecting the project throughout. Whether in less positive circumstances the target cost mechanism could have provided the right balance of control and motivation is difficult to conclude, but on this project it played a part.

07 Advantages

Provides contractors and subcontractors with an incentive to improve performance and enables the client to secure a share of the benefits of a well-managed project

Encourages active and equitable risk sharing, based on a clearly defined allocation of risk agreed at the outset of the project.

Can incorporate lump-sum and prime-cost subcontracts under a single target price

Target costs provide incentive for the timely administration of change control mechanisms

Provides an accountable mechanism to enable public sector clients to use incentives.

Provides an incentive for the effective management of prime cost contracts.

08 Disadvantages

Requires contractor to share savings derived from improved performance with the client and other members of the supply chain

Client and contractor must share gain and pain if the full benefits are to be secured. The client may have greater exposure to cost risk

Potential for failure on insufficiently defined projects owing to misunderstandings of the operation of the incentive mechanism

Complex target price, gain/pain share and change controls may not be understood by all

Separation of target and actual costs before completion creates the potential for loss of control

Relies on administration best practice and a competent project manager.

Contracts in use

A Survey of Building Contracts in Use during 2007

RICS the mark of property professionalism worldwide

Davis Langdon

Introduction

This RICS Contract in Use Survey – the 11th we have undertaken – is the single most authoritative survey of construction contracts used in the UK market. However, publishing the results of a survey taken during relative boom years of 2007 during a recession makes interesting reading: it tells us what was happening in a year in a boom period but it also fits in with the evidence of previous years' surveys and this helps point the way to a likely future.

While smaller projects continue to be dominated by 'plan and specification' procurement routes and lump sum contracts, larger projects show a preference for Construction Management or a version of Design and Build.

The key trends that emerge from this survey are as follows:

Lump Sum Design and Build v Bills of Quantities

In the 1985 survey, Bills of Quantities dominated the survey with minor use of the Design and Build forms. By the 1998 survey, Design and Build was ahead of Bills of Quantities. This was the time of major shifts in procurement strategies. Clients wanted certainty of risk transfer. This survey (2007) reinforces the dominance of Design and Build as a procurement strategy, with a continued decline in Bills of Quantities. However, Bills of Quantities refuse to die.

It should be noted that while the use of the 'with quantities forms' have declined there are still SMM7 Bills of Quantities being measured, often by Professional QS Practices, for Contractors in support of Design and Build tenders. It will be interesting in future years to see what is happening in the market when the RICS publishes NRM 2, the procurement section of the NRM suite of documents.

Negotiation and Two Stage tendering

Both saw a reported increase over other surveys and this reflects a market that was booming and probably under-reports what was actually happening. Two stage tendering often increases when contractors are reluctant to price single stage tenders. A survey undertaken in 2009 is likely to show very little use of two stage tendering as contractors are considerably more keen to price single stage tenders.

Plan and Specification

Procurement using specification and drawings or activity schedules is still the way the largest number of projects are procured. That it is the third most popular when looking at value indicates that it continues to dominate the smaller projects market.

Guaranteed Maximum Price

There is little reported use of procurement based upon a Guaranteed Maximum Price. This is often a Client driven contractual amendment to standard forms.

Use of Guaranteed Maximum Price is a fundamental part of the UK Health Service Procure 21 system; however, the survey picked up very few of these health projects and this area was considered to be under-reported.

Management Contracting/Construction Management

Management Contracting peaked in 1989 and has declined ever since and can be seen as a blip on the procurement market, although this survey shows some slight increase on the last survey. Construction Management is still being used, particularly on larger projects.

Electronic Tendering

It is worrying that there is still little evidence of the use of electronic tendering. It may well be that we are going through a period of paper based tendering with the documents being issued on CD as well, leading to under-reporting.

Extranet based tendering is the logical next step in the market, using such examples as the RCIS e-tendering service. Future surveys should pick up an increase in usage.

JCT v NEC

Once again the survey records the dominance of the JCT suite of contracts. However, this has dropped in relation to previous years as the NEC contracts are seeing an increase in usage.

Of the JCT suite of contracts the most popular is the Design and Build Form with the Standard Form with Quantities Form coming second. The Intermediate Form is solidly represented in lower value project bands as is the Minor Works Form. The survey is beginning to show an impact of the Major Project Contracts form.

The NEC was strongly supported in the Egan and Latham Reports but the forms have taken a long time to make any real showing, although they are now solidly established.

Partnering

Partnering Contracts were recorded for the first time in the 2001 survey and the 2004 survey recorded a substantial increase in the use of partnering agreements. However, the 2007 survey shows no increase in numbers but does show an increase by value. It is probably too early to tell what impact Partnering is having on the market.

PFI/PPP

The survey again asked about PFI/PPP but received no information. This probably means that the organisations returning forms were either not working in this field or, more likely, that the contractual relationships were managed by lawyers, who do not complete this survey.

Conclusions

In summary the survey reinforces many of the issues brought up in earlier surveys. It reinforces the dominance of Design and Build in the middle market, but Bills of Quantities are still out there being used on a regular basis. The JCT still dominates but the use of alternative standard forms is growing, particularly the NEC.

Michael Sullivan
Chairman Quantity Surveying and Construction Professional Group

Contracts in use
2007 survey

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Executive Summary

This survey captured a smaller number of projects than previous surveys but was able to reveal the following trends:

- The majority of building contracts in this country continue to use 'traditional' procurement
- The vast majority of building projects use a standard form of contract
- JCT contracts continue to be the preferred family of use
- There has been an increase in the use of negotiation
- There has been a reduction in the adoption of Guaranteed Maximum Price
- There has been a marked increase in the use of two stage procurement across all project values
- The survey suggests that electronic tendering has not proliferated
- There has been a measurable decline in the use of Bills of Quantities
- Procurement using specifications and drawings or activity schedules has increased
- Over 50% of contracts in the £10k to £50m value bands were procured on a design and build basis
- There has been no apparent increase in partnering between the 2004 and 2007 surveys
- Little use of partnering arrangements in conjunction with standard forms of contract

Tables 1 and 2 show the trends identified in general procurement methods since 1985.

General procurement methods 2007

Chart 1:

Distribution of methods of procurement – by number of contracts

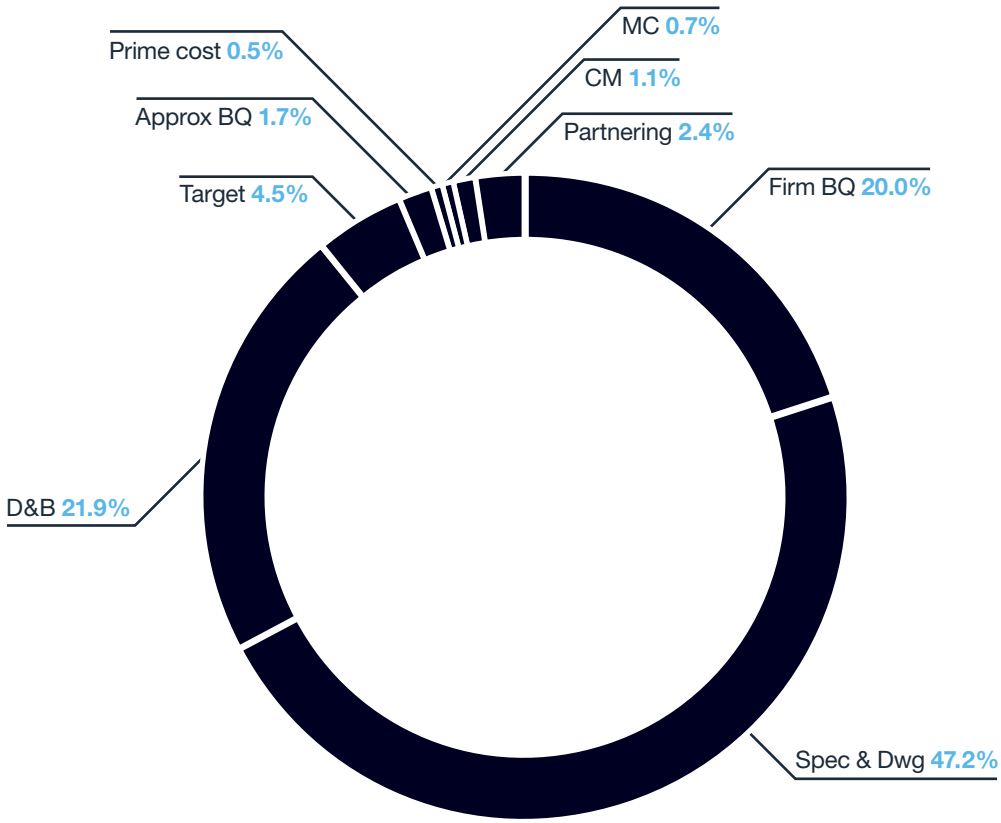
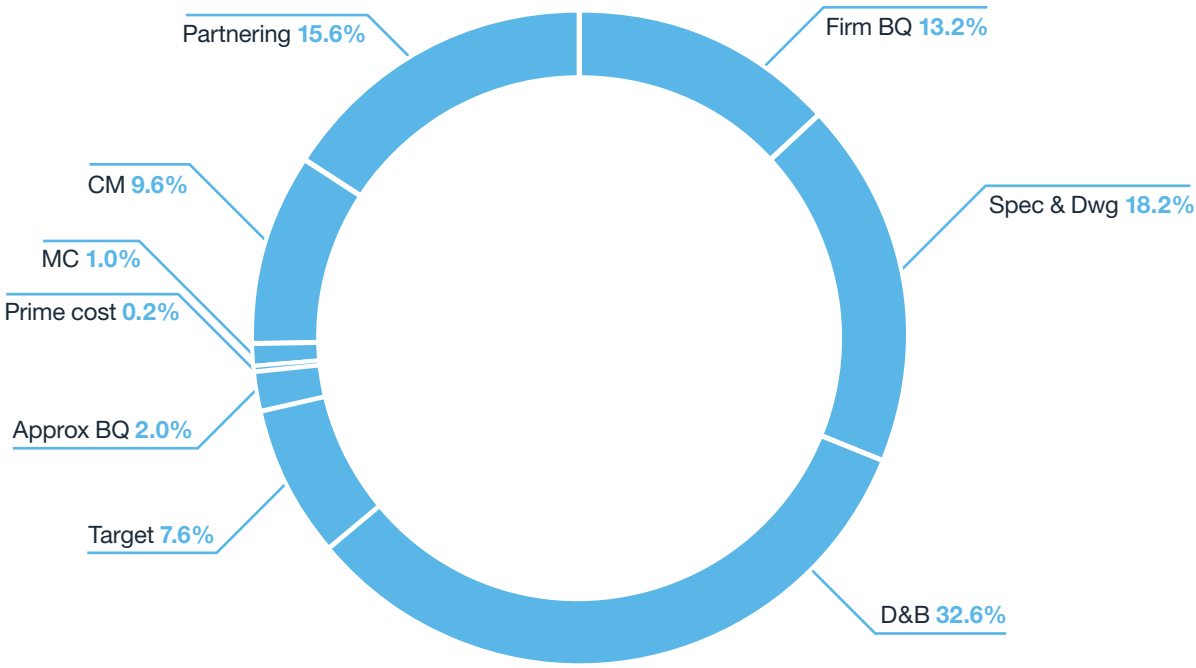


Chart 2:

Distribution of methods of procurement – by value of contracts



General procurement methods 2007

Table 1:

Trends in Methods of Procurement – by numbers of contracts

	1985 %	1987 %	1989 %	1991 %	1993 %	1995 %	1998 %	2001 %	2004 %	2007 %
Lump Sum – Firm BQ	42.8	35.6	39.7	29.0	34.5	39.2	30.8	19.6	31.1	20.0
Lump Sum – Spec & Drawings	47.1	55.4	49.7	59.2	45.6	43.7	43.9	62.9	42.7	47.2
Lump Sum – Design & Build	3.6	3.6	5.2	9.1	16.0	11.8	20.7	13.9	13.3	21.9
Target contracts	-	-	-	-	-	-	-	-	6.0	4.5
Remeasurement – Approx. BQ	2.7	1.9	2.9	1.5	2.3	2.1	1.9	1.7	2.9	1.7
Prime Cost Plus Fixed Fee	2.1	2.3	0.9	0.2	0.3	0.7	0.3	0.2	0.2	0.5
Management Contract	1.7	1.2	1.4	0.8	0.9	1.2	1.5	0.6	0.2	0.7
Construction Management	-	-	0.2	0.2	0.4	1.3	0.8	0.4	0.9	1.1
Partnering Agreements	-	-	-	-	-	-	-	0.6	2.7	2.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 2:

Trends in Methods of Procurement – by value of contracts

	1985 %	1987 %	1989 %	1991 %	1993 %	1995 %	1998 %	2001 %	2004 %	2007 %
Lump Sum – Firm BQ	59.3	52.1	52.3	48.3	41.6	43.7	28.4	20.3	23.6	13.2
Lump Sum – Spec & Drawings	10.2	17.7	10.2	7.0	8.3	12.2	10.0	20.2	10.7	18.2
Lump Sum – Design & Build	8.0	12.2	10.9	14.8	35.7	30.1	41.4	42.7	43.2	32.6
Target contracts	-	-	-	-	-	-	-	-	11.6	7.6
Remeasurement – Approx. BQ	5.4	3.4	3.6	2.5	4.1	2.4	1.7	2.8	2.5	2.0
Prime Cost Plus Fixed Fee	2.7	5.2	1.1	0.1	0.2	0.5	0.3	0.3	<0.1	0.2
Management Contract	14.4	9.4	15.0	7.9	6.2	6.9	10.4	2.3	0.8	1.0
Construction Management	-	-	6.9	19.4	3.9	4.2	7.7	9.6	0.9	9.6
Partnering Agreements	-	-	-	-	-	-	-	1.7	6.6	15.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: Percentages adjusted to exclude ‘Other Contracts’.

The Survey

The survey encompasses projects for which work on site started during the calendar year, 1 January to 31 December 2007. The survey samples all building work carried out in the United Kingdom, both new build and refurbishment. Survey respondents were asked to exclude specifically all overseas work, civil engineering work and heavy engineering projects. Term contracts, routine maintenance and repair work and sub-contracts forming part of larger contracts were also asked to be excluded. The Survey Questionnaire can be seen at Appendix 1. The detailed results can be viewed at Appendix 2.

Response

The response to the survey is set out in Table 3 alongside the equivalent figures from the most recent surveys for comparison.

Table 3:

Response to the Survey

	1993	1995	1998	2001	2004	2007
Number of surveys returned	**153**	**194**	**151**	**230**	**143**	**83**
Number of projects captured	**3786**	**4652**	**2457**	**2955**	**2330**	**1370**
Value of projects captured (£m)	**2819**	**3224**	**4767**	**3337**	**3035**	**7813**
Average value of project (£m)	**0.74**	**0.69**	**1.94**	**1.13**	**1.30**	**5.70**
Average value (2007 prices) (£m)	**1.65**	**1.30**	**3.26**	**1.59**	**1.49**	**5.70**
Proportion of total value of new orders (%)	**17.7**	**18.0**	**20.7**	**13.6**	**8.6**	**17.4**

The number of returns and the number of projects captured in the current survey were well below the numbers received in earlier surveys but, conversely, the value of projects captured in the survey was considerably higher than in the previous surveys. As a result the average project value was much higher than in all the previous surveys. The higher value of projects captured means that the sample represents 17.4% of the total value of new orders received in Great Britain in 2007.

This means that the survey sample has different characteristics to the previous surveys and needs to be borne in mind when comparing results over time. The primary difference is that the current survey has captured many more large projects than the earlier surveys, e.g. in the 2004 survey only 4 projects over £50m value were included in the study; in the current survey 28 schemes over £50m value have been included. At the other end of the scale, 404 schemes (29%) below £250,000 value have been included in the current survey, compared to 1157 schemes (50%) in the 2004 survey.

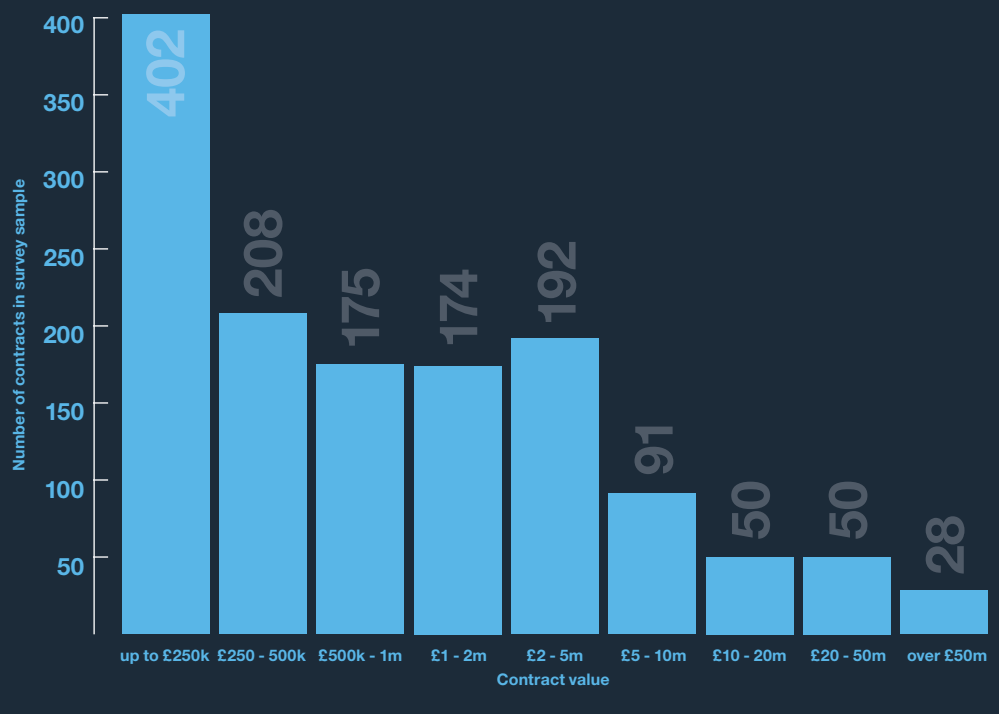
Analysis of returns

Distribution of Contracts

Appendix 2 shows the cumulative results of the survey and the distribution of contracts in use in 2007. As in previous surveys, contracts are arranged in value bands. The only change from the previous survey was to combine the two smallest value bands into a single 'up to £250,000' band, reducing the number of bands to 9. Chart 3 shows the distribution of contracts by value.

Chart 3:

Distribution of contracts by value bands (number of contracts)

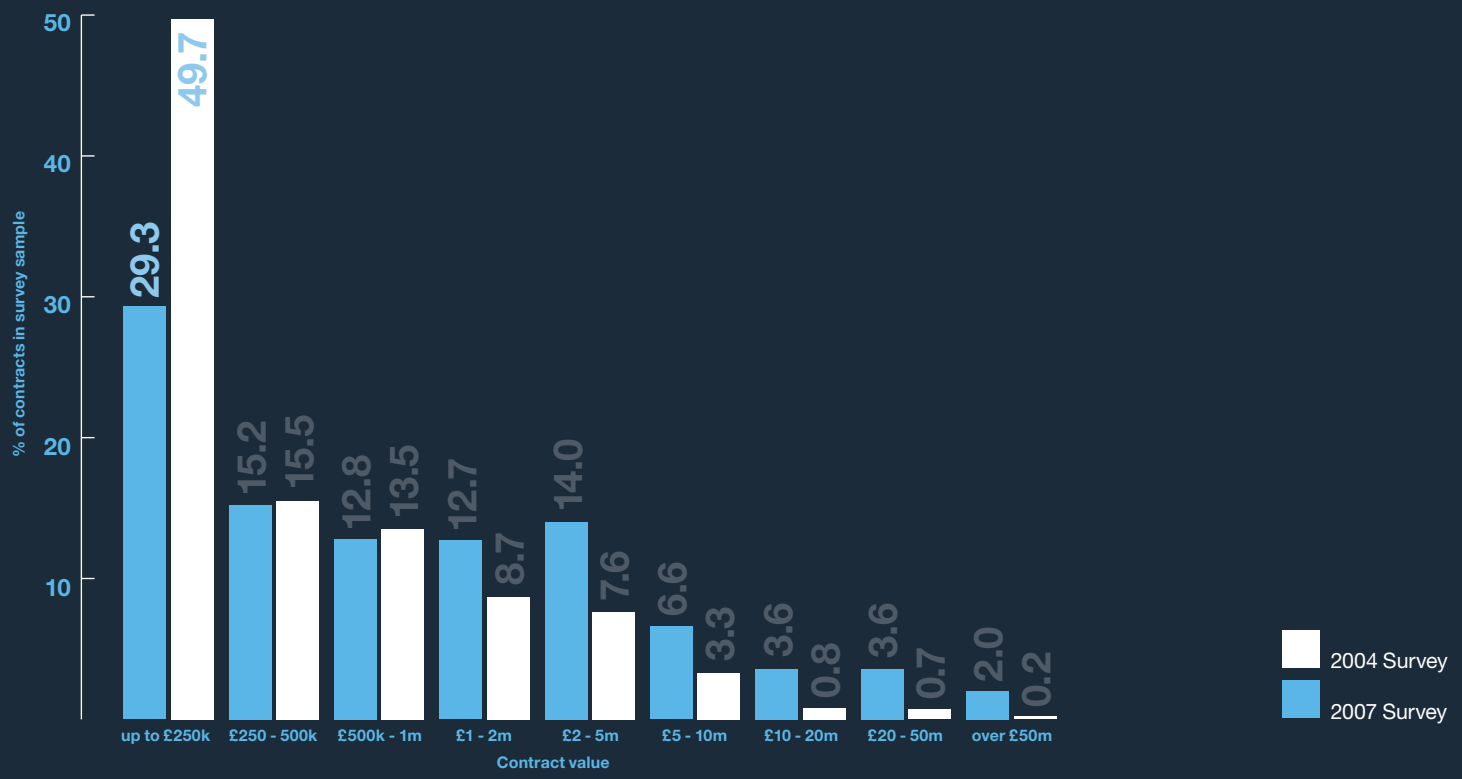


As in previous surveys, the smallest value contracts dominate the returns: in this case, contracts less than £250,000 in value accounted for 29% of the survey sample. However, this is a considerably lower percentage than in the previous two surveys, where contracts of under £250,000 accounted for 50% and 58% respectively of the samples (not allowing for inflation).

Chart 4 compares the distribution of projects by value in the 2004 and 2007 surveys by proportion of the total samples. The contract values have not been adjusted for inflation which increased prices by about 15% between 2004 and 2007, meaning that some 2004 contracts in each value band would shift into the next larger value category for a true comparison. However, the chart demonstrates that the 2007 survey has captured a greater proportion of larger value projects than the previous survey and this should be borne in mind when comparing the results.

Chart 4:

Distribution of contracts by value bands (percentage of contracts), 2007 and 2004 compared



Standard forms of contract

The vast majority of construction contracts still use one of the standard forms of contract, albeit sometimes with client or consultant amendments. Only 2.5% by number and 1.8% by value have used a non-standard form of contract, down from the figures recorded in the previous two surveys.

Table 4:

Use of Standard Forms of Contract

Contract family	% used by number	% used by value
JCT	79.3	61.5
ICE	1.2	2.1
NEC	7.7	14.0
GC/Works	6.1	2.9
ACA	2.2	5.5
Prime Contracting agreement	0.1	9.4
Other standard forms	0.9	2.8
Other contracts	2.5	1.8

Chart 5:

Use of Standard Forms of Contract (by number of contracts)

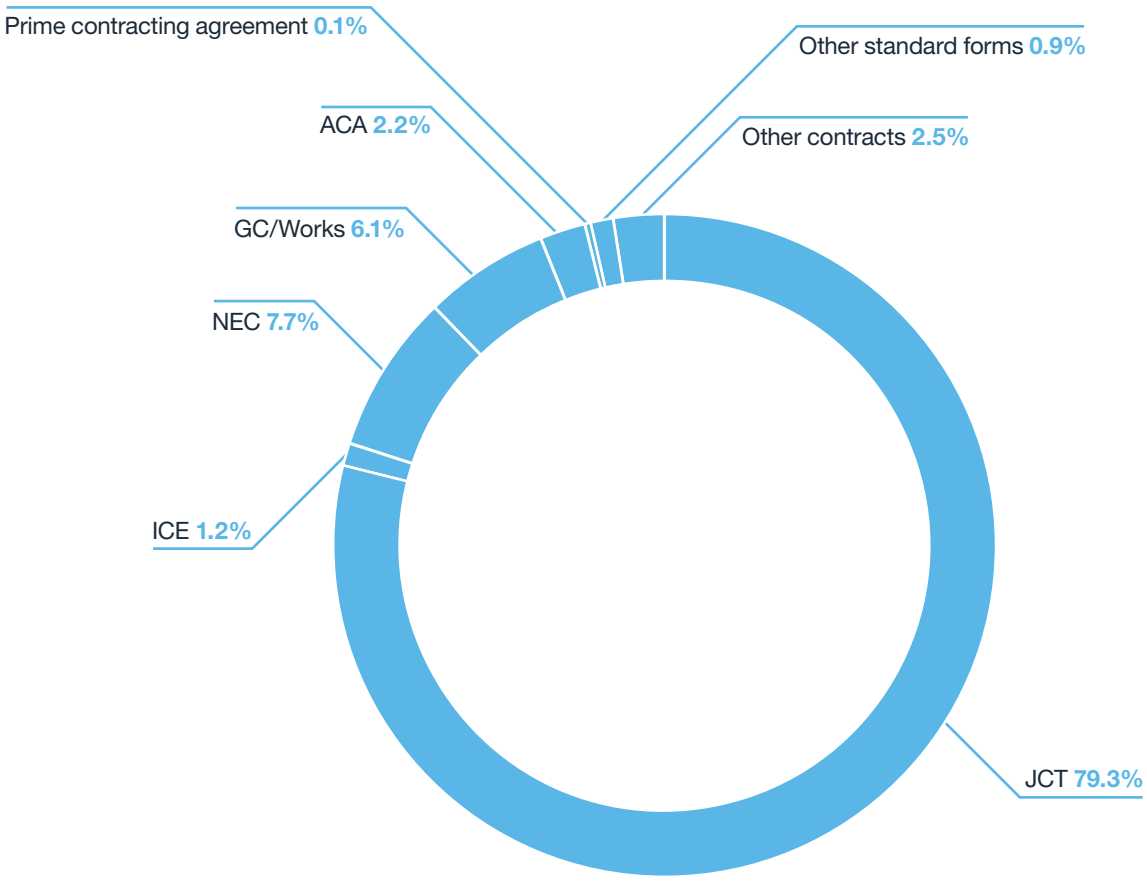
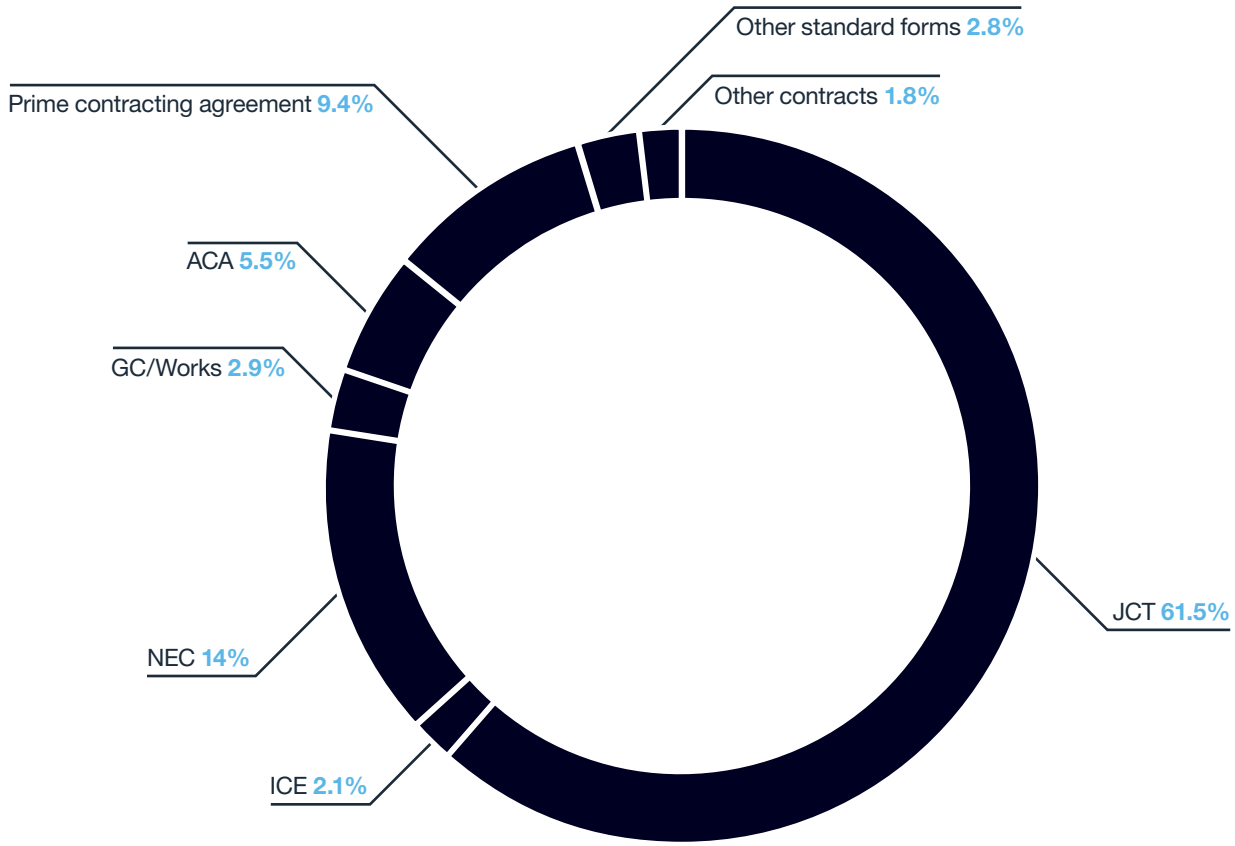


Chart 6:

Use of Standard Forms of Contract (by value of contracts)



JCT Forms

The JCT standard forms continue to dominate the construction contracts market: within the survey sample, 79% of all contracts by number employed a JCT standard form, almost identical to the last survey, though not quite as dominant as in 1998 or 2001. By value, the proportion of contracts employing one of the JCT family of contracts drops to 62% – its second lowest figure in the 22-year survey history.

Table 5:

Long Term Trends in the use of JCT Standard Forms

	1985 %	1987 %	1989 %	1991 %	1993 %	1995 %	1998 %	2001 %	2004 %	2007 %
Percentage of total number	**81**	**86**	**81**	**78**	**82**	**85**	**91**	**91**	**78**	**79**
Percentage of total value	**70**	**74**	**81**	**61**	**80**	**76**	**68**	**79**	**70**	**62**

By value the proportion has always recorded a slightly lower percentage than by number. This is because higher value schemes have had a greater tendency to employ some alternative form of contract such as construction management, NEC or PPC 2000. Nevertheless, in the current survey 61% of contracts over £50m in value have used one of the contracts in the JCT family.

Chart 7:

Use of JCT contracts by value bands

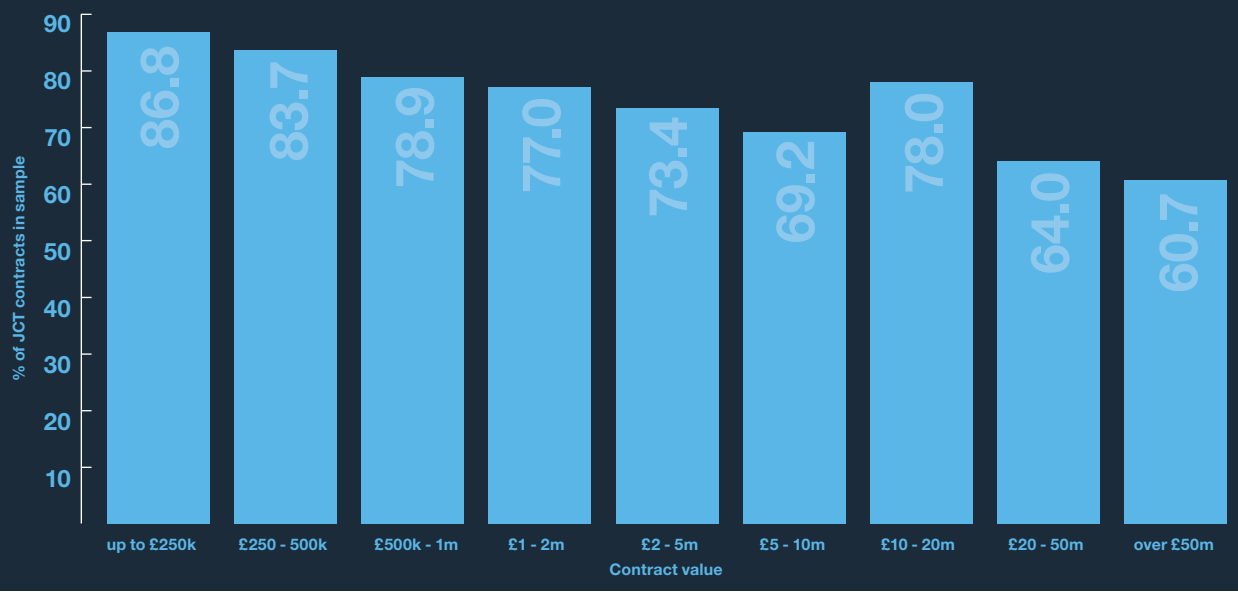


Chart 7 shows a general decline in the percentage of contracts employing a JCT form of contract as value increases.

The latest suite of JCT forms was introduced in 2005. However, a significant number of contracts employed on projects that started on site during 2007 still used the 1998 editions of the JCT forms. Of the 2005 suite of contracts for which a 1998 edition existed, 76% of contracts used the later 2005 version but 24% still used the 1998 edition. Similarly, 3 out of 15 examples of use of construction management used the 2002 documentation rather than the 2005 Construction Management Agreement while 2 out of 5 projects used the 2003 Major Project Form rather than the 2005 Major Project Construction Contract.

Table 6 plots the breakdown by type of JCT form, showing a comparison with the 2001 and 2004 survey results.

Table 6:

Use of JCT Standard Forms (irrespective of edition)

Form	Percentage in Numbers			Percentage by Value		
	2001	2004	2007	2001	2004	2007
JCT Standard Contract						
with quantities	**8.5**	**14.9**	**11.7**	**12.7**	**18.4**	**10.2**
without quantities	**4.6**	**5.3**	**6.2**	**10.4**	**3.6**	**7.8**
with approximate quantities	**0.4**	**2.6**	**0.9**	**0.9**	**2.5**	**1.5**
Design and Build	**13.3**	**11.2**	**19.4**	**39.7**	**35.6**	**25.3**
Intermediate Form with quantities	**9.4**	**11.8**	**6.7**	**5.2**	**3.5**	**1.1**
Intermediate Form without quantities	**14.0**	**8.1**	**8.5**	**4.8**	**2.4**	**1.4**
Minor Works	**40.0**	**23.5**	**23.5**	**2.9**	**2.4**	**0.9**
Prime Cost Contract	**0.2**	**0.1**	**0.4**	**0.3**	**<0.1**	**<0.1**
Management Contract	**0.4**	**0.2**	**0.6**	**2.0**	**0.7**	**0.6**
Construction Management	**-**	**0.1**	**1.1**	**-**	**0.5**	**9.1**
Major Project Contract	**-**	**0.1**	**0.4**	**-**	**0.4**	**3.5**
Total JCT Forms	**90.8**	**77.9**	**79.3**	**78.9**	**70.0**	**61.5**

By number, the proportion of contracts employing a JCT contract remains very similar to that seen in the previous survey though lower than either of the two previous surveys. By value, the proportion of contracts using a JCT form has fallen, in part, at least, due to the larger proportion of higher value projects in the current sample (see Chart 4).

Standard Building Contract

with quantities

The proportion of contracts using the JCT Standard Building Contract with quantities (or its 1998 version) declined slightly by number from the 2004 survey but was higher than that recorded in 2001. By value the proportion in 2007 declined to 10%, the lowest figure recorded in the history of the survey. 27% of the sample still used the 1998 edition.

Only 7 of the 117 instances of use of the 2005 Standard Building Contract with quantities used the 'without contractor's design' variant (SBC/Q/XD). Similarly the majority of those contracts using the 1998 edition of the form also employed the Contractor's Designed Portion Supplement. This was in contrast to the 2004 and 2001 surveys, in which only 28% and 25% respectively of the contracts used the CDPS.

with approximate quantities

The With Approximate Quantities form was used only in 0.9% of occasions by number and 1.5% by value, a similarly low proportion of use to earlier surveys. When this form was used, the 'without contractor's design' variant was used in 75% of cases.

without quantities

Compared to the 2004 survey, there was a slight increase in the use of the Without Quantities forms. This form was used mostly on contracts below £10m in value but the percentage use by value was boosted by four instances of its use on contracts over £50m in value. The use of the 'without contractor's design' variant was again used on only a very small percentage of contracts (13% of the 2005 edition forms).

Intermediate Building Contract

The use of the Intermediate Building Contract (or the 1998 Intermediate Form of Contract) has declined to its lowest ever level, particularly that with quantities.

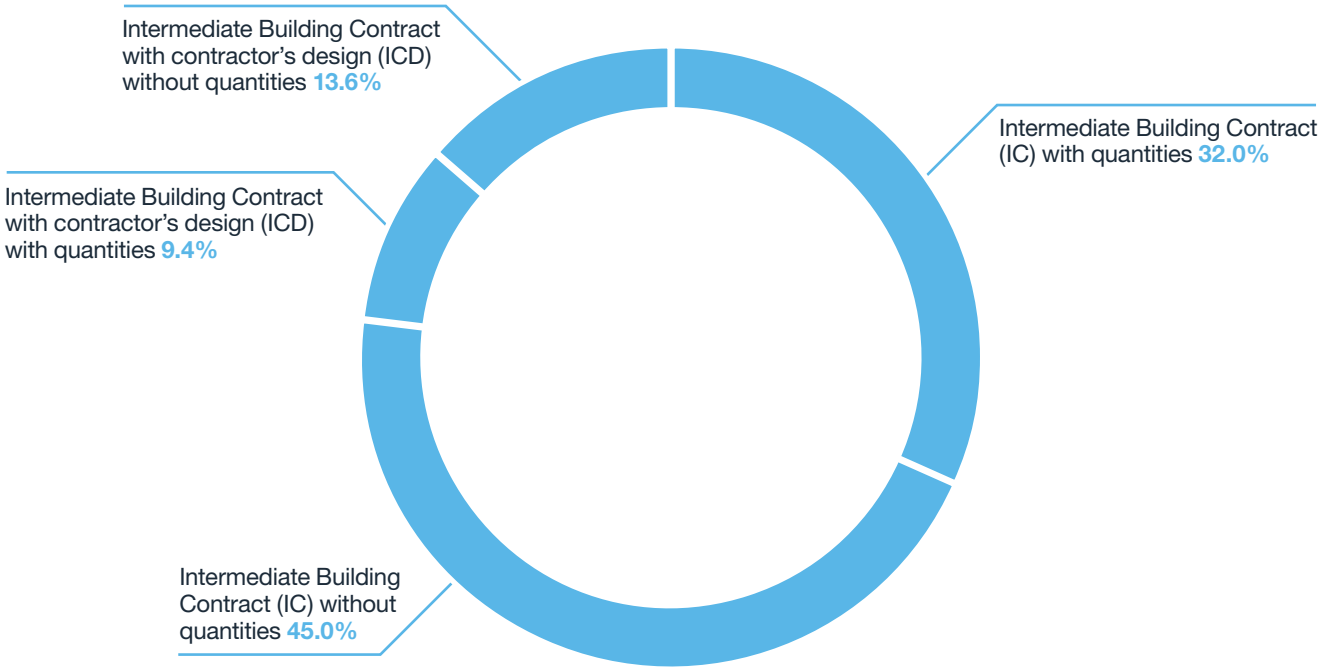
The JCT Practice Note 'Deciding on the appropriate JCT contract' no longer suggests maximum values of projects to which the different contracts are suited but based on the 2001 Practice Note relative to the 1998 contract editions, the normal maximum would be a little over £500,000 at 2007 prices. Only 50% of the instances of the use of the Intermediate Building Contract were on projects below £500,000 value, though this percentage increased to 80% for projects below £1m.

Only 18% of Intermediate contracts used the old 1998 version of the form.

The following chart shows the proportion of projects using the various alternative options, with and without quantities, with and without contractor's design, of the 2005 Intermediate Building Contract.

Chart 8:

The 2005 Intermediate Building Contract



45% of contracts were without quantities and without contractor design while 32% were with quantities but without contractor design. Only 23% of the projects used the 'with contractor's design' variants.

Minor Works Building Contract

The use of the Minor Works Building Contract or the 1998 Agreement for Minor Building Works exactly matched the 2004 Survey in proportion by number but was lower by value. Considering the different sample characteristics, it may have been expected that the proportion by number may have fallen as well as that by value.

The 2001 Practice Note suggested that the Agreement for Minor Building Works was suitable for contracts up to a value of approximately £150,000 (2007 prices) though the current Practice Note makes no recommendation regarding project size. 24% of projects using the Minor Works Building Contract or the 1998 Agreement for Minor Building Works were over £250,000 in value with instances up to £2m in value.

Only 11% of the sample used the old 1998 version of the form.

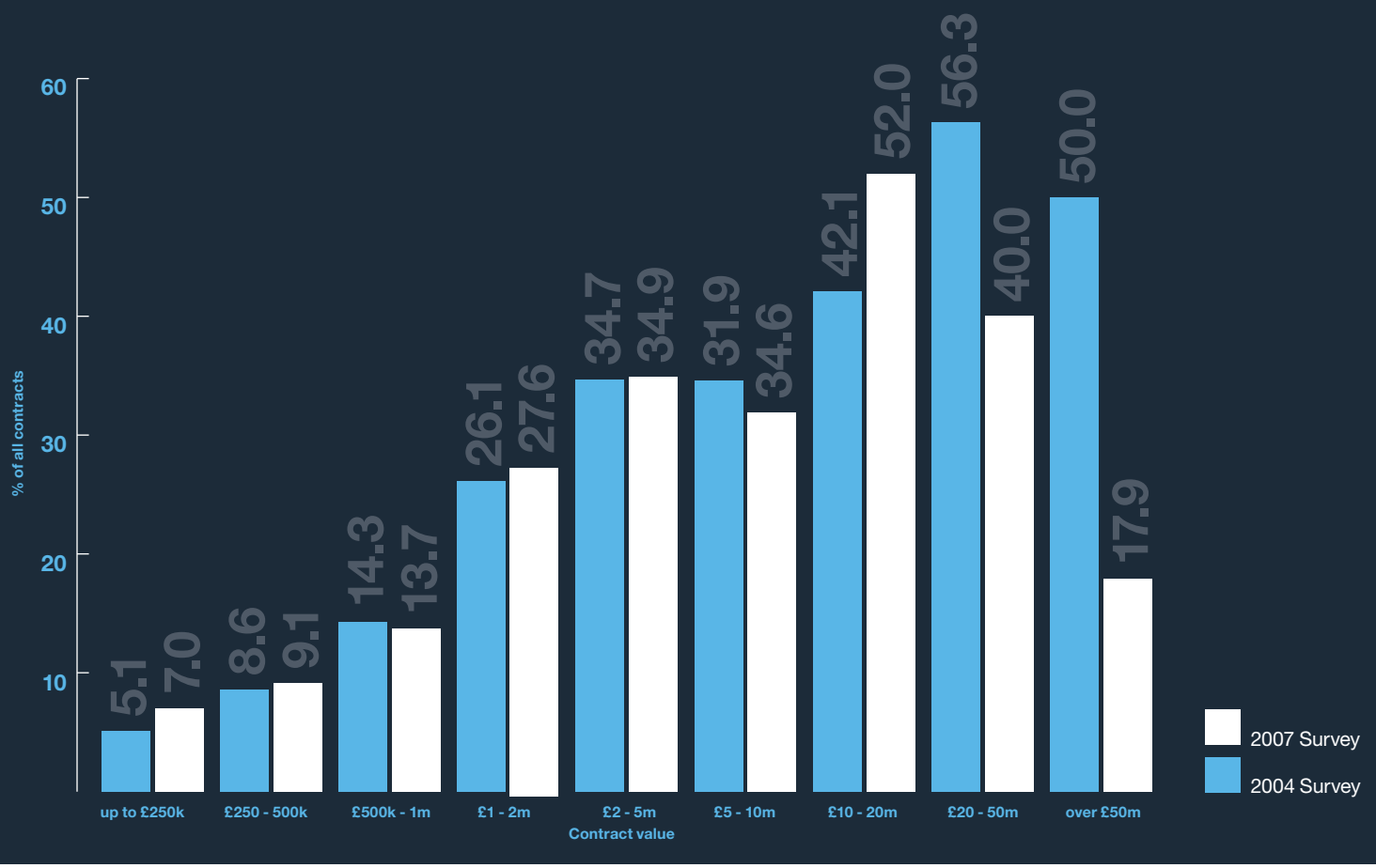
The 2005 Contract introduced a Minor Works Building Contract with contractor's design option (MWD) when there was no design supplement available for the 1998 edition. The MWD contract was used on 14% of projects using the 2005 Minor Works Building Contract.

Design and Build Contract

The use of the JCT Design and Build Contract (or the 1998 Standard Form with Contractor's Design) declined as a proportion of all contracts by value but rose sharply as a proportion by number. At 19% of all contracts used, the proportion by number is the highest figure ever recorded. To a large extent, these variations are a function of the different characteristics of the two samples. The following chart shows how, to a large extent, the use of JCT design and build contracts has remained constant between the 2004 and 2007 surveys. Within each value band the proportional use of the D&B form has remained remarkably consistent except at the highest value band: the latter is the result of the very small number of contracts in the 2004 survey over £50m value.

Chart 9:

The use of JCT Design and Build by value (2007 and 2004 compared)



32% of instances recorded used the old 1998 Form rather than the 2005 version.

Major Project Construction Contract

The original Major Project Form was introduced in 2003 and found only two instances of its use in the 2004 survey.

The 2007 survey has found two instances of the use of the 2003 Form and three instances of the 2006 Major Project Construction Contract. Two of the five examples were used on projects over £20m value but the others were for schemes in the £2–5m, £1–2m and £250–500,000 range.

For schemes over £20m, the Major Project Construction Contract (or its 2003 equivalent) was used on less than 3% of occasions.

Construction Management

The 2007 survey has identified a much greater use of the JCT Construction Management documentation than the 2004 survey. This time 15 instances of its use were captured (12 using the 2005 version and 3 the 2002 edition) compared to just 3 instances in the 2004 survey. This still accounts for only a tiny proportion of contracts used but represents 9% of the value of projects in the sample, largely accounted for by 3 very large schemes averaging £216m each.

In addition to these, the CM documentation has been used for projects in every value band.

Management Building Contract

Management contracts continue to be used sparingly. Only 8 instances of the use of the JCT forms (6 using the 2005 Management Building Contract and 2 the 1998 edition) were identified in the current survey, though this was more than in 2004.

7 of the 8 projects were in conjunction with projects in the £500,000 to £5m value bands.

Prime Cost Building Contract

Just 5 instances of use of the Prime Cost Building Contract were identified in the current survey, similar to the single figures identified in each of the previous three surveys. The contract was used on projects up to £2m in value.

Each instance employed the 2005 Contract; no examples were recorded of use of the earlier 1998 contract.

Constructing Excellence Contract

The Constructing Excellence Contract was introduced only in 2006 but not a single use of the form was identified in the survey.

Partnering Charter (Non-binding)

The JCT Partnering Charter (Non-binding) 2005 superseded the 2001 JCT Non-Binding Partnering Charter for Single Project and is intended for use with any contract where the parties wish to inculcate a partnering philosophy into the contractual arrangement. In the 2004 survey, the Charter was recorded as being used on 11 occasions. In the 2007 survey, this has slumped to just 2 instances, both on contracts of £500,000 to £1m value.

ICE Forms of Contract

Although the ICE family of forms were designed largely for use in connection with works of civil engineering construction, they are sometimes used for building works, particularly where large amounts of earthworks are involved, and for this reason the forms continue to be included in this survey.

16 instances have been identified in this survey of the use of one of the ICE family, accounting for 1% of all the contracts recorded, a similar level to that recorded in the previous two surveys. The ICE forms accounted for 2% by value of all the contracts, higher than the previous two surveys. This was because of 2 instances of use of the ICE Target Cost Version introduced in 2006, both used on contracts over £50m value.

The ICE 6th Edition (1991) contract accounted for 50% of the ICE contracts recorded, covering contracts in each value band between £250,000 and £20m.

Only 2 instances of the ICE Measurement Version 7th Edition (1999) were recorded.

The ICE Design & Construct 2nd edition (2001) was used on 3 occasions, each on contracts in the £2–5m range.

A single example of the use of the ICE Minor Works 3rd edition (2001) was recorded.

Just as in the 2004 survey, not one example of the use of the ICE Partnering Addendum was found in this survey.

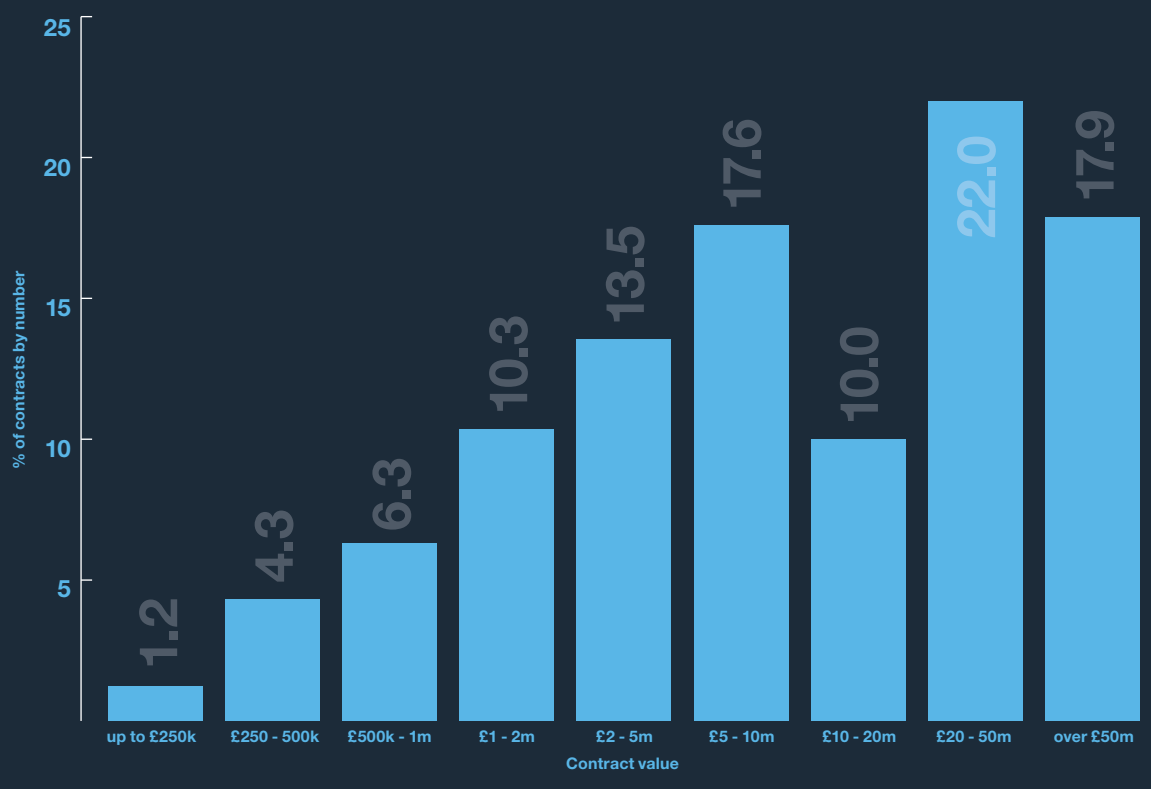
NEC Family of Contracts

The survey sought to separately record the use of the NEC2 1995 and NEC3 2005 Engineering and Construction Contracts. 37% of the contracts recorded used the 1995 versions. In total, NEC contracts accounted for 7.7% of the total number of contracts surveyed and 14% of the value of contracts surveyed. This is just slightly higher than the figures recorded in the 2004 survey – 6.7% and 12.8% respectively.

The following chart shows the proportion of each value band in which an NEC contract was used.

Chart 10:

The proportion of contracts employing an NEC Contract



There is a clear upward trend towards greater use as contract value increases.

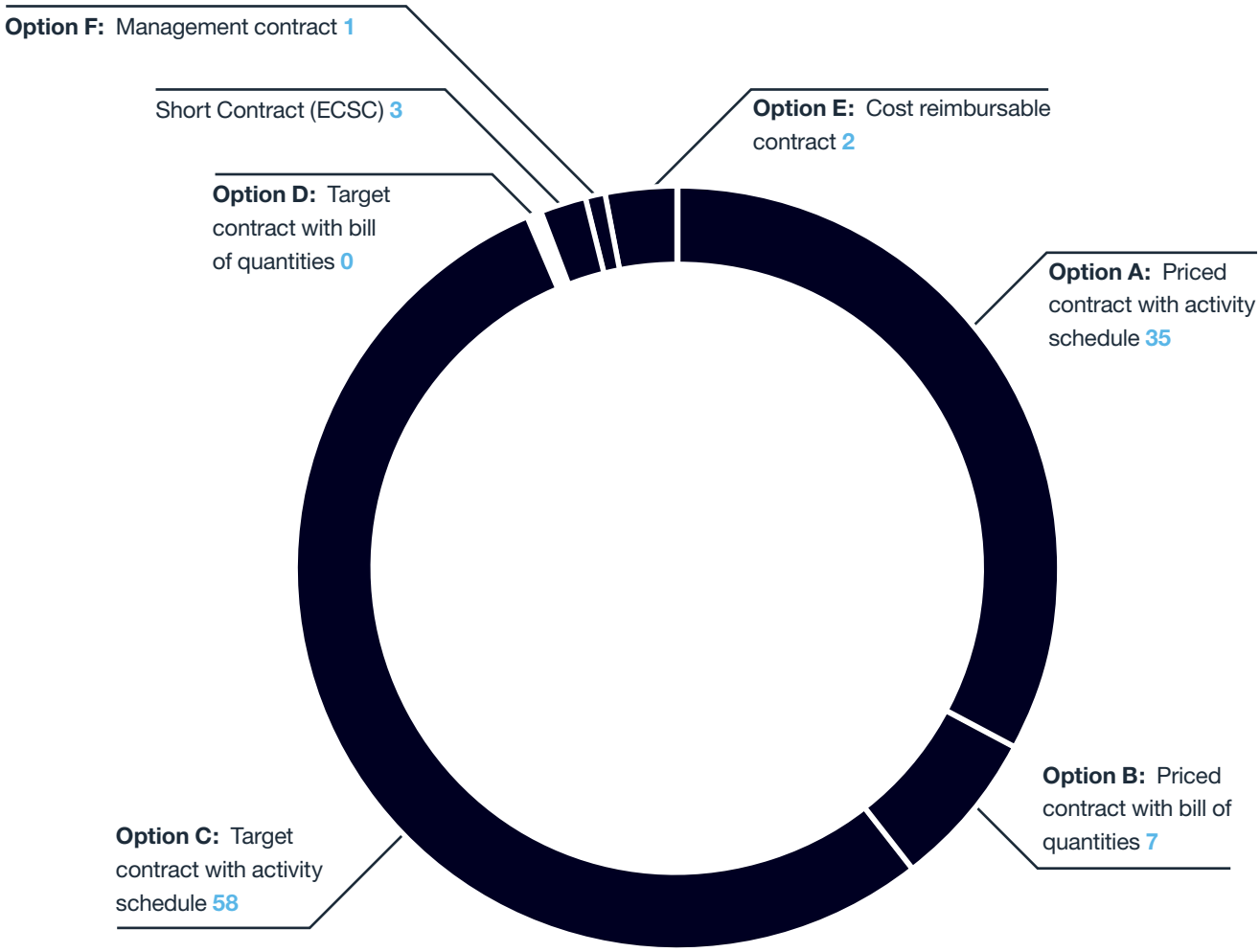
As in the 2004 survey, Option C Target contract with activity schedule continues to dominate the option choice, being used in 55% of NEC contracts (though down from 77% in 2004).

This time Option A Priced contract with activity schedule has found greater use, being used in 33% of NEC contracts.

The following chart shows the comparative use of the various NEC options, whether NEC2 or NEC3.

Chart 11:

Use of NEC Options (by number)



Option A was largely used on contracts below £10m value.

Option B Priced contract with bill of quantities was used on 7 occasions, largely in the mid value range bands.

Option D Target contract with bill of quantities was not used at all.

Option E Cost reimbursable contract was used on 2 occasions in the £2–10m value ranges.

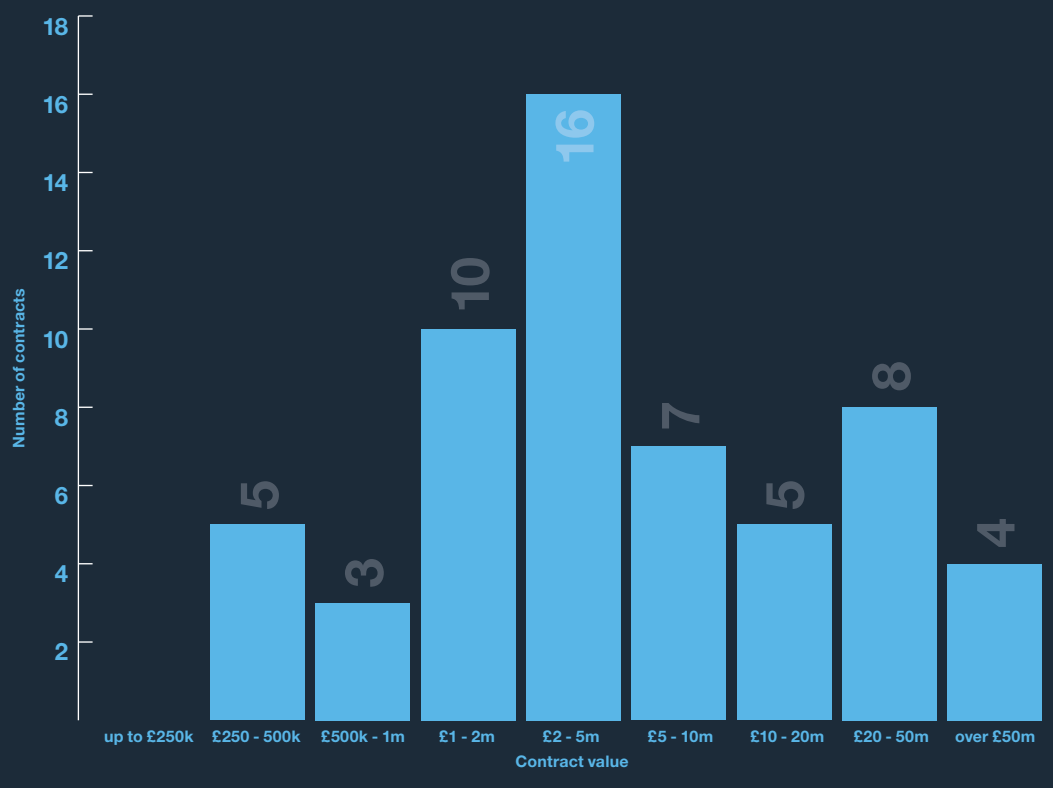
Option F Management Contract found a single use on a £20–50m contract.

The Short Contract (ECSC) was used on 3 occasions on contracts below £500,000 in value.

Option C Target contract with activity schedule was used throughout the value bands though predominantly on mid-range contracts as illustrated in Chart 12.

Chart 12:

Contracts using Option C Target contract with activity schedule



Option X12 is the NEC's Partnering Option, intended for use as a secondary option as part of the NEC family of contracts. In the 2004 survey, 17 cases were identified of its use with one or other of the NEC contracts, representing 11% of all the NEC contracts identified in the survey. In the current survey, 10 examples of use of the Partnering Option were identified, representing 9% of the NEC sample, a similar proportion but not suggestive of any increase in partnering arrangements.

No examples were reported of NEC forms used in conjunction with ProCure21, at the time the NHS Estates' preferred means of procuring construction. As in the previous survey, it would appear that this has simply been under-reported.

GC/Works Contracts

The 2007 survey has recorded a much higher incidence in the use of GC/Works Contracts than previous surveys. 83 instances were recorded of the use of one of the family of GC/Works contracts, representing 6% of the total number of contracts recorded and nearly 3% of the value of contracts. The preceding three surveys recorded just 1 to 1.6% of GC/Works contracts in their samples, though percentages by value were more variable.

The main difference between the 2007 survey and the 2004 survey has been the number of instances recorded of use of the Minor Works and Small Works contracts. The current survey found 29 instances of GC/Works/2 Minor Works and 20 instances of GC/Works/4 Small Works compared to 2 and 0 in 2004.

The GC/Works/1 Construction Management form was not used at all in 2007 or 2004.

GC/Works/1 Amendment 1 (Achieving Excellence) was introduced in 2000 to provide new conditions for the Design and Build variants of GC/Works/1 in support of 'Achieving Excellence' – the construction procurement initiative championed by the Government Construction Clients Panel. Although there were comparatively few D&B GC/Works contracts in the samples, not a single instance was recorded of the use of this Amendment in either 2004 or 2007.

PC/Works Forms

The PC/Works (1998) suite of contracts was introduced as an adapted form of GC/Works for use by private sector, local authority, NHS trust and all non-Central Government employers.

It has never achieved much use since its introduction and not a single occurrence was recorded in the current survey.

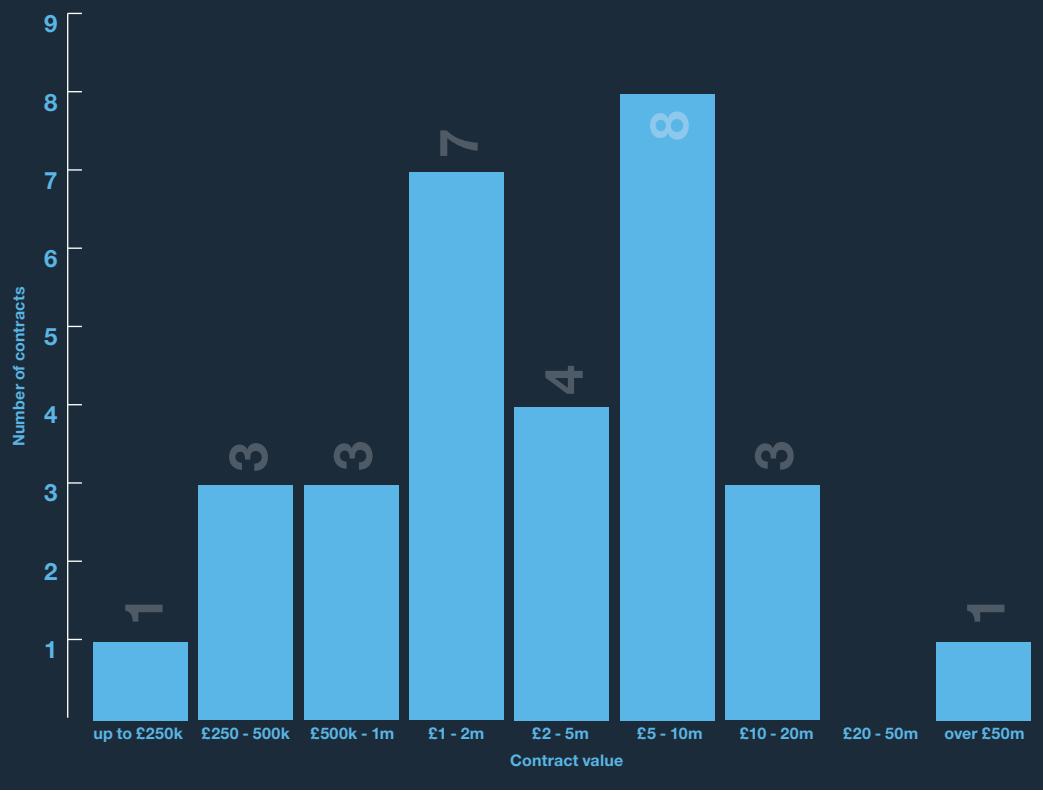
Association of Consultant Architects

The ACA Standard Form of Project Partnering (PPC2000) was promoted as the first Standard Form Project Partnering Contract and was published in September 2000. The current survey has recorded 30 instances of its use, representing 2.2% of the survey sample by number and 5.5% by value. These figures are very similar to those recorded in the 2004 survey.

The form is used on a wide variety of contract values as illustrated below.

Chart 13:

Use of ACA Standard Form of Project Partnering (PPC2000)



Other Standard Forms of Contract

No examples were reported of the use of Defcon 2000, the forms of contract introduced by Defence Estates in 2000, in the current survey.

Under the heading of 'Other Standard Forms', two examples were recorded of the use of FIDIC, the contract of the International Federation of Consulting Engineers, including for a project over £50m in value.

Also included under this heading were 3 examples of the I-ChemE Reimbursable Contract, used on projects between £500,000 and £5m.

Non-Standard Forms

Non-standard forms accounted for 2.5% of all the contracts identified by number and 1.8% by value, much smaller percentages than in any of the previous surveys. The majority of the forms of contract under this heading were private clients' own forms.

Additional Contract Provisions

The questionnaire requested survey respondents to provide additional data relative to procurement trends. It seems likely from the survey forms that some respondents failed to complete this section of the forms and for this reason the data results may under-record the true level of usage in this section of the report.

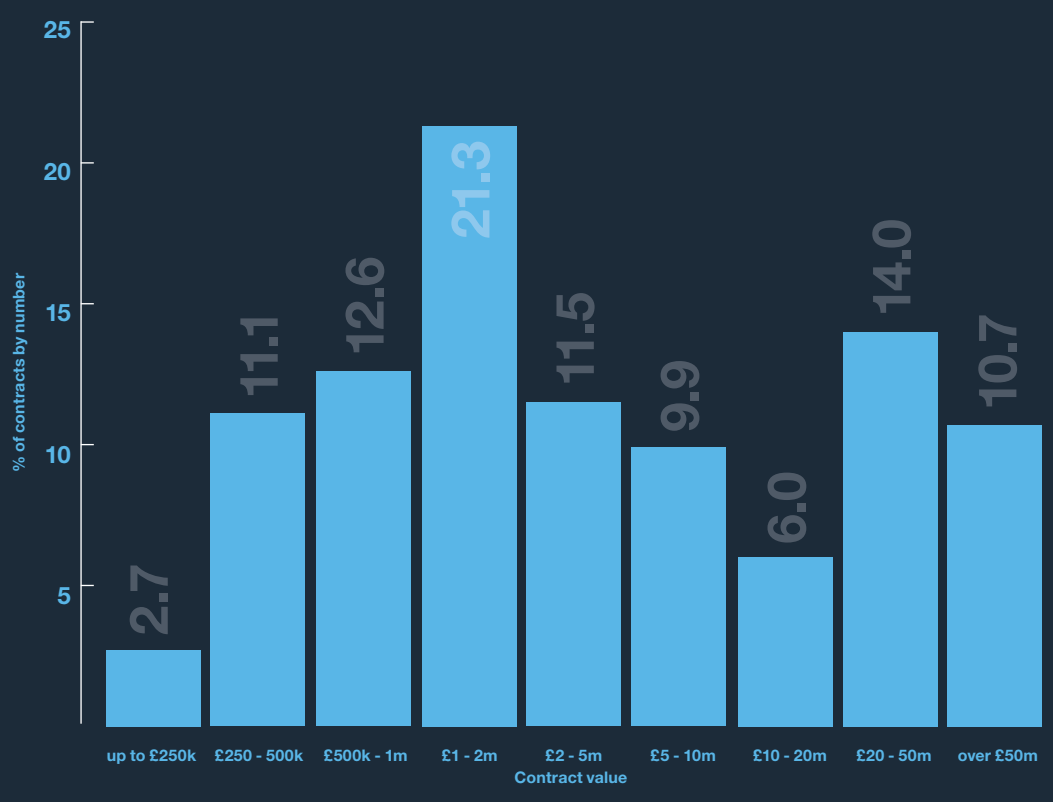
Negotiated contracts

137 of the total of 1370 contracts were listed as negotiated, i.e. exactly 10% of the sample. Despite possible under-recording, this still represents a rise in the use of negotiated contracts compared to the most recent previous surveys. The previous two surveys (2004 and 2001) identified 8.7% and 5.9% of the samples respectively though the 1998 survey found a higher incidence of the use of negotiation – just under 13%.

Negotiation varied from just 2.7% of the smallest value contracts (under £250,000) to 21.3% of contracts in the £1–2m range. (See Chart 14).

Chart 14:

The use of negotiation



Fluctuating Price Contracts

In the whole sample, only 2 contracts were identified as having variation of price provision, both in connection with contracts of just £5–10m in value. The dearth of fluctuating price contracts was the same in earlier surveys.

Guaranteed Maximum Price

The numbers indicate that the use of Guaranteed Maximum Price provisions has fallen away. Just 16 instances were recorded in the current survey, representing just over 1% of the sample by number and just under 1% by value. In the 2001 survey, GMP was noted in 3.9% of the sample by number and 2.8% by value.

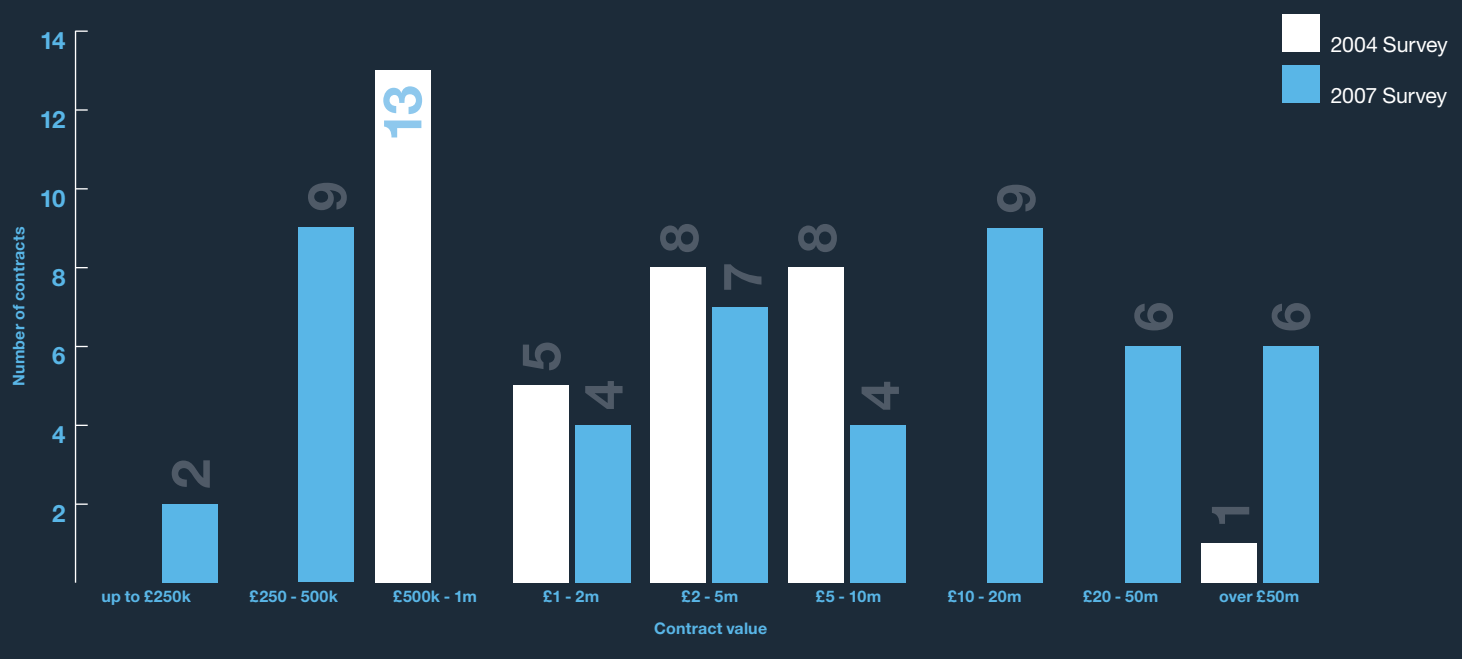
All the reported instances were in mid value contracts, between £500,000 and £20m value, whereas, in the previous survey, 27% of occurrences were with contracts below £500,000 value.

Two stage procurement

Unsurprisingly, this survey has identified a marked increase in the use of two stage tendering across all project values. 3.4% of contracts used a two stage procurement strategy compared to 1.5% in the 2004 survey. However, by value, the increase was less marked, up from 5.1% to 6.1% of the respective samples. In 2001, the use of two stage procurement was largely restricted to projects in the £500,000 to £10m value ranges. The current survey saw its use more widely spread:

Chart 15:

Two stage procurement strategies



The survey did not identify which types of contracts were most likely to be used with a two stage procurement strategy.

Incentivisation

For the second survey running, this survey enquired about the use of additional incentivisation provisions in building contracts. Only 8 instances were noted of the use of such provisions (just 0.6% of the sample) compared with 77 occurrences in the last survey (representing 3.3% of contracts). In 2004 the majority of uses were in connection with small contracts up to £250,000 but, in this survey, the instances were on larger projects in the value range of £1m to £50m. Details of the type of incentivisation or the methodology employed were not requested.

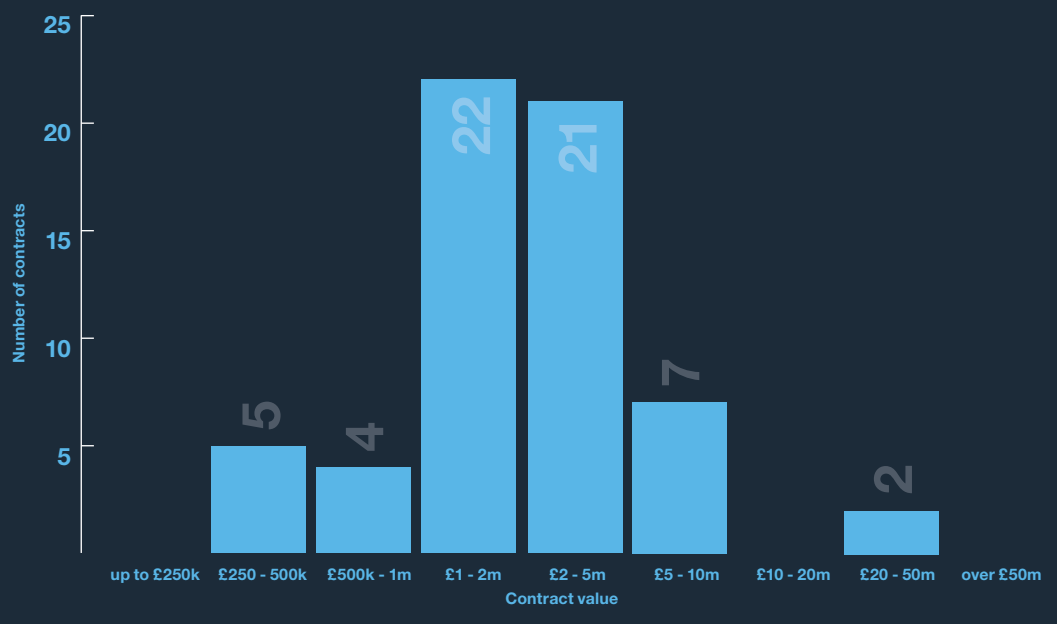
Electronic tendering

An additional question on the use of electronic tendering was also asked for the second time. Perhaps surprisingly, the number of instances recorded fell markedly. Only 6 occurrences were recorded (on projects up to £10m), representing just 0.4% of the total sample, compared to 54 projects (or 2.3% of the sample) in 2004. Under-recording may partly explain the apparent lack of use, though the 2004 sample suffered from a similar deficiency.

Framework agreements

This survey, for the first time, enquired about projects procured under framework agreements. 61 contracts, representing 4.5% of the sample, were noted as being procured under a framework agreement. These projects represented 2.9% of the sample by value. Chart 16 shows the project sizes that were procured under a framework agreement.

Chart 16:
Framework agreements



Private Finance Initiative/Public Private Partnership

Although the survey questionnaire enabled respondents to identify where schemes had been procured under PFI/PPP arrangements, no such schemes were picked up in the survey or identified as such.

Procurement Methods

Bills of Quantities

The use of Bills of Quantities dropped to its lowest level in the survey's history. Firm B.Q.'s were used on 20% of contracts in the sample, similar to the results in the 2001 survey (which was characterized by a high proportion of very small value contracts) but considerably less than all previous surveys.

By value, the proportion of contracts using firm BQs dropped to just 13.2% – the first time this measure has dropped below 20%.

The use of Approximate Bills of Quantities, which has never featured heavily in the survey, also declined compared to the previous survey, in both number and value terms (1.7% and 2.0% respectively), though, numerically, the figure is only slightly below the long term average.

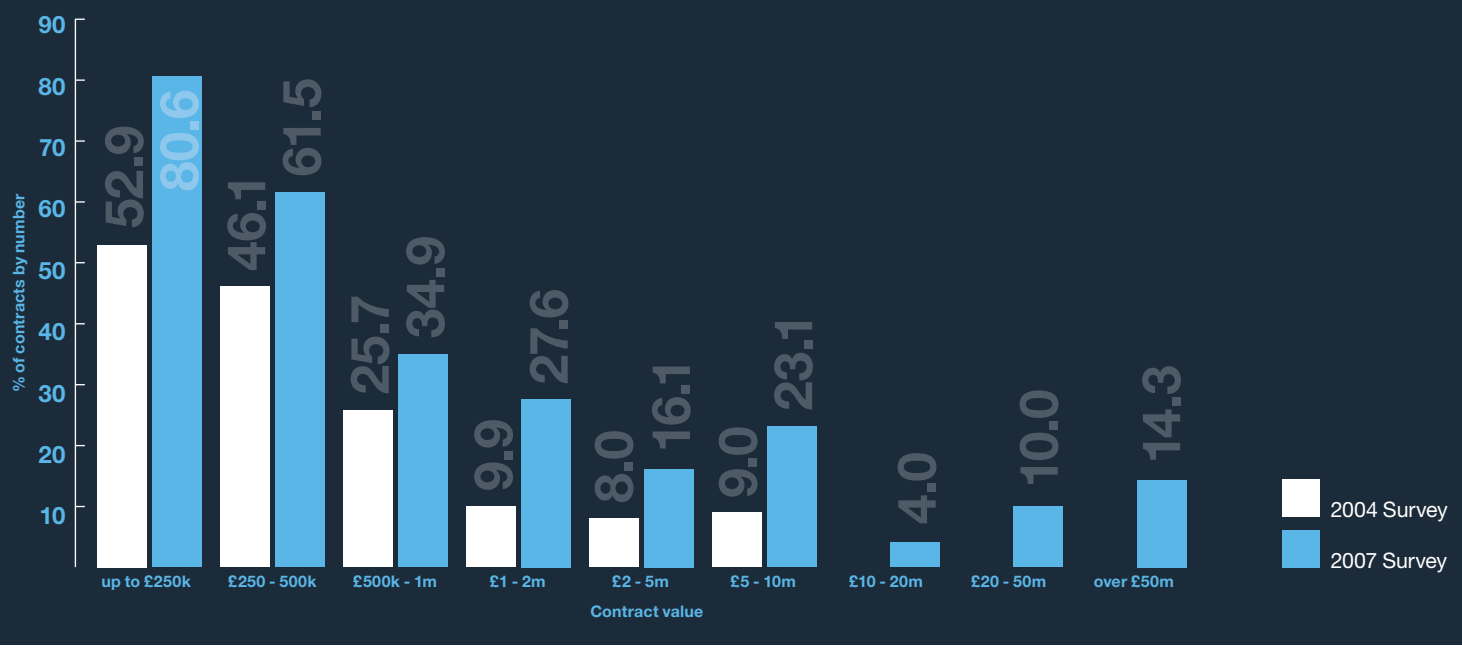
Specification and Drawings/ Activity Schedules

Unsurprisingly, given the results above, contracts employing specification and drawings or activity schedules (rather than Bills of Quantities) increased compared to the last survey. 47.2% of contracts by number used this method compared to 42.7% last time, though this is below the long term average of 50%. By value, 18.2% of contracts used specification and drawings or activity schedules compared to 10.7% last time and this is well above the long term average of 12%.

The chart below shows the percentages within each contract value band using specification and drawings or activity schedules compared to the previous survey.

Chart 17:

Specification and Drawings / Activity Schedules by project value



The chart shows that the percentage use of specification and drawings or activity schedules increased in every contract value range. They were also used on contracts above £10m value, for which no examples were recorded in the 2001 survey.

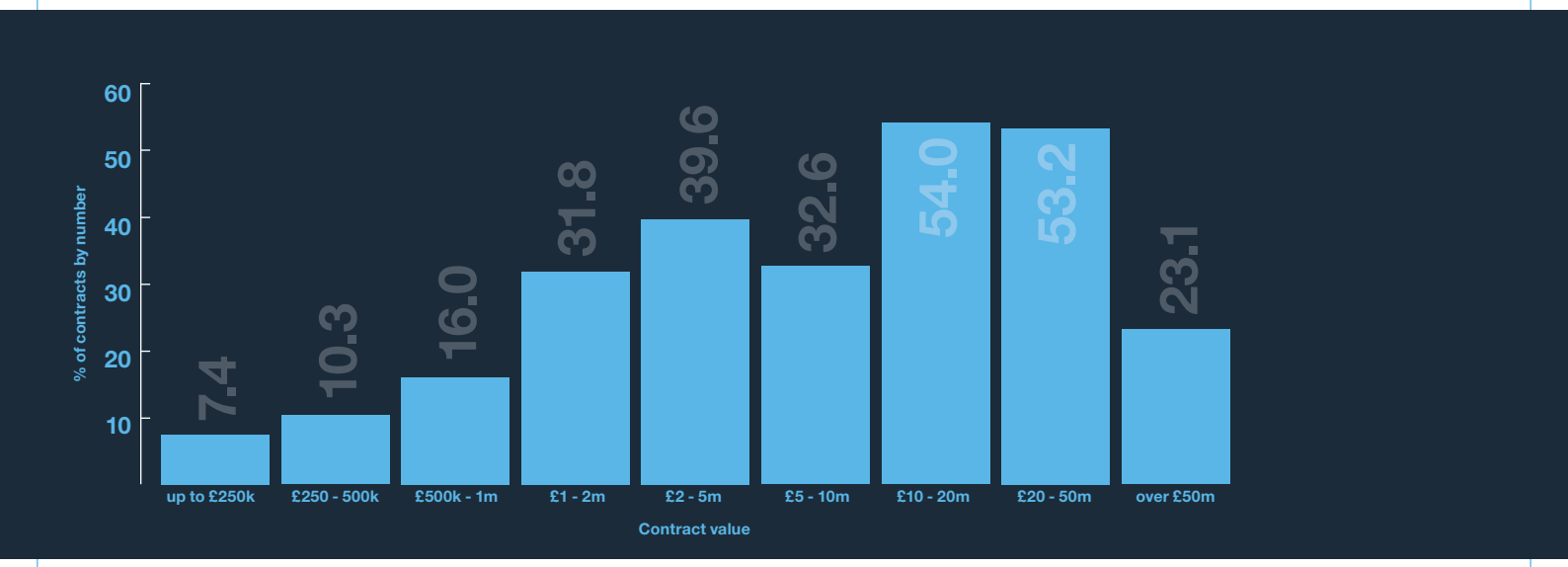
Design and Build procurement

Table 1 shows that, in terms of the number of building contracts undertaken in the UK, the design and build route has shown a significant increase. In the 2007 survey 21.8% of all contracts used a D&B route, up from 13.3% in the 2004 survey and the highest figure so far recorded in the survey's history. However, in value terms, 32.6% of the sample employed a D&B route, which was the lowest figure since 1995, since when the intervening three surveys have averaged 42.4%.

The following chart shows the percentage of each contract value band using a D&B procurement route and how over 50% of contracts in the £10–50m value range have used a D&B contract.

Chart 18:

Use of Design and Build procurement



In the 2004 survey, 87% of contracts in the £20-50m value range (13 out of 15 schemes) used Design and Build, whereas in the current survey, a much wider range of procurement options has been used on projects of this size including NEC target contracts (8 out of 47 schemes) and with quantities contracts (6 nr).

Table 7 shows that the JCT Design and Build Contract (or its 1998 predecessor) continues to dominate by far the field of Design and Build. The ICE Design and Construct form is more likely to be used on civil engineering contracts outside the scope of this survey and hence has recorded minimal use in this survey.

The 'Other Design and Build' category in the table represents, in the 2007 survey, 3 occurrences of the use of the JCT Major Project Construction Contract and 2 instances of the earlier 2003 Major Project Form.

Table 7:

Use of Design and Build Forms

	Percentage in Numbers				Percentage by Value			
	1998	2001	2004	2007	1998	2001	2004	2007
JCT With Contractor's Design	**18.9**	**13.8**	**12.4**	**20.1**	**27.1**	**42.7**	**36.7**	**26.6**
GC/Works Design & Build	**0.2**	**0.0**	**0.4**	**1.1**	**0.2**	**0.0**	**5.7**	**2.2**
ICE Design & Construct	**0.4**	**0.0**	**0.0**	**0.2**	**9.6**	**0.0**	**0.0**	**0.1**
Other Design & Build	**1.3**	**0.0**	**0.6**	**0.4**	**4.6**	**0.0**	**0.8**	**3.7**
TOTAL	**20.7**	**13.9**	**13.3**	**21.8**	**41.4**	**42.7**	**43.2**	**32.6**

Note: Percentages adjusted to exclude 'Other Contracts'

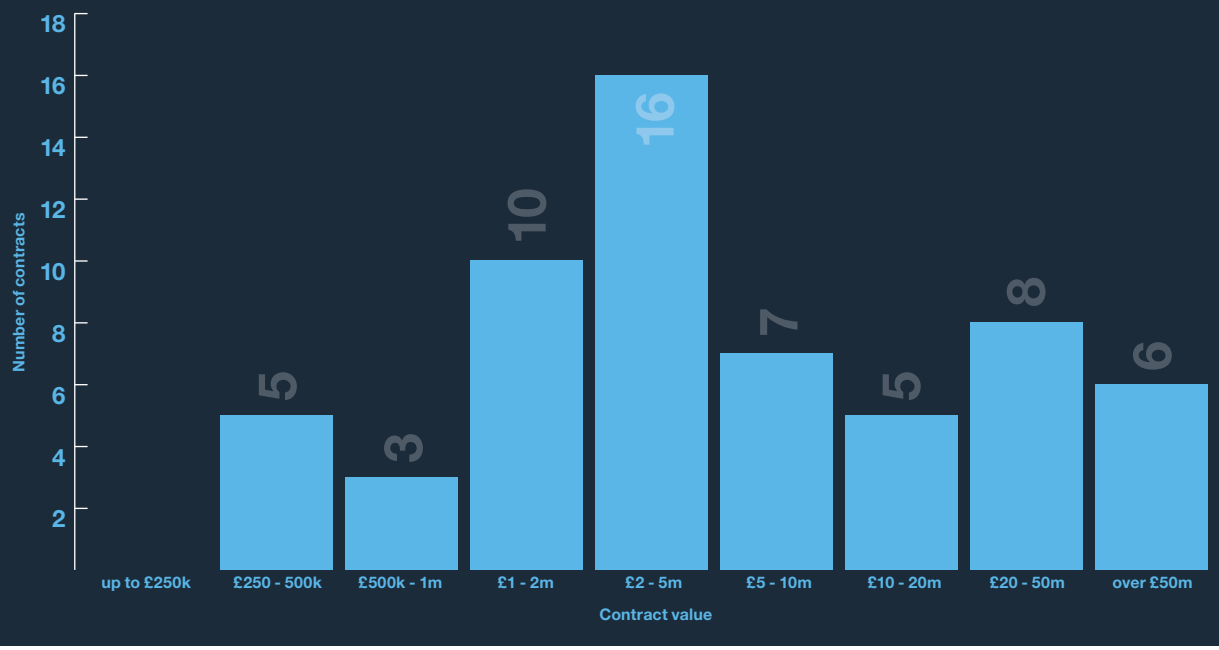
Target Contracts

Although the proportion of NEC contracts used in the current survey was slightly higher than in 2004, the use of the target options fell. 4.5% of contracts sampled used a target contract (representing 7.6% of the sample value) compared to 6.0% by number and 11.6% by value in the 2004 survey. 58 of the target contracts were NEC (all with activity schedules) while 2 employed the ICE Target Cost Version. The 2 ICE examples were both in conjunction with contracts over £50m value.

Nevertheless, Target contracts were used on all project values except for contracts of less than £250,000 (see chart 19). In 2004 40% of NEC Target contracts were in conjunction with contracts below £250,000 value.

Chart 19:

Target contracts



Prime Cost Contracts

Prime Cost contracts are represented in the survey by the JCT Prime Building Cost Contract (and its earlier 1998 version the Prime Cost Contract) and the NEC Cost Reimbursable Contract. Their instances of use in the 2007 survey increased slightly but are still used on only a tiny minority of building contracts.

The survey recorded 5 instances of use of the JCT form (2005 edition) on contracts below £2m in value and 2 examples of the use of the NEC form on contracts between £2m and £10m value.

Management Contracts

Management contracts were used on 9 occasions, representing a slight increase on the numbers found in the 2004 survey. Six of them used the 2005 JCT Management Building Contract, all within the value ranges of £500,000 to £2m; two used the 1998 JCT Management Contract (£500,000 to £10m); while one used the NEC Option F: Management Contract (1995 edition) on a £20–50m project.

These numbers represent just 0.7% of contracts in the sample by number and 1.1% by value.

Construction Management

The use of construction management also showed a slight increase, up to 1.1% of the sample by number but a much more significant increase by value, up to 9.6% from just 0.9% in 2004. This is similar to the proportions found in 2001 and 1998.

Of the 15 instances of use of construction management, 12 used the 2005 JCT Construction Management Agreement and 3 the 2002 JCT Construction Management Documentation. No examples of use were found of the GC/Works/1 Construction Management form (as in 2004).

The use of construction management contracts was spread throughout all value ranges, including some very large projects which boosted the percentage by value to 9.6%. In the 2004 survey, CM was used only on projects below £5m in value, while, in the 2001 survey, all examples were in the £2m to £50m+ ranges.

Partnering

Agreements and Arrangements

Numerically, there has been a decline in partnering agreements compared to the 2004 survey, back from 2.7% of the sample to 2.3%. However, in value terms, 15.6% of the sample used some partnering agreement, up from 6.6% in 2004.

30 instances were recorded of the use of the ACA PPC 2000 Project Partnering form compared to 45 occasions in the last survey (though within a larger sample). The form was used on most contract values, although its predominant use was in mid-value contracts (see Chart 13).

The only other agreement under this heading was a single use of a Prime Contracting agreement. However, this was in connection with a very large value scheme and was responsible for boosting the value proportion of Partnering Agreements in Table 2.

The only other stand alone agreement that comes under this heading – the JCT Constructing Excellence Contract – failed to find any users in this survey.

The principle of partnering can be incorporated into most contractual arrangements and each of the contract families now has an additional document that parties to a contract can sign up to formalize the introduction of a partnering philosophy into the contractual arrangement.

The JCT introduced its Non-Binding Partnering Charter for Single Projects in 2001, supplanted by the Partnering Charter (Non-binding) 2005. This has not achieved great take-up: 11 instances were recorded of its use in 2004 (accounting for 0.6% of all JCT contracts recorded) but only 2 in the current survey (both in conjunction with relatively small (£500,000 to £1m) projects).

The ICE introduced its ICE Partnering Addendum in 2003 and failed to achieve any usage in the 2004 survey. A similar response occurred in the current survey though only 16 examples of ICE contracts were captured in the survey.

The NEC family of contracts has NEC Option X12: Partnering Option, introduced in 2001. In 2004, this option was used in 11% of cases where an NEC form of contract had been used. In the current survey, the Partnering Option was used 10 times, representing 9% of the cases where an NEC form had been used, suggesting no further movement in favour of partnering principles.

To emphasise this, the GC/Works/1 Amendment 1 (2000) (Achieving Excellence) was apparently not called upon in conjunction with any of the 83 recorded uses of GC/Works/1 contracts in a repeat of the 2004 survey results.

However, the survey questionnaire also sought to identify the use of other partnering arrangements, other than those specifically noted above, that may have been used in conjunction with standard forms of contract. In this respect 10 examples were noted of contracts incorporating binding Partnering Agreements (other than those specifically noted), on contracts up to £10m in value. But no examples were noted of contracts incorporating non-binding 'Partnership' or 'Alliance' provisions. This is a complete reversal of the situation found in 2004 when 31 non-binding provisions were recorded but just one binding partnering agreement.

The survey questionnaire also sought to identify any 'Other Partnering Agreements/ Contracts specifically drafted for use in Partnering'. Whereas in 2004 this question solicited a further 11 project responses, no further instances were noted in the 2007 survey.

In total, the use of partnering agreements and arrangements increased markedly between the 2001 and 2004 surveys. In 2001 45 projects (1.5% of the total), worth a total £143m (4.3% of the total), were recorded as using some form of partnering. In 2004 the figures increased to 116 projects (5.0%) and £316m (10.4%). In 2007 the use of partnering appears to have passed its peak as only 53 projects (3.9% of the sample) employed a partnering contract or used some subsidiary partnering agreement. These 53 projects accounted for £1261m of work (15.8% of the sample) but only because of the inclusion of the high value Prime Contracting project: excluding this, the proportion of work by value falls to 7.1%.

Chart 20 shows the percentage of each contract value range using a Partnering Agreement or Arrangement. Contracts in the range of £5–10m are the most likely to have used some partnering arrangement.

Chart 20:

Partnering Agreements and Arrangements by contract value

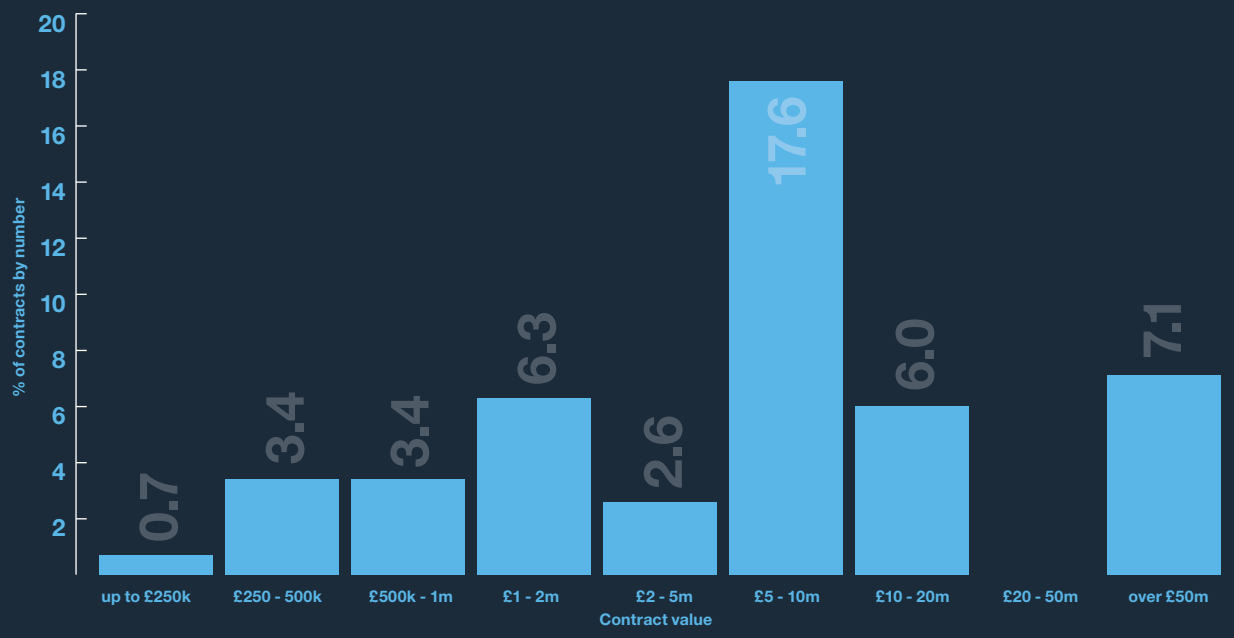
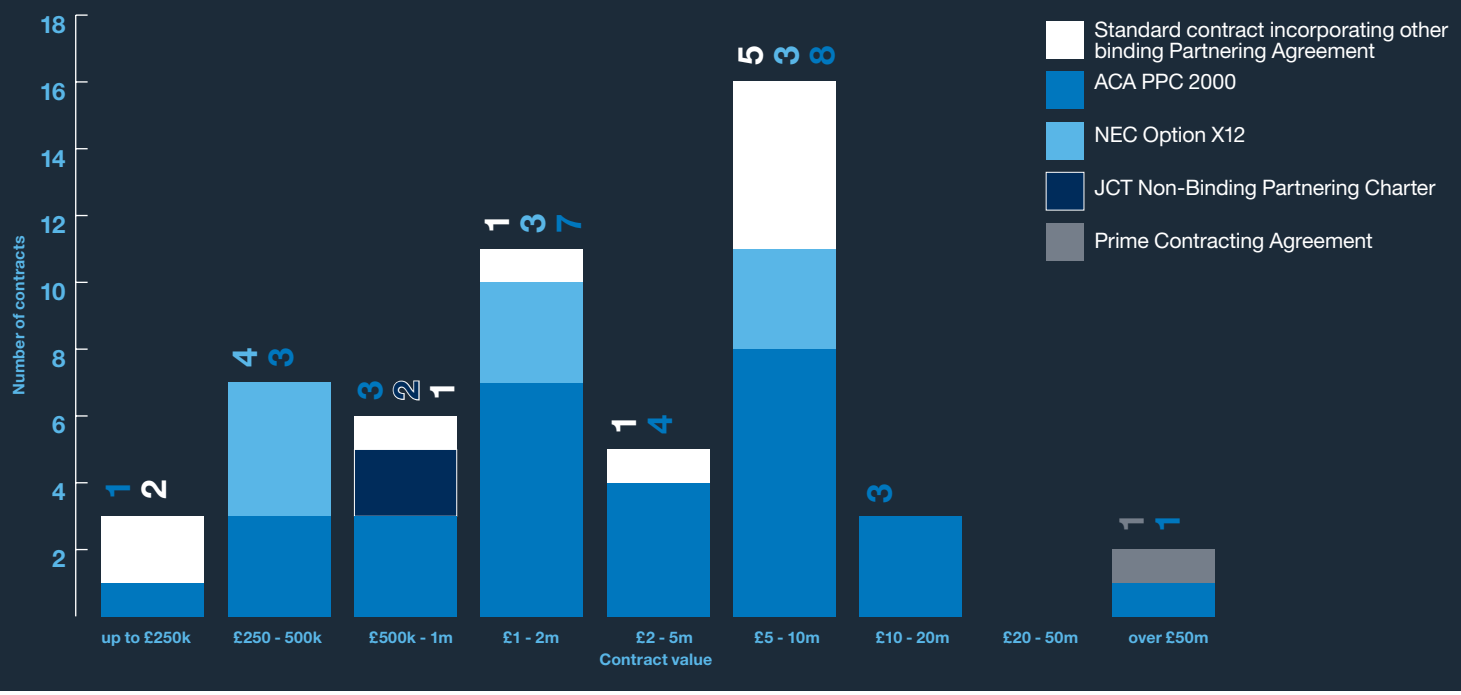


Chart 21 demonstrates the spread of the various forms of partnering by different contract values.

Chart 21:

Partnering Agreements and Arrangements by type



Appendix 1

Survey questionnaire

Notes on completion of questionnaire

In order to ensure that the information provided in the survey is valid, please ensure that the following rules are followed:

1 Include all projects for which work on site commenced during the year 1 January to 31 December 2007.

2 Include all building work carried out in the United Kingdom (new-build and refurbishment) but exclude term contracts, routine maintenance or repair work and individual sub-contracts.

3 Exclude all overseas work, civil engineering works and heavy engineering projects.

4 In the case of Management Contracts and Construction Management Agreements, base your returns on the total project value and ignore the number and value of individual trade contracts.

5 If you are completing this return on behalf of a public body, to avoid possible duplication, exclude all work handled by private Quantity Surveyors.

6 Insert the number of contracts in each value band and, for projects over £50m value, also state the value of those projects.

7 On page 5 of the survey form, you are requested to state the total number of projects and the approximate total value of those projects listed previously.

8 Also on page 5, you are requested to identify additional procurement options such as two stage tendering etc. which may be applicable to any of the preceding contract forms. Please do not overlook these additional questions, which are important to identify industry trends.

9 Please asterisk the numbers on the survey form which relate to contracts that incorporate significant amendments by yourself / your client. Please briefly indicate in the additional data section of the form the nature of the principal amendments.

10 PFI/PPP contracts – the value should be the capital (construction)) cost only. In order to prevent possible double counting, it would be helpful if you would note the names of PFI/PPP projects in the additional data section of the form.

11 Scotland –Separate contracts have not been identified in the Questionnaire for Scottish Building Contracts. Where JCT forms have been used with Scottish Supplements, please just mark the appropriate JCT form. Where forms such as the Scottish Minor Works Contract have been used, please mark its JCT equivalent, e.g. Agreement for Minor Works

12 On the final page you are invited to include any general remarks you have about procurement trends and current contract usage.

13 Please note that all information will be treated as confidential and will not be used for any other purpose

Appendix 2

The distribution of contracts in use

JCT Contracts

JCT 2005 Suite of Contracts

Form of Contract	Contract value									
	Up to £250k- (Nr)	£250k- £500k (Nr)	£500k- £1m (Nr)	£1m- £2m (Nr)	£2m- £5m (Nr)	£5m- £10m (Nr)	£10m- £20m (Nr)	£20m- £50m (Nr)	Over £50m (Nr)	Over £50m (£m)
Standard Building Contract 2005										
With Quantities (SBC/Q)	19	10	15	21	21	9	6	5	4	231
With Quantities without contractor's design (SBC/Q/XD)				4	3					
With Approximate Quantities (SBC/AQ)				1	1	1				
With Approximate Quantities without contractor's design (SBC/AQ/XD)		1	1	1	1	1	4			
Without Quantities (SBC/XQ)	4	6	7	4	3	5		1	3	180
Without Quantities without contractor's design (SBC/XQ/XD)			1	1	3					
Intermediate Building Contract										
Intermediate Building Contract (IC) with quantities	9	15	20	4	4	2				
Intermediate Building Contract (IC) without quantities	23	26	16	11	1					
Intermediate Building Contract with contractor's design (ICD) with quantities	1	3	11	1						
Intermediate Building Contract with contractor's design (ICD) without quantities	5	3	5	4	5			1		
Minor Works Building Contract										
Minor Works Building Contract (MW)	190	45	8	4						
Minor Works Building Contract with contractor's design (MWD)	25	11	2	1						
Design and Build Contract										
Design and Build Contract (DB)	27	14	16	28	44	17	18	14	2	120
Major Project Construction Contract										
Major Project Construction Contract (MP)				1				1	1	240
Construction Management										
Construction Management Agreement/Trade Contracts	2	1	1	1	2	2	1	1	1	87
Management Building Contract										
Management Building Contract			1	4				1		
Prime Cost Building Contract										
Prime Cost Building Contract (PCC)	1	1	2	1						

JCT 1998 Editions

Form of Contract	Contract value									
	Up to £250k- (Nr)	£250k- £500k (Nr)	£500k- £1m (Nr)	£1m- £2m (Nr)	£2m- £5m (Nr)	£5m- £10m (Nr)	£10m- £20m (Nr)	£20m- £50m (Nr)	Over £50m (Nr)	Over £50m (£m)
Standard Form										
With Quantities	2	9	6	5	16	4	1			
With Approximate Quantities								1		
Without Quantities	3	3	8	11	10	9	1	1	1	155
Supplements/Options	**Please note numbers here in addition to the principal contracts above**									
Contractor's Designed Portion Supplement	2	4	8	4	11	6				
Optional clause 30.4A Contractor's bond in lieu of Retention										
Intermediate Form of Contract										
IFC 98: Intermediate Form with quantities	3	5	7	5	2					
IFC 98: Intermediate Form without quantities	3	10	2	1						
Minor Building Works										
Agreement for Minor Building Works	31	5								
Standard Form With Contractor's Design										
With Contractor's Design	1	5	8	20	23	12	8	6	3	264
Management Contract										
Management Contract			1		1					
Prime Cost Contract										
Prime Cost Contract										

Other earlier JCT Forms

Construction Management Documentation 2002 Edition										
Construction Management Documentation						1			2	562
Major Project Form 2003 Edition										
Major Project Form		1			1					

Other later JCT Forms

Constructing Excellence Contract 2006										
Constructing Excellence Contract										0

Partnering with JCT

	Please note numbers here in addition to the principal contracts above									
Contracts above incorporating JCT Non-Binding Partnering Charter for Single Project (Practice Note 4: 2001) or JCT Partnering Charter (Non-binding) (PC/N) 2005			2							

ICE / NEC Contracts

ICE Forms of Contract

Form of Contract	Contract value									
	Up to £250k- (Nr)	£250k- £500k (Nr)	£500k- £1m (Nr)	£1m- £2m (Nr)	£2m- £5m (Nr)	£5m- £10m (Nr)	£10m- £20m (Nr)	£20m- £50m (Nr)	Over £50m (Nr)	Over £50m (£m)
ICE 6th edition (1991)		1	3	1	1	1	1			
ICE Measurement Version 7th edition (1999)	1				1					
ICE Design & Construct 2nd edition (2001)					3					
ICE Minor Works 3rd edition (2001)		1								
ICE Target Cost Version (2006)									2	120
Partnering with ICE	Please note numbers here in addition to the principal contracts above									
Contracts above incorporating ICE Partnering Addendum										0

NEC Family of Contracts

NEC3 Engineering and Construction (ECC) (2005)										
Option A: Priced contract with activity schedule	3	2	6	7	6	5		2		
Option B: Priced contract with bill of quantities			1	1	3				1	60
Option C: Target contract with activity schedule		5	3	6	3	1	2	3	3	292
Option D: Target contract with bill of quantities										
Option E: Cost reimbursable contract						1				
Option F: Management contract										
Short Contract (ECSC)	2	1								
NEC2 Engineering and Construction (ECC) (1995)										
Option A: Priced contract with activity schedule		1	1			2				
Option B: Priced contract with bill of quantities						1				
Option C: Target contract with activity schedule				4	13	6	3	5	1	60
Option D: Target contract with bill of quantities										
Option E: Cost reimbursable contract					1					
Option F: Management contract								1		
Short Contract (ECSC) (1999)										0
Partnering with NEC	Please note numbers here in addition to the principal contracts above									
Contracts above incorporating NEC Option X12: Partnering Option (2001)		4		3		3				
Contracts above used in conjunction with ProCure 21										0

GC/Works Contracts

Form of Contract	Contract value									
	Up to £250k- (Nr)	£250k- £500k (Nr)	£500k- £1m (Nr)	£1m- £2m (Nr)	£2m- £5m (Nr)	£5m- £10m (Nr)	£10m- £20m (Nr)	£20m- £50m (Nr)	Over £50m (Nr)	Over £50m (£m)
GC/Works (1998/1999 editions)										
GC/Works/1 With Quantities (1998)	1		1	1	2	1				
GC/Works/1 Without Quantities (1998)	2	3	1	4	2		1			
GC/Works/1 Single Stage Design & Build (1998)	1	1	1	5			1			
GC/Works/1 Two Stage Design & Build (1999)			1		1			4		
GC/Works/2 Minor Works (1998)	13	11	4		1					
GC/Works/4 Small Works (1998)	20									
GC/Works/1 Construction Management (1999)										
PC/Works (1998 editions)										
PC/Works/1-4 State version										
GC/Works/1 Amendments	**Please note numbers here in addition to the principal contracts above**									
Amendment 1 (2000) (Achieving Excellence)										

Other Contracts

Defence Estates										
Defcon 2000										
Authority's design										
Works Contractor's design										
Association of Consultant Architects										
ACA PPC 2000 Project Partnering (2000)	1	3	3	7	4	8	3		1	305
Other Standard Forms										
(Please state)			4		2	1		1	1	140
Other Contracts										
Local Authority's own forms	2		1							
Private client's own forms	3	5	7	2	6	1		1		
Others (please state)	4			2	2			1	1	60

Partnering Arrangements

Form of Contract	Contract value									
	Up to £250k- (Nr)	£250k- £500k (Nr)	£500k- £1m (Nr)	£1m- £2m (Nr)	£2m- £5m (Nr)	£5m- £10m (Nr)	£10m- £20m (Nr)	£20m- £50m (Nr)	Over £50m (Nr)	Over £50m (£m)
	Partnering arrangements in conjunction with standard forms									
Contracts above incorporating binding Partnering Agreements (other than those specifically noted)	2		1	1	1	5				
Contracts above incorporating non-binding 'Partnership' or 'Alliance' provisions (other than those specifically noted)										
Other Partnering Agreements	(for Partnering arrangements in conjunction with standard forms - see above)									
Prime Contracting agreement									1	750
Other Agreement/Contract specifically drafted for use in Partnering										

Total number and total value of projects recorded in this survey:

Total number of projects	1370 nr	Approximate total value of projects	7813 m

Additional procurement questions

	Please note numbers here in addition to the principal contracts above									
Negotiated rather than tendered	11	23	22	37	22	9	3	7	3	
Fluctuations or Variation of Price provision						2				
Guaranteed Maximum Price (GMP) provision			2	5	4	3	2			
Two stage procurement strategy	2	9		4	7	4	9	6	6	
Additional incentivisation provision				3	1	2		2		
Employing electronic tendering	2		1	1		2				
Procured under framework agreement		5	4	22	21	7		2		
PFI/PPP										
Contracts above let under PFI/PPP arrangements										
Industry standard										
Bespoke										

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9 Appendix B – Survey Forms

FAITHFUL+GOULD CONSTRUCTIVE EXPERTISE

Survey of International Major Program / Program Execution & Contracting Strategies - Faithful+Gould - July 2010

Project or Project Name (optional)		**Industry:**		**Geographic Region**	
Report completed by:		**Date:**		**Owner Name or Type**	e.g. International Oil Corporation
Program Budget at Sanction (USD)		**Planned Duration**	Months	**Program Commencement Date**	
Program Forecast Final Cost (USD)		**Forecast Duration**	Months	**Contractor / Scope**	
Key Drivers [state the key drivers for the program or project from the client's perspective]		**Key Constraints / Challenges** [state the key constraints and challenges for the program or project]		**Key Risks & Mitigations** [state the key risks and mitigations for the program or project]	
Project Development (To Sanction)		**Design / Detailed Engineering**		**Major Equipment / Long Lead Item Procurement**	
Contracting Relationships		**Contracting Relationships**		**Contracting Relationships**	
Client Role [specify the role performed by the client, e.g. project manager; project manager & designer; owner operator]	e.g. Who provided oversight - Owner or Owners/Consulting Engineer	**Client Role** [specify the role performed by the client, e.g. project manager; project manager & designer; owner operator]	e.g. Who provided oversight - Owner or Owners/Consulting Engineer	**Client Role** [specify the role performed by the client, e.g. project manager; project manager & designer; owner operator]	e.g. Who provided oversight - Owner or Owners/Consulting Engineer
Contractor Role [specify the role performed by the main contractor, e.g. design & build; design, build, operate; construction only]		**Contractor Role** [specify the role performed by the main contractor, e.g. design & build; design, build, operate; construction only]		**Contractor Role** [specify the role performed by the main contractor, e.g. design & build; design, build, operate; construction only]	
Commercial Relationships		**Commercial Relationships**		**Commercial Relationships**	
Contractor Reimbursement [specify the method of payment made to the main contractor at each project phase, e.g. fixed price; reimbursable; target cost with incentives]		**Contractor Reimbursement** [specify the method of payment made to the main contractor at each project phase, e.g. fixed price; reimbursable; target cost with incentives]		**Contractor Reimbursement** [specify the method of payment made to the main contractor at each project phase, e.g. fixed price; reimbursable; target cost with incentives]	
Commercial Variables		**Commercial Variables**		**Commercial Variables**	
Main Contractor Overhead		Main Contractor Overhead		Main Contractor Overhead	
Main Contractor Profit		Main Contractor Profit		Main Contractor Profit	
% Effort for Low Cost Engineering Center		**% Effort for Low Cost Engineering Center**		**% Effort for Low Cost Engineering Center**	N/A
Budget at Sanction (US $ Billion)		**Budget at Sanction** (US $ Billion)		**Budget at Sanction** (US $ Billion)	
Forecast Final Cost (US $ Billion)		**Forecast Final Cost** (US $ Billion)		**Forecast Final Cost** (US $ Billion)	
Planned Duration	Months	**Planned Duration**	Months	**Planned Duration**	Months
Forecast Duration	Months	**Forecast Duration**	Months	**Forecast Duration**	Months
Buls Materials Procurement (Supply & Delivery)		**Construction**		**Commissioning**	
Contracting Relationships		**Contracting Relationships**		**Contracting Relationships**	
Client Role [specify the role performed by the client, e.g. project manager; project manager & designer; owner operator]	e.g. Who provided oversight - Owner or Owners/Consulting Engineer	**Client Role** [specify the role performed by the client, e.g. project manager; project manager & designer; owner operator]	e.g. Who provided Scaffold & Construction Equipment	**Client Role** [specify the role performed by the client, e.g. project manager; project manager & designer; owner operator]	e.g. Was this Turnkey?
Contractor Role [specify the role performed by the main contractor, e.g. design & build; design, build, operate; construction only]		**Contractor Role** [specify the role performed by the main contractor, e.g. design & build; design, build, operate; construction only]		**Contractor Role** [specify the role performed by the main contractor, e.g. design & build; design, build, operate; construction only]	
Commercial Relationships		**Commercial Relationships**		**Commercial Relationships**	
Contractor Reimbursement [specify the method of payment made to the main contractor at each project phase, e.g. fixed price; reimbursable; target cost with incentives]		**Contractor Reimbursement** [specify the method of payment made to the main contractor at each project phase, e.g. fixed price; reimbursable; target cost with incentives]		**Contractor Reimbursement** [specify the method of payment made to the main contractor at each project phase, e.g. fixed price; reimbursable; target cost with incentives]	
Commercial Variables		**Commercial Variables**		**Commercial Variables**	
Main Contractor Overhead		Main Contractor Overhead		Main Contractor Overhead	
Main Contractor Profit		Main Contractor Profit		Main Contractor Profit	
% Effort for Low Cost Engineering Center	N/A	**% Effort for Off Site Fabrication**		**% Effort for Low Cost Engineering Center**	N/A
Budget at Sanction (US$Billion)		**Budget at Sanction (US$Billion)**		**Budget at Sanction (US$Billion)**	
Forecast Final Cost (US$ Billion)		**Forecast Final Cost (US$ Billion)**		**Forecast Final Cost (US$ Billion)**	
Planned Duration	Months	**Planned Duration**	Months	**Planned Duration**	Months
Forecast Duration	Months	**Forecast Duration**	Months	**Forecast Duration**	Months
Comments					

Range of Mark-Up as a percentage of overall cost - %		
Categories	Original Plan	Trend
Professional Services		
Major Equipment		
Materials		
Construction		
Subcontracts		
Total		

Cost Deviation from original price - %		
Categories		Trend
Professional Services		
Major Equipment		
Materials		
Construction		
Subcontracts		
Total		

Financial Ratios – Variable Cost/Fixed Cost		
Categories	Original Plan	Trend
Professional Services		
Major Equipment		
Materials		
Construction		
Subcontracts		
Total		

Operational Ratios – Direct Labour/Indirect Labour		
Categories	Original Plan	Trend
Professional Services		
Major Equipment		
Materials		
Construction		
Subcontracts		
Total		

Total Project Cost - $		
Categories	Original Plan	Trend
Professional Services		
Major Equipment		
Materials		
Construction		
Subcontracts		
Total		

Definitions

Professional Services	Cost associated to professional services such as engineering, environmental studies, project management, preliminary and detail design, etc
Major Equipment	Cost associated to the acquisition of major pieces of equipment such as tanks, vessels, pumps, calandria tubes, end fittings, etc.
Materials	Cost associated to the acquisition of construction material and consumables such as concrete, steel, parts, etc.
Construction	Cost associated to the construction work such as labor, rental equipment and field supervision.
Subcontracts	Cost associated to the acquisition of third party services such as facilities management, hydro blasting, vacuum cleaning, etc
Mark-Up	Rise on the acquisition cost for an item or service to embrace anticipated profits.
Variable Cost	The cost of professional services, major equipment, material or construction that changes according to the size of the project.
Fixed Cost	The cost of professional services, major equipment, material or construction that does not change in accordance to the size of the project.
Direct Labour	Wages of the personnel directly involved in the construction such as laborer, pipe fitter, welder, etc.
Indirect Labour	Wages of the personnel non directly involved in the construction such superintendent, supervisor, engineering field support, etc.

CONSTRUCTIVE EXPERTISE

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Report

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Document Number: NK38-REP-09701-10084	Usage Classification:
Retention: [TBC]	Revision: R000

Title:
DNGS REFURBISHMENT R&FR RFP EVALUATION AND NEGOTIATION PROCESS SUMMARY

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Dngs Refurbishment R&FR RFP Evaluation And Negotiation Process Summary

NK38-REP-09701-10084-R000 [TBC]

2012-06-25

Order Number: N/A
Other Reference Number:

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1.0 SUMMARY

This report documents the evaluation of the initial and final submitted Proposals of the two Proponents. Background on the process leading up to receipt of Proposals is documented under "Contracting Strategy for Retube & Feeder Replacement (NK38-REP-09701-10034).

A Request for Proposals (RFP) was issued to two Proponents on March 7, 2011. The two Proponents included a consortium led by Babcock and Wilcox Canada, GE Hitachi Canada, and Black and Macdonald (code name "Lion") and a joint venture between SNC Lavalin Nuclear Inc. and Aecon Construction Limited (code name "Tiger"). The RFP, as amended by Amendments 1 through 7, set out the evaluation criteria, weightings, and methodologies for the evaluation of the initial Proposals (including Alternative Proposals).

Each Proponent submitted an Alternative Proposal, within the meaning of the RFP, to OPG on June 20, 2011.

The initial Alternative Proposal evaluation, which took place in June and July of 2011, led to a recommendation by the Evaluation Team to the Evaluation Steering Committee and Executive Vice President Nuclear Refurbishment to enter into parallel negotiations with both Proponents. During the evaluation and negotiation processes the Proponents' code names noted above were used to differential between the Alternative Proposals to ensure confidentiality. These parallel negotiations were conducted in accordance with the RFP, as supplemented by letters to the Proponents' dated July 25, 2011 and November 16, 2011, and led to submission by both Proponents of Final Proposals on November 30, 2011.

Evaluation of the Final Proposals was carried out between November 30 and December 15, 2011. A final scoring determination by the Evaluation Team was made and a recommendation on December 15 2011 was made to enter into discussions with the higher ranking Proponent ("Preferred Proponent") SLN – Aecon Joint Venture, to reach an acceptable Agreement based on that Proponent's Final Proposal. These discussions took place between December 15, 2011 and February 28, 2012.

An Agreement was executed between OPG and SLN - Aecon Joint Venture on March 1, 2012.

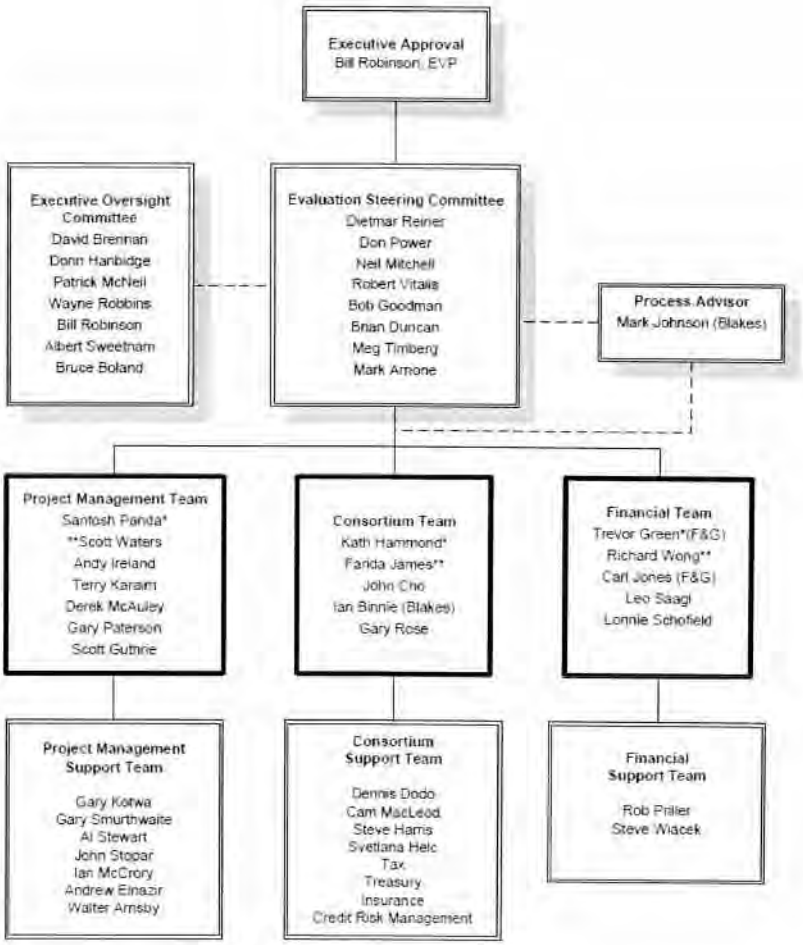
OPG's procurement governance was followed at all times during the RFP, evaluations, and negotiation processes.

2.0 INITIAL ALTERNATIVE PROPOSAL EVALUATION

Following receipt of the initial Alternative Proposals by Supply Chain, evaluations were performed in accordance with NK38-PLAN-09701-10009 R000, 'Retube & Feeder Replacement Project RFP Submission Evaluation Plan'. This Evaluation Plan established the procedure for evaluating the initial Proposals (including Alternative Proposals), responsibilities of the Evaluation Teams and Evaluation Steering Committee, and Evaluation Recommendation approval process. The Evaluation Plan also established confidentiality and conflict of interest protocols including the requirement for Evaluation Team members to execute Confidentiality Agreements and Conflict of Interest Statements (see Confidential Appendix A – Initial RFP Evaluation Process Documents). Upon receipt the Alternative Proposals were reviewed for completeness by the Supply Chain organization and then distributed to secure data rooms with access restricted to Evaluation Team members and Support Team members. The initial Proposal evaluation process commenced on June 21, 2011.

The Evaluation Team was composed of three sub-teams: the Project Management Evaluation Team, the Financial Evaluation Team, and the Commercial Evaluation Team. Each sub-team was tasked with evaluating the elements of the Alternative Proposals assigned under the Evaluation Plan to that sub-team in accordance with the Evaluation Criteria. In order to assist the Evaluation Team, Evaluation Team members were provided with a preparatory package including the Evaluation Criteria, Guidelines for Evaluation, and Scoring Outline for Evaluation Process. These items were introduced to Evaluation Team members at face-to-face training meetings on June 2, 2011 and June 13, 2011, prior to receipt of the initial Proposals.

R+FR RFP Evaluation Teams



* Denotes Team Lead
** Denotes Team Alternates

A formal Team Member Evaluation Package was issued to each Team Member via email on June 17, 2011 to provide sufficient background and material to ensure the evaluation process was followed. The evaluation package contained the following items:

- Evaluation Team Member Acknowledgement Form
- Confidentiality Agreement (Support Team)
- Conflict of Interest Statement
- Evaluation Scoring Form

- Guidelines for Evaluation
- Scoring Outline for Evaluation Purposes
- Evaluation Criteria
- Proponent Information Form (blank)
- Pricing Submission Form (blank)
- RFP Submission Evaluation Plan (NK38-09701-10009)

OPG's external legal advisors, Blake, Cassels & Graydon LLP attended the training meetings to provide advice and guidance regarding the Evaluation Process. Blakes remained available throughout the evaluation period, as process advisors, to answer questions from the sub-team leads and Evaluation Steering Committee members regarding process.

The sub-teams reported their progress to the Evaluation Steering Committee at meetings on June 28, 2011, July 8, 2011, and July 15, 2011.

2.1 Project Management Evaluation Team

Following individual scoring by the sub-team members, two consensus scoring meetings were held by the Project Management sub-team on July 5, 2011 and July 6, 2011 to arrive at consensus scores based on discussion and debate (see Confidential Appendix B – Initial RFP Evaluation Results and Scoring).

2.2 Commercial Evaluation Team

Following individual scoring by the sub-team members, a consensus scoring meeting was held on July 11, 2011 to arrive at consensus scores based on discussion and debate (see Confidential Appendix B – Initial RFP Evaluation Results and Scoring).

2.3 Financial Evaluation Team

The financial evaluation was based on a financial model developed by Faithful & Gould (F+G) specifically for evaluation purposes. Essentially a predefined reference project, the Microsoft Excel-based financial evaluation model was developed by F+G with OPG oversight concurrent with the evaluation criteria. F+G personnel led the modeling efforts during the RFP evaluation process, and continued providing post-evaluation modeling support as fundamental members of the Financial Evaluation Team.

The model was designed to perform a side-by-side comparison of both Proponents' financial submissions using five of the six pre-defined evaluation categories set out in Part III of the Evaluation Criteria. The five financial evaluation categories were based

on pricing or costing data from the Proponent's Pricing Submission Forms. These five categories and weightings were:

1) Execution Phase Target Cost (30% of financial evaluation score)

2) Execution Phase Sensitivity to Change (10%)

3) Execution Phase Fixed Fee (10%)

4) Definition Phase Total Cost (25%); and

5) Definition Phase Sensitivity to Change (5%)

The model was designed to collect inputs such as costs, labour rates, and resource requirements from the Proponent's submissions, particularly the Pricing Submission Forms and Tooling Performance Guarantees, process the data into the appropriate form in separate evaluation worksheets, apply it to the pre-established reference project model, and transfer the outputs (typically costs) to a scoring summary page. The relative outputs for each of the five evaluation categories determined the financial 'winner' for each respective category, assigning the maximum available score to the Proponent with the lowest cost. The model then reduced the other Proponent's scoring based on the delta in cost between the two Proponents, using a pre-defined set of scoring bands.

F&G performed model testing with OPG oversight prior to receiving the Proponents' Proposals. This testing involved discussion with the Project Team on likely scenarios, potentially extreme scenarios, and undesirable scenarios to establish the model's performance in varied situations. After confirming the model's performance in these scenarios F&G finalized the model and 'locked it in' for Proposal evaluation purposes. The model was finalized prior to receipt of Proponents' Proposals.

The sixth evaluation category, Financial Risks and Deviations (20%), was scored individually by each Financial Evaluation Team member. A consensus scoring meeting was held on July 11 2011, and consensus scores were developed based on discussion and debate.

Final evaluation scores were obtained by summing the scores of the six categories for both Proponents. Overall, the Financial Evaluation scores represented 30% of the overall RFP evaluation scores.

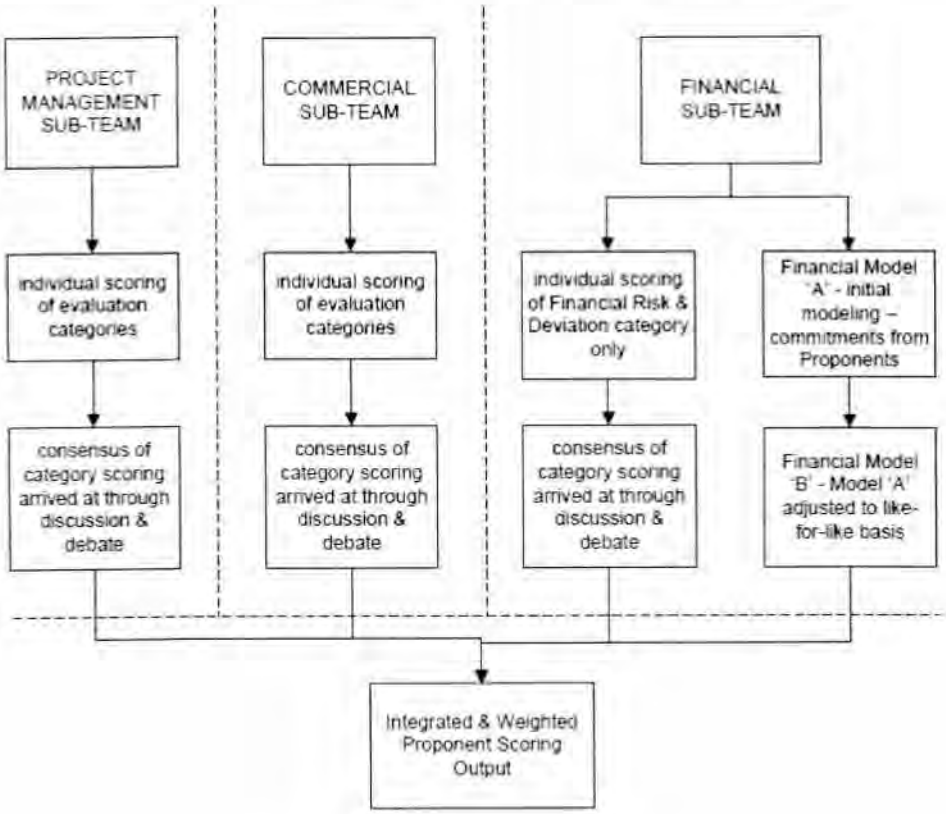
Each Proponent submitted an Alternative Proposal with an incomplete set of inputs to the model. To maintain fairness, the sub-team elected to make adjustments to achieve 'like-for-like' comparison between the two Proposals by removing elements that were not present in both (see Confidential Appendix B – Initial RFP Evaluation Results and Scoring).

2.4 Initial Consensus Scoring

On July 12 the Evaluation Team Leads and Alternates met to compile and assess the sub-team consensus scores and review comments from the sub-teams. They engaged in discussions designed to verify that the Evaluation Criteria was followed, that there was no double counting of risks or other items across the different teams and to reach a recommendation as to path forward based on the consensus scores. The final consensus scores and the breakdown were kept confidential and not shared with anyone beyond the Evaluation Team Leads and Alternates.

Consensus scoring results did not change as a result of these discussions (see Confidential Appendix B – Initial RFP Evaluation Results and Scoring).

R&FR RFP Evaluation Process



2.5 Initial RFP Evaluation Recommendations

A recommendation was made to the Evaluation Steering Committee on July 15, and subsequently to the Executive Vice President Nuclear Refurbishment, to enter into dual-track negotiations with both Proponents based on the evaluation results.

3.0 NEGOTIATIONS

Following concurrence by the Evaluation Steering Committee and Executive Vice President Nuclear Refurbishment, dual-track negotiations were initiated with both Proponents following the process described in further detail below.

3.1 Negotiation Structure and Oversight

The structure of the negotiation process was established prior to commencement of negotiations per Retube & Feeder Replacement Project RFP Submission Negotiation Plan NK38-PLAN-09701-10011-000 (see Confidential Appendix C – Negotiation Process and Meetings).

Executive Approval	
Albert Sweetnam	EVP, Nuclear Projects
Executive Oversight Committee	
Donn Hanbidge	SVP & Chief Financial Officer
Patrick McNeil	SVP, Corp Business Dev & CRO
Wayne Robbins	Chief Nuclear Officer
Bill Robinson	EVP, Business Transformation Project
Bruce Boland	SVP, Corporate Affairs
Negotiation Steering Committee	
Dietmar Reiner	SVP, Nuclear Refurbishment
Don Power	VP, Corporate Investment & Asset Planning
Neil Mitchell	VP, Refurbishment Engineering
Robert Vitalis	Director, Refurbishment Supply Chain
Bob Goodman	Director, Management System Oversight
Gary Rose	Director, Refurbishment Planning & Control
Brian Duncan	SVP, Darlington
Dave Brennan	SVP, Law & General Counsel
Negotiation Team	
Kath Hammond (Team Lead)	Director – Refurb Commercial Strategy
Mark Arnone	VP, Refurbishment Execution
Ian McCrory	Project Manager – R&FR
Ken Pearce	Blakes – outside Legal Counsel
Meg Timberg	Assistant General Counsel

Richard Wong	Assistant Treasurer
Negotiation Support Team	
Farida James (Team Lead)	OPG Counsel
Ian Binnie	Blakes – outside Counsel
Trevor Green	VP, Faithful & Gould
Mark Johnson	Blakes – outside Counsel
Cameron MacLeod	Manager – Refurb Commercial Strategy
Santosh Panda	Sr. Tech/Engineering Officer
Steve Harris	Supply Chain- Sr. Specialist Strategic Planning
Neill Allen	Sr. Advisor – Refurb Commercial Strategy
Scott Waters	Section Manager – R+FR Project

3.2 Negotiation Team, Negotiation Support Team, and Sub-Teams

The Negotiation Team was composed of experienced senior level individuals and was responsible for face-to-face negotiations with both Proponents and for ensuring OPG's internal stakeholders, Negotiation Steering Committee, and Executive Oversight Committee were involved in development of OPG's negotiating positions on substantive issues. They also ensured internal stakeholder alignment with respect to any changes in OPG's negotiating positions as negotiations progressed.

The Negotiation Support Team provided assistance and resources to the Negotiation Team during negotiations and assisted in preparing material and discussions with internal stakeholders and the Negotiation Steering Committee. Support Team members also led or participated in various sub-teams established by the Negotiation Team where specific areas of focus and detailed discussions with each Proponent were required (i.e. technical issues, financial gaps, etc.), and attended negotiation sessions as required.

3.3 The Negotiation Steering Committee

The Negotiation Steering Committee included senior executives from the R&FR Project Team, Finance, Law, and Darlington GS and oversaw activities of the Negotiation Team. As negotiations progressed the Negotiation Steering Committee was advised regularly as to progress with each Proponent and specific OPG negotiating positions were brought to the Negotiation Steering Committee for comment and concurrence (see Confidential Appendix D – Negotiation Steering Committee Meetings).

3.4 The Executive Oversight Committee:

The Executive Oversight Committee included senior OPG executives and was available as a resource for the Negotiation Steering Committee if they believed

significant OPG-wide issues were raised during the Proponent negotiations. The Executive Oversight Committee was briefed periodically as to the status of the negotiations.

3.5 Cross Functional Sourcing Team (CFST)

To support development of the RFP and evaluation criteria in accordance with OPG governance and good business practices a Cross Functional Sourcing Team was established in January 2010 to involve key stakeholders in the contracting process.

Prior to the evaluation and negotiation processes the CFST was advised of the evaluation and negotiation plans and periodically individual CFST members were consulted and feedback and input was sought for evaluation and negotiation perspectives related to their areas of expertise.

At the conclusion of negotiations and prior to contract execution key CFST members in accordance with the Organizational Authority Register (OAR) indicated their concurrence with the negotiated contract via the Major Contract Memorandum (MCM).

3.6 Negotiation Preparation

The Negotiation Team commenced preparations in May 2011 in anticipation of potential negotiations with one or more Proponents. Preparatory meetings continued in June and July 2011 concurrent with the initial evaluations of Proponent submissions.

Following the recommendation of the Evaluation Team to the Evaluation Steering Committee on July 15, 2011, the Negotiation Team and general members of the Negotiation Support Team held intensive preparatory meetings during the week of July19th prior to negotiations with the Proponents. During these intensive meetings the issues identified by the Evaluation Team were reviewed and assessed and a written set of negotiation objectives was developed together with a timeline for the negotiations. These items were presented to the Negotiation Steering Committee and were also reviewed with the EVP, Nuclear Projects.

The negotiation period began July 25, 2011 (see Confidential Appendix C – Negotiation Process and Meetings).

3.7 Negotiation Process

Each Proponent was advised via letter on July 25, 2011 that OPG intended to enter into separate but contemporaneous negotiations with each Proponent with the expectation of identifying a Preferred Proponent as a result of these negotiations. The letter also included an Issues List sorting out the issues identified by the Evaluation Team. Negotiations commenced with each Proponent before the end of July 2011 under the terms of the Negotiation Protocol established in the letter of July 25, 2011.

The letter established the following phases of negotiation:

Phase I – High-Level Clarification and Principles

Phase IIA – Issues and Terms and Conditions

Phase IIB – Working Sub-Groups

Phase III – Detailed Issues / Mechanics

Phase IV – Pricing

Initial discussions with each Proponent focused on obtaining agreement to a set of "Key Principles" which would form the basis of future more detailed discussions. Following agreement on "Key Principles" the Negotiation Team met separately with each Proponent on a weekly basis and sub-teams as required met to resolve more detailed information gaps or inconsistencies in the Proposals.

The negotiation sessions were structured to address various aspects of the Proposals, with each session's meeting notes being kept by F&G. Prior to each negotiation session, the Negotiating Team met to prepare its position on various items and to obtain informative direction from OPG personnel as required.

3.8 Negotiation Process Outcome

Negotiations with each Proponent ended November 10, 2011. As of that date an updated draft Agreement was issued to each respective Proponent based on the Issues Lists and negotiations. The draft agreements were not identical, and the Proponents were aware that this was the case. This approach was taken to permit each Proponent to arrive at a 'biddable' document that addressed the individual concerns of each Proponent. Each Proponent confirmed they would submit a revised, conforming bid based on the updated draft Agreement. Final Proposals were due by November 30, 2011.

Each Proponent was advised via letter on November 16, 2011 as to the process OPG intended to follow with respect to the submission and evaluation of the Final Proposals, Preferred Innovation Submissions, Innovation Submissions and Option Pricing, as well as the process by which OPG expected to award a contract to the successful Proponent.

4.0 FINAL RFP EVALUATION

Final Proposal evaluations were performed in accordance with NK38-PLAN-09701-0401039 'Retube & Feeder Replacement Project RFP Submission Evaluation Plan for Final Proposals'.

4.1 Final Evaluation Team

The Evaluation Team, consisting of 6 executives, was charged with the evaluation of the Final Proposals. This team was made up of the following individuals:

- Dietmar Reiner, SVP- Darlington Refurbishment (Team Lead),
- Paul Pasquet, SVP- Nuclear Programs & Training,
- Don Power, VP- Corporate Investment & Asset Planning and
- Paul Spekkens, VP- Science & Technology,
- Mark Arnone, VP- Refurbishment Execution,
- Kath Hammond, Director- Commercial Strategy.

Final Proposal evaluation scoring was the exclusive responsibility of the Evaluation Team. Methodologies and weighting used to evaluate the initial Alternative Proposals were updated by OPG's November 16, 2012 letter to accommodate the negotiated forms of agreement and the requested Preferred Innovation Submissions, Innovation Submissions and Option Pricing.

4.2 Final Evaluation Support Teams

The Evaluation Team was supported by Support Teams. Each Support Team was composed of a segregated group of subject matter experts assembled to review the proposals. The Support Teams leads were as follows:

- Technical: Neil Mitchell, VP- Engineering
- Project Management: Gary Rose, Director- Planning & Controls
- Commercial: Cameron MacLeod, Manager- Commercial Strategy
- Financial (Pricing): Richard Wong- Director Financial Strategies + Performance. Management

- Risk: Bob Goodman, Director- Management System Oversight.

Although evaluation scoring was performed by the Evaluation Team, the Support Teams played an important role in assisting the Evaluation Team with their detailed review of the Final Proposals in accordance with the Evaluation Plan for Final Proposals. The Support Teams had access to all relevant historic information including, but not limited to, the initial Alternative Proposals, expression of interest, initial Alternative Proposal evaluation and negotiation results, and were available to provide information to the Evaluation Team.

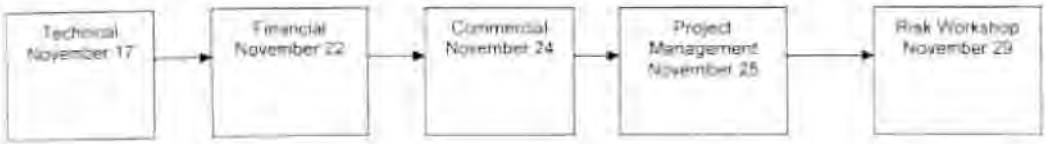
4.3 Pre-submission

Proposal evaluations were performed in accordance with NK38-PLAN-09701-0401039. This Evaluation Plan for Final Proposals established the procedure for evaluating the Final Proposals, responsibilities of the Evaluation Team, and the evaluation recommendation approval process. The Evaluation Plan for Final Proposals also established confidentiality and conflict of interest protocols including the requirement for Evaluation Team members and Support Team members to execute Confidentiality Agreements and Conflict of Interest Statements. A kick-off meeting was held with Blakes where the Evaluation Team and Support Team were briefed on the Evaluation Plan for Final Proposals and the process.

Prior to the Final Proposal submissions, the Evaluation Team was briefed by the Support Teams on the results of the previous round of evaluations and the results of the negotiations.

Timing & Content of Workshops

1. Each Evaluation Team member would read the applicable documents from the original Proponent submissions prior to each meeting
2. Evaluation Team members would receive a presentation from each Support Team lead, similar to what was presented to the steering committee
3. Evaluation Team members would receive a presentation on Issues List associated with that team
4. Evaluation Team members would receive an update from Support Team leads as to where the issues landed
5. Evaluation Team members would be made aware of which items were to be handled after award vs. what had to be re-submitted
6. Evaluation Team members would review new material and score accordingly
7. Support Team members could be used as sounding board for questions and clarity



4.4 Post-submission

Final Proposal submissions from both Proponents were received by Supply Chain on November 30, 2011.

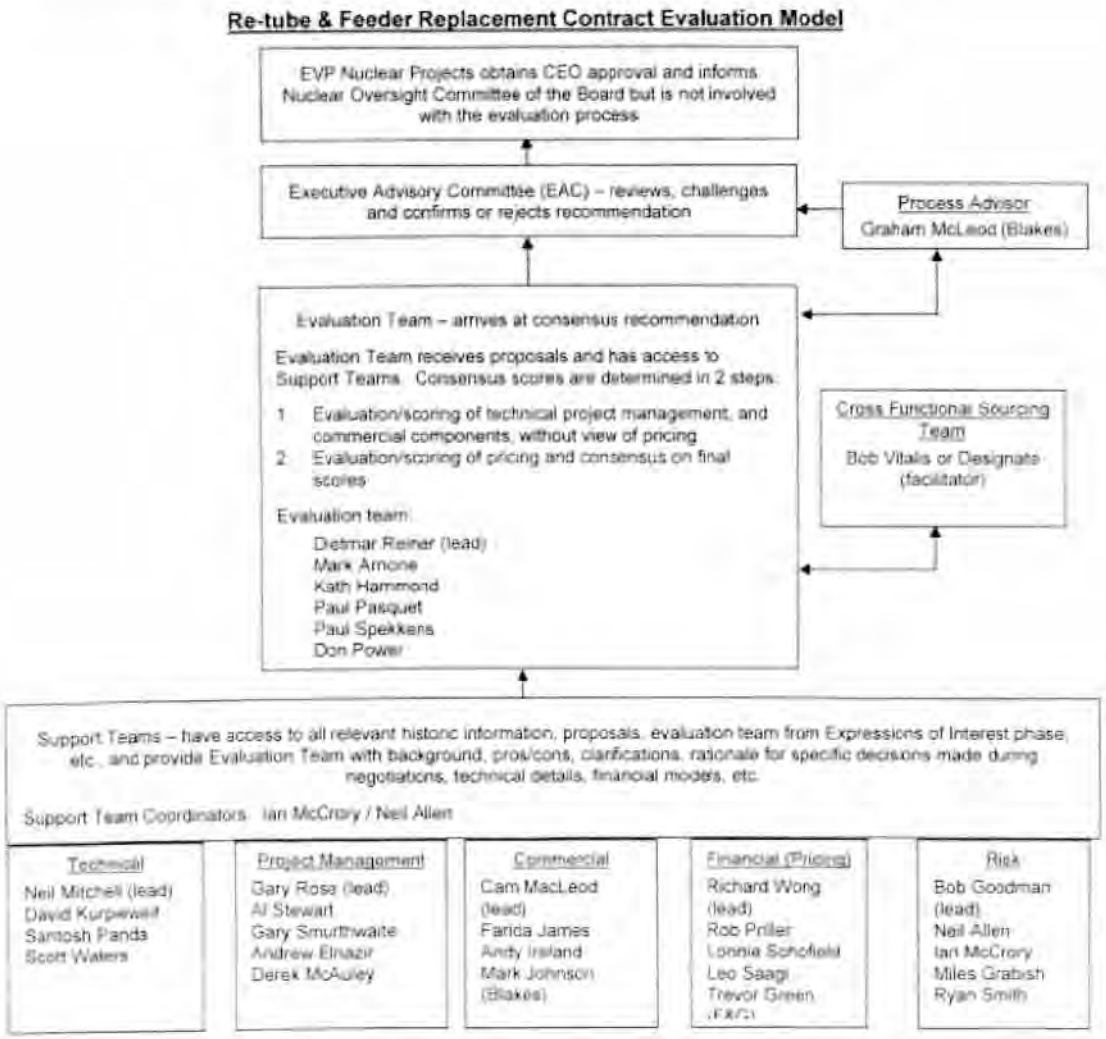
Upon receipt the Final Proposals were reviewed for completeness by the Supply Chain organization and then distributed to secure data rooms with access restricted to Evaluation Team members and Support Team members. Each Evaluation Team member was also provided with a full electronic copy of both Final Proposals on a secure laptop computer (see Confidential Appendix E – Final RFP Evaluation Process Documents).

Correspondence from one of the Proponents containing additional information that was received by Supply Chain following the submission deadline for Final Proposals was reviewed by the Supply Chain organization and, with concurrence from the Executive Oversight Committee, deemed ineligible for inclusion in the evaluation process. This additional information was not provided to the Evaluation Team.

OPG's external legal counsel, Blake, Cassels & Graydon LLP, was retained as the Process Advisor. Blakes remained available throughout the evaluation period to answer questions from Supply Chain, the Evaluation Team members and the Support Team members regarding process.

In accordance with OPG's letters dated November 16, 2011 any submitted Preferred Innovation Submissions, Innovation Submissions and Option Pricing were not subject to the evaluation process but would be reviewed once a preferred Proponent was identified.

The structure of the Evaluation Team, and the Support Teams and high-level process is captured in the following model:



Following receipt of the Final Proposals, each Evaluation Team member reviewed each Final Proposal independently. The Evaluation Team also received presentations from the Support Teams, and where they had questions and requested follow ups from the Support Teams. Please refer to Confidential Appendix B for the Support Team presentation materials from these meetings.

The Evaluation Team held a consensus scoring meeting on December 8, 2011. At that session, each Evaluation Team member first submitted all of their individual scores for the Technical, Project Management, and Commercial components of the bid. The Evaluation Team then engaged in discussion and debate to arrive at consensus scores in all categories (see Confidential Appendix F – Final RFP Evaluation Results and Scoring).

The Financial Support Team was sequestered to a remote location from November 30 through December 8 to model the Proponents' final pricing submissions submitted with their Final Proposals. Per the Evaluation Plan for Final Proposals, no Evaluation Team members or Support Team members were allowed access to the Proponents' final pricing submissions submitted with their Final Proposals or results of the modeling exercise during this time. The result of the Financial Support Team's modeling and final presentation to the 6 members of the Evaluation Team was made on December 9 2011. The Evaluation Team members were given the opportunity to ask questions regarding the application of the financial model, the quality assurance process utilized, the outputs of the model, and the assigned numerical scores. Following the presentation, the Evaluation Team members each performed independent scoring of the financial risks and deviations category for purposes of the Evaluation Criteria for Final Proposals. The Evaluation Team then engaged in discussion and debate to arrive at consensus scores for the Financial Risk category

4.5 Final RFP Evaluation Recommendation

The Evaluation Team Lead imported the consensus scores into a model that calculated an overall score for each Proponent per the published weightings set out in the Evaluation Criteria. The result of the evaluation was one of the two Proponents scored clearly ahead per the Evaluation Criteria. This Proponent was recommended by the Evaluation Team as the Preferred Proponent for award of the Darlington Refurbishment R&FR contract.

The Evaluation Team presented its recommendation and supporting rationale to the Executive Advisory Committee on December 15, 2011. This recommendation, with CEO approval, was then communicated to the Nuclear Oversight Committee of the Board by the Executive Vice President, Nuclear Projects (see Confidential Appendix F – Final RFP Evaluation Results and Scoring).

4.6 Communication with the Preferred Proponent and Second-ranked Proponent

On December 15 each of the Proponents was contacted via telephone by the Executive Vice President, Nuclear Projects to advise them of the evaluation results and the next steps in the process. SLN-Aecon JV was advised that they were the Preferred Proponent and B&W Canada was advised they were the Second-ranked Proponent.

4.7 Final Discussions with Preferred Proponent and Execution of Agreement

The Key members of the Negotiation Team engaged in discussions with the preferred Proponent based on the Final Proposal. These discussions began in late December 2011 and were not intended to revisit the Terms and Conditions negotiated prior to November 10 2011 but to add clarity and address remaining OPG concerns about the Final Proposal.

At this point the correspondence containing additional information from the preferred Proponent noted in Section 4.4 was reviewed by the Negotiation Team. Where savings were indicated the Negotiation Team incorporated the information into the contract.

The preferred Proponent's Preferred Innovation Submissions, Innovation Submissions and Option Pricing were reviewed by the Negotiation Team and expiry dates on OPG's right to exercise these submissions was obtained. The expiry dates received from the preferred Proponent were beyond the anticipated Agreement execution date and the decision to accept these submissions or not was left to the RFR project team post-execution.

During January and February 2012 clarification discussions and document cleanup exercises included exchange of black-line versions between the parties, co-ordinated by Blake, Cassels & Graydon LLP. As part of these discussions several additional Exhibits were incorporated into the Agreement to provide examples to provide clarify and avoid disputes. Internal approval was also sought by each party during this time period.

Discussions concluded on February 28, 2012 and the Agreement was executed between OPG and SNC Nuclear Inc and Aecon Construction Group Inc as of March 1, 2012.

4.8 Final Discussions with Second-ranked Proponent

After execution of the Agreement a meeting with the second-Ranked Proponent, Babcock and Wilcox Canada, was held on March 30, 2012. The meeting discussed the process OPG followed during the evaluation and provided an opportunity for general discussion of the process and confirmation that B&W had met the criteria for payment of the Honorarium incorporated into the RFP process. OPG received signed Release documents materials from the B&W consortium (see Confidential Appendix G – Release Documentation and Honorarium).

SEC Interrogatory #15

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/3, p.11-14]

Please provide a similar chart showing the following scenarios for the RFR Target Pricing:

a) Contractor cost overrun of 25%

b) Contractor cost overrun of 50%

c) Contractor cost overrun of 75%

d) Contractor cost overrun of 100%

Response

OPG provides the requested scenarios below as illustrative examples to demonstrate how the Retube and Feeder Replacement (RFR) contract mechanisms work. OPG notes, however, that at cost overruns such as those contemplated by the requested scenarios, OPG would have taken a number of actions before these levels were reached. OPG also carries contingency for certain events. Furthermore, these examples do not consider schedule impacts, which would likely drive different outcomes at the overrun thresholds contemplated in the requested scenarios. Also, OPG notes that as the mock-up is complete, the inclusion of the mock-up overruns in the examples is for illustration only and to reflect the original example in the evidence at Ex. D2-2-3. Finally, although OPG's contract with the SNC/AECON Joint Venture utilizes cost-plus mark-up pricing for the owner specified materials (OSM), a large portion of the SNC/AECON Joint Venture's contracts with its subcontractors for this work is on a fixed/firm price model, and therefore the cost overruns depicted below are unlikely.

For all of the scenarios below, all the same features and assumptions for Charts 4-7 in Ex. D2-2-3 apply:

- Scenarios are based on approved scope at the time of the Release Quality Estimate.
- The contractor Fixed Fee was negotiated as a percentage of target cost. Once established, the Fixed Fee paid by OPG does not change as actual costs change, and is subject to the incentive/disincentive mechanism. In the examples, the "contractor cost" for the Fixed Fee varies with the scenarios to represent changes in contractor overheads and profits based on changes in actual costs.

- For simplicity, an incentive or disincentive adjustment of 20% is used for target cost savings or overruns outside of the neutral band. The actual percentage is calculated using a graded approach.
- Also for simplicity, the cost categories of OSM, Reimbursable Costs and Goods assume the increased costs all include any contractor markups, and any cost savings or overruns are excluded from the Fixed Fee incentives/disincentives.
- No schedule disincentives are applied.
- The numbers may not add due to rounding.

a) In the first scenario set out in Chart 1 below, the contractor incurs a 25% cost overrun. For the fixed fee or price portions of work, there is no negative cost impact to OPG (Chart 1, lines 2, 5, 7 and 9). For the target cost portions of work, OPG reimburses the actual (allowed) costs of the contractor and pays the cost variance to the contractor (Chart 1, lines 1 and 4). For the Definition Phase Target Cost, the cost variance is $46M (Chart 1, line 1), which is outside of the $2.5M Definition Phase neutral band. The contractor must pay OPG a Definition Phase disincentive payment of $9M (Chart 1, line 3). Additionally, for the Execution Phase Target Cost, the cost variance is $417M (Chart 1, line 4), which is also outside of the Execution Phase neutral band of $75M. The contractor must pay OPG a disincentive of $68M (Chart 1, line 6). OSM and Goods are paid at actual costs and the cost overrun is paid by OPG.

Chart 1 – Contractor Cost Overrun of 25%

			% Contractor Cost Overrun = 25%				
#	Category ($ Million)	Contract Costs (from table 3)	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost (Incl RWPB)	185	231	46	0	46	231
2	Definition Phase Fixed Fee	74	92	18	18	0	74
3	Definition Phase Fixed Fee Incentive/ Disincentive				9	(9)	(9)
4	Execution Phase Target Cost	1,667	2,084	417	0	417	2,084
5	Execution Phase Fixed Fee	492	615	123	123	0	492
6	Execution Phase Fixed Fee Incentive/ Disincentive				68	(68)	(68)
7	Mock-up Fixed Price	38	48	10	10	0	38
8	Non-target Reimbursable Costs	6	8	2	0	2	8
9	Tooling Fixed Price	375	469	94	94	0	375
10	OSM with Fee(estimate)	579	724	145	0	145	724
11	Goods with Fee(estimate)	48	60	12	0	12	60
12	Total	3,464	4,329	866	322	544	4,008

b) In the second scenario set out in Chart 2 below, the contractor incurs a 50% cost overrun. For the fixed fee or price portions of work, there is no negative cost impact to OPG (Chart 2, lines 2, 5, 7 and 9). For the target cost portions of work, OPG reimburses the actual (allowed) costs of the contractor and pays the cost variance to the contractor (Chart 2, lines 1 and 4). For the Definition Phase Target Cost, the cost variance is $93M (Chart 2, line 1), which is outside of the $2.5M Definition Phase neutral band. The contractor must pay OPG a Definition Phase disincentive payment of $18M (Chart 2, line 3). Additionally, for the Execution Phase Target Cost, the cost variance is $834M (Chart 2, line 4), which is also outside of the Execution Phase neutral band of $75M. The

contractor must pay OPG an Execution Phase disincentive payment of $152M (Chart 2, line 6). OSM and Goods are paid at actual costs and the cost overrun is paid by OPG.

Chart 2 – Contractor Cost Overrun of 50%

			% Contractor Cost Overrun = 50%				
#	Category ($ Million)	Contract Costs (from table 3)	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost (Incl RWPB)	185	278	93	0	93	278
2	Definition Phase Fixed Fee	74	110	37	37	0	74
3	Definition Phase Fixed Fee Incentive/ Disincentive				18	(18)	(18)
4	Execution Phase Target Cost	1,667	2,501	834	0	834	2,501
5	Execution Phase Fixed Fee	492	738	246	246	0	492
6	Execution Phase Fixed Fee Incentive/ Disincentive				152	(152)	(152)
7	Mock-up Fixed Price	38	57	19	19	0	38
8	Non-target Reimbursable Costs	6	9	3	0	3	9
9	Tooling Fixed Price	375	563	188	188	0	375
10	OSM with Fee(estimate)	579	869	290	0	290	869
11	Goods with Fee(estimate)	48	72	24	0	24	72
12	Total	3,464	5,195	1,732	659	1,073	4,536

c) In the third scenario set out in Chart 3 below, the contractor incurs a 75% cost overrun. For the fixed fee or price portions of work, there is no negative cost impact to OPG (Chart 3, lines 2, 5, 7 and 9). For the target cost portions of work, OPG reimburses the actual (allowed) costs of the contractor and pays the cost variance to the contractor (Chart 3, lines 1 and 4). For the Definition Phase Target Cost, the cost variance is $139M (Chart 3, line 1), which is outside of the $2.5M Definition Phase neutral band. The contractor must pay OPG a Definition Phase disincentive payment of $27M (Chart 3, line 3). Additionally, for the Execution Phase Target Cost, the cost variance is $1,250M (Chart 3, line 4), which is also outside of the Execution Phase neutral band of $75M. The contractor must pay OPG an Execution Phase disincentive payment of $235M (Chart 3, line 6). OSM and Goods are paid at actual costs and the cost overrun is paid by OPG.

Chart 3 – Contractor Cost Overrun of 75%

			% Contractor Cost Overrun = 75%				
#	Category ($ Million)	Contract Costs (from table 3)	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost (Incl RWPB)	185	324	139	0	139	324
2	Definition Phase Fixed Fee	74	129	55	55	0	74
3	Definition Phase Fixed Fee Incentive/ Disincentive				27	(27)	(27)
4	Execution Phase Target Cost	1,667	2,917	1,250	0	1,250	2,917
5	Execution Phase Fixed Fee	492	861	369	369	0	492
6	Execution Phase Fixed Fee Incentive/ Disincentive				235	(235)	(235)
7	Mock-up Fixed Price	38	67	29	29	0	38
8	Non-target Reimbursable Costs	6	11	5	0	5	11
9	Tooling Fixed Price	375	656	281	281	0	375
10	OSM with Fee(estimate)	579	1,013	434	0	434	1,013
11	Goods with Fee(estimate)	48	84	36	0	36	84
12	Total	3,464	6,061	2,598	996	1,601	5,065

d) In the fourth scenario set out in Chart 4 below, the contractor incurs a 100% cost overrun. For the fixed fee or price portions of work, there is no negative cost impact to OPG (Chart 4, lines 2, 5, 7 and 9). For the target cost portions of work, OPG reimburses the actual (allowed) costs of the contractor and pays the cost variance to the contractor (Chart 4, lines 1 and 4). For the Definition Phase Target Cost, the cost variance is $185M (Chart 4, line 1), which is outside of the $2.5M Definition Phase neutral band. Because the Definition Phase Cost Disincentive is capped at 48% of the Definition Phase Fixed Fee, the contractor must pay OPG a Definition Phase disincentive payment of $35M (as opposed to $36M) (Chart 4, line 3). Additionally, for the Execution Phase Target Cost, the cost variance is $1,667M (Chart 4, line 4), which is also outside of the Execution Phase neutral band of $75M. Similarly, because the Execution Phase Cost Disincentive is capped at 48% of the Execution Phase Fixed Fee, the contractor must pay OPG an Execution Phase disincentive payment of $236M (as opposed to $318M) (Chart 4, line 6). OSM and Goods are paid at actual costs and the cost overrun is paid by OPG.

Chart 4 – Contractor Cost Overrun of 100%

			% Contractor Cost Overrun = 100%				
#	Category ($ Million)	Contract Costs (from table 3)	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost (Incl RWPB)	185	370	185	0	185	370
2	Definition Phase Fixed Fee	74	147	74	74	0	74
3	Definition Phase Fixed Fee Incentive/ Disincentive				35	(35)	(35)
4	Execution Phase Target Cost	1,667	3,334	1,667	0	1,667	3,334
5	Execution Phase Fixed Fee	492	984	492	492	0	492
6	Execution Phase Fixed Fee Incentive/ Disincentive				236	(236)	(236)
7	Mock-up Fixed Price	38	76	38	38	0	38
8	Non-target Reimbursable Costs	6	12	6	0	6	12
9	Tooling Fixed Price	375	750	375	375	0	375
10	OSM with Fee(estimate)	579	1,158	579	0	579	1,158
11	Goods with Fee(estimate)	48	96	48	0	48	96
12	Total	3,464	6,927	3,464	1,250	2,214	5,677

SEC Interrogatory #16

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/3/p.15]

With respect to the $333 Engineering Services and Equipment Supply contract with Alstom as part of the Turbine Generator work bundle:

a. Please explain how OPG can demonstrate the reasonableness of the contract if it was conducted on a sole source basis.

b. Please explain what analysis was undertaken to reach the conclusion that the OEM was the best option to undertake the work project.

c. Please provide copies of all reports, analysis, opinion, evaluations and/or assessments undertaken by or for OPG, regarding the appropriateness of the contract being awarded on a sole source basis.

d. Please provide a similar chart as that provided for the RFR Target Pricing (Chart 1-4, D2/2/3), for each of the following cost scenarios Engineering Services and Equipment Supply contract:

   i. Contractor cost savings of 1%
   ii. Contractor cost savings of 10%
   iii. Contractor cost overrun of 1%
   iv. Contractor cost overrun of 10%

Response

a. As specified in section 3.3 of Ex. D2-2-3, the turbine generator sets are highly specialized machines designed and manufactured to order specifically for the Darlington Nuclear Generating Station by BBC Brown Boveri Canada Inc. Through a series of corporate mergers and acquisitions, Alstom Power Canada Inc. is the original equipment manufacturer (OEM). Following OPG's procurement process, OPG determined that single sourcing with the OEM mitigates compatibility risk and eliminates reverse engineering risk, as well as provides value for money for OPG. The detailed review OPG

underwent is set out in the Darlington Turbine Generator Equipment Single Source Justification memo included as Attachment 1.

b. As set out in Attachment 1, OPG conducted and engaged in many studies in order to determine if the single sourced agreement represented value for money, including:

- an evaluation and validation of the scope identified for the turbine generator project by an independent third party;
- obtaining an independent third party estimate;
- a detailed evaluation of Alstom's proposal by an experienced team of commercial and finance professionals;
- review of OPG's historical costs for similar equipment and services; and
- obtaining a benchmarking report from Alstom comparing prices charged to OPG with prices charged to other customers for similar work.

c. Please see the following documents attached:

- Darlington Turbine Generator Equipment Single Source Justification summary memo (Attachment 1). The appendices to the memo are voluminous and contain confidential and proprietary information, and have not been included.
- Contracting Strategy for Turbine Generators (L-4.3-15 SEC-031, Attachment 3).
- Turbine Generator Refurbishment Project Alternate Contracting Plan (L-4.3-15 SEC-031, Attachment 4).
- Concentric Energy Advisor’s Assessment of Commercial Strategies Developed for the Darlington Refurbishment Project’s Turbine Generators Work Package, previously filed in EB-2013-0321 at Ex. D2-2-1, Attachment 7-2, and re-attached here as Attachment 2.

d. OPG provides the requested scenarios below as illustrative examples to demonstrate how the Turbine Generators (TG) Engineering Services and Equipment Supply (ESES) contract mechanisms, incentives and disincentives work. For all of the scenarios below, the following features and assumptions apply:

- Cost estimates are based on Amendment 2 to the TG ESES.
- The majority of the TG ESES is fixed/firm price. The work for the first unit is fixed price, and the remaining units are firm price. For simplicity, the fixed/firm portions of the contract are assumed to be all fixed.
- For the target cost portion of the work, 50% of any cost savings and overruns will be paid as incentives and disincentives respectively.
- There is no neutral band for cost incentives or cost disincentives.
- The reimbursable items (including shipping, travel, and other expenses) are estimated amounts only.
- No schedule disincentives are applied.
- The numbers may not add due to rounding.

In the first scenario set out in Chart 1 below, the contractor achieves a 1 per cent cost savings. For the fixed price portions of work, there is no impact to OPG (Chart 1, line 1). For the target cost portions of work, OPG shares in the contractor's cost savings as the contractor is reimbursed for only its actual costs incurred (Chart 1, lines 2 and 4). A payment equal to half of the cost savings is then paid to the contractor as an incentive payment (Chart 1, lines 3 and 5). Reimbursable items are paid at the lower, actual costs.

Chart 1 – Illustrative Example of the TG ESES Contract (Contractor 1% Cost Savings)

			% Contractor Cost Savings 1%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Fixed/ Firm Cost (Equipment Supply)	256.7	254.2	(2.6)	(2.6)	0	256.7
2	Target Cost (Installation & Static Commissioning)	38.5	38.1	(0.4)	0	(0.4)	38.1
3	Target Cost Incentive				(0.2)	0.2	0.2
4	Target Cost (Dynamic Commissioning)	14.0	13.8	(0.1)	0	(0.1)	13.8
5	Target Cost Incentive				(0.1)	0.1	0.1
6	Reimbursable (no markup)	28.2	27.9	(0.3)	0	(0.3)	27.9
7	Total	337.4	334.0	(3.4)	(2.8)	(0.5)	336.8

In the second scenario set out in Chart 2 below, the contractor achieves a 10 per cent cost savings. For the fixed price portions of work, there is no impact to OPG (Chart 2, line 1). For the target cost portions of work, OPG shares in the contractor's cost savings as the contractor is reimbursed for only its actual costs incurred (Chart 2, lines 2 and 4). A payment equal to half of the cost savings is then paid to the contractor as an incentive payment (Chart 1, lines 3 and 5). Reimbursable items are paid at the lower, actual costs.

Chart 2 – Illustrative Example of the TG ESES Contract (Contractor 10% Cost Savings)

			% Contractor Cost Savings 10%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Fixed/ Firm Cost (Equipment Supply)	256.7	231.1	(25.7)	(25.7)	0	256.7
2	Target Cost (Installation & Static Commissioning)	38.5	34.6	(3.8)	0	(3.8)	34.6
3	Target Cost Incentive				(1.9)	1.9	1.9
4	Target Cost (Dynamic Commissioning)	14.0	12.6	(1.4)	0	(1.4)	12.6
5	Target Cost Incentive				(0.7)	0.7	0.7
6	Reimbursable (no markup)	28.2	25.4	(2.8)	0	(2.8)	25.4
7	Total	337.4	303.6	(33.7)	(28.3)	(5.4)	331.9

In the third scenario set out in Chart 3 below, the contractor incurs a 1 per cent cost overrun. For the fixed price portions of work, there is no negative cost impact to OPG (Chart 3, line 1). For the target cost portions of work, OPG reimburses the actual costs of the contractor and pays the cost variance to the contractor (Chart 3, lines 2 and 4). However, the contractor will pay to OPG a disincentive payment equal to 50 per cent of

the cost overrun (Chart 3, lines 3 and 5). Reimbursable items are paid at the actual costs.

Chart 3 – Illustrative Example of the TG ESES Contract (Contractor 1% Cost Overrun)

			% Contractor Cost Overrun = 1%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Fixed/ Firm Cost (Equipment Supply)	256.7	259.3	2.6	2.6	0	256.7
2	Target Cost (Installation & Static Commissioning)	38.5	38.8	0.4	0	0.4	38.8
3	Target Cost Disincentive				0.2	(0.2)	(0.2)
4	Target Cost (Dynamic Commissioning)	14.0	14.1	0.1	0	0.1	14.1
5	Target Cost Disincentive				0.1	(0.1)	(0.1)
6	Reimbursable (no markup)	28.2	28.5	0.3	0	0.3	28.5
7	Total	337.4	340.8	3.4	2.8	0.5	337.9

In the fourth scenario set out in Chart 4 below, the contractor incurs a 10 per cent cost overrun. For the fixed price portions of work, there is no negative cost impact to OPG (Chart 4, line 1). For the target cost portions of work, OPG reimburses the actual costs of the contractor and pays the cost variance to the contractor (Chart 4, lines 2 and 4). However, the contractor will pay to OPG a disincentive payment equal to 50 per cent of the cost overrun (Chart 4, lines 3 and 5). Reimbursable items are paid at the actual costs.

Chart 4 – Illustrative Example of the TG ESES Contract (Contractor 10% Cost Overrun)

			% Contractor Cost Overrun = 10%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Fixed/ Firm Cost (Equipment Supply)	256.7	282.4	25.7	25.7	0	256.7
2	Target Cost (Installation & Static Commissioning)	38.5	42.3	3.8	0	3.8	42.3
3	Target Cost Disincentive				1.9	(1.9)	(1.9)
4	Target Cost (Dynamic Commissioning)	14.0	15.4	1.4	0	1.4	15.4
5	Target Cost Disincentive				0.7	(0.7)	(0.7)
6	Reimbursable (no markup)	28.2	31.1	2.8	0	2.8	31.1
7	Total	337.4	371.1	33.7	28.3	5.4	342.8

ONTARIO POWER GENERATION

Report

OPG Confidential	
Document Number: NK38-REP-09701-10172	Usage Classification: N/A
Retention: N/A	Revision: R000

Title:
DARLINGTON TURBINE GENERATOR EQUIPMENT SINGLE SOURCE JUSTIFICATION

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Darlington Turbine Generator Equipment Single Source Justification

NK38-REP-09701-10172-R000

2013-03-18

OPG Confidential

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2013-03-19

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2013-03-19

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1.0 EXECUTIVE SUMMARY

This Single Source Justification (SSJ) report provides the justification for the approval of the attached OPG-FORM-0003 (Single/Sole Source Justification), (attached as Exhibit 1), for the Darlington Refurbishment Turbine Generator Project Engineering Services and Equipment Supply Agreement between OPG and Alstom Power and Transport Canada Inc.

The SSJ is based on the allowable criteria set out in OPG-PROC-0058 (Procurement Activities), in particular:

- to ensure compatibility with existing products; or
- to maintain specialized products.

Furthermore, the single source strategy provides value for money for OPG, as shown through comparisons to independent estimates and benchmarking.

The contract value is approximately $395M.

2.0 BACKGROUND INFORMATION

The Turbine Generator ("TG") Project is one of seven major projects under the Darlington Refurbishment Program. The Darlington turbine generator sets, auxiliaries, and controls are highly specialized equipment designed and supplied as an integrated system for the Darlington station by Alstom, the Original Equipment Manufacturer ("OEM"). OPG has determined that the most cost effective way to refurbish and extend the life of the Darlington turbine generator sets is through targeted work packages, as opposed to an overall steam path retrofit. Five Scope of Supply documents were developed by the project team to undertake the project:

- Turbines and Auxiliaries Refurbishment
- Generator and Auxiliaries Refurbishment
- Moisture Separator Reheater Refurbishment
- Turbine Controls Replacement / Upgrade
- Generator Excitation Controls Replacement / Upgrade

The TG project scope of supply documents have been developed based on a comprehensive review of the station's operating history, OPG's operating experience ("OPEX"), and results from Component Condition Assessments ("CCAs") and were approved by the Darlington Refurbishment Scope Review Board.

The Contracting Strategy Summary for Turbine Generators document NK38-09701-10030 R000 (Exhibit 3) describes the pros and cons of the available options for undertaking the TG project.

OPG unsuccessfully attempted to negotiate an EPC contract for the entire TG project Scope of Work ("SOW") with the OEM. Then, in accordance with the contracting strategy document, the project team developed Plan B -Turbine Generator Refurbishment Project Alternate Contracting Plan NK38-09701-10112 R000 (Exhibit 4). The alternate contracting plan involved negotiating an Engineering Services and Equipment Supply Agreement with the OEM.

On October 9th, 2012, OPG issued a Request for Expressions of Interest ("EOI") to evaluate market capability for the project work scope not contemplated in the Engineering Services and Equipment Supply Agreement, and to evaluate market capability to perform the engineering services and equipment work scope in the event of the failure of negotiations with the OEM. The EOI was issued to 13 prospective proponents (excluding the TG OEM), and 9 companies expressed interest in all or parts of the project SOW and will be used to competitively bid the Engineering Integration and Construction work.

3.0 KEY RISKS

The Darlington turbine generator equipment is both unique and highly specialized equipment designed and supplied as an integrated system for the station by the OEM. The OEM has provided parts, specialized services, and engineering for the turbine generator equipment for the last 25 years. The turbine rotors / spindles have never been removed, which presents a specific risk if executed without the involvement and support of the OEM. A mix of OEM and non-OEM components may increase operational risks of the units post refurbishment; in the worst case, forced loss rate may be impacted. The scope for the turbine generator project is not a steam path retrofit and involves numerous discrete components and highly integrated systems which require significant reverse engineering to mitigate key technical risks. Reverse engineered components may drive compatibility risks, further costs during commissioning, and lost revenue that could be significantly higher than reverse engineering costs. In addition, past experience for scope of this complexity and type of work has confirmed the OEM is best able to manage key technical risks which could have significant implications in terms of project cost and schedule as well as potential operational impacts.

4.0 SINGLE SOURCE JUSTIFICATION APPROACH

OPG procedure OPG-PROC-0058, section 1.5.3 (d) (7) states that single sourcing is permitted:

"Where only one supplier is able to meet the requirement in the following circumstances: to ensure **compatibility** with existing products, to recognize exclusive rights, such as exclusive licenses, copyright, and patent rights, or to maintain **specialized products** that must be maintained by the manufacturer or its representatives."

This report also provides justification that OPG will receive value for money through the single sourcing strategy.

4.1 Single Source Technical Considerations

4.1.1 Compatibility with Existing Products

Single sourcing engineering services and equipment with the OEM ensures compatibility with the existing Darlington Turbine Generator sets based on the following considerations:

- reverse engineering by non-OEM may lead to unacceptable compatibility risk, latent problems, and major impact on cost and schedule;
- the OEM is capable of manufacturing and replacing compatible Turbine Generator hardware within a reasonable timeframe; and
- compatible interfacing of the control systems and generator excitation with the TG hydraulics is paramount.

An independent 3rd party technical review was performed by specialists from Burns& Roe (acting as a sub-consultant to Worley Parsons) on the TG scope (Exhibit 5). The report describes key technical project risks which OPG has considered and are mitigated or eliminated by obtaining compatible products from the OEM. The main TG compatibility risks identified in the report are:

- integration risk with existing systems and equipment if the work is awarded to a non-OEM vendor that does not have the optimal technical knowledge and full understanding of the complexity of the TG scope and adjacent plant systems;
- integration risk of TG sets if the TG project SOW is unbundled;
- reverse engineering risk if part or all of the SOW is awarded to a non-OEM manufacturer that does not have the required TG design basis documentation;
- latent defect risk if part or all of the SOW is awarded to a non-OEM manufacturer that does not have the required TG design basis documentation; and
- complexity / compatibility / interfacing risks if the TG Project SOW is unbundled and part or all of the SOW is awarded to a non-OEM manufacturer that does not have required TG design basis documentation.

4.1.2 Maintenance of Specialized Products

The Darlington TG sets are specialized products that have been maintained by OPG with ongoing technical support from the OEM. The turbine generator maintenance requires complex activities and highly specialized workforce due to unique design.

OPG does not currently possess the technical documentation that would be required to support a competitive sourcing strategy. OPG assessed the gaps between existing access to documentation, and the documentation that would be required to support a competitive sourcing strategy. Results are shown in Exhibit 6.

The potential costs to acquire the necessary documentation that OPG does not currently possess were assessed by Faithful & Gould. (Exhibit 7).

4.1.2.1 D.C. Cook OPEX

D.C. Cook is a two unit nuclear power plant located in Michigan. One of the two units has a Brown Boveri Corporation (BBC) turbine generator set that is similar in design to the Darlington sets. BBC is a predecessor company of Alstom. D.C. Cook is the only generating station that OPG has identified as having a similar design to the Darlington design.

D.C. Cook's turbine generator contracting strategies have involved single sourcing of maintenance work to Alstom, and competitively bidding their steam path retrofit work. This aligns with OPG's approach since OPG's refurbishment scope is comparable to maintenance work and is substantially different from a steam path retrofit since a steam path retrofit involves replacement of an entire system rather than integrating with existing components. Exhibit 8 provides details of OPG's communication regarding DC Cook.

4.2 Value for Money

In order to determine if the single sourced agreement represents value for money, the team employed several tools including:

- an evaluation and validation of the scope identified for the TG project by an independent third party (Burns & Roe, as a sub-consultant to Worley Parsons);
- obtaining an independent third party estimate from a reputable multi-national consultancy (F&G);
- a detailed evaluation of Alstom's proposal by an experienced team of commercial and finance professionals;
- review of OPG's historical costs for similar equipment and services; and
- obtaining a benchmarking report from Alstom comparing prices charged to OPG with prices charged to other customers for similar work.

4.2.1 Third Party Estimate of RFP Prerequisites

As noted in section 4.1.2, F&G performed a third party analysis to quantify the costs associated with obtaining the design basis information that is necessary to facilitate a competitive contracting strategy. A competitive strategy would increase the total project estimated cost and OPG would be exposed to latent defects that could lead to significant problems during the return to service and operation periods. Single sourcing mitigates the reverse engineering risk.

Even after possibly obtaining design basis information from the OEM, it would be difficult to arrange a fair competitive request for proposals process that provided a level playing field for all proponents due to the OEM's inherent advantage gained through manufacturing and maintaining the specialized Darlington equipment.

4.2.2 Evaluation of Alstom's Pricing Proposal

The scope of work for the contract was independently estimated by F&G using OPG Nuclear internal data, external benchmarking and industry norms. F&G's report is included in Exhibit 9.

The F&G estimate became the basis for the pricing team evaluation of Alstom's comprehensive pricing submission provided on January 31, 2013. The pricing evaluation team report is included as Exhibit 10. The pricing team concluded that after adjusting for differences in scope assumptions between the F&G estimate and the Alstom proposal, Alstom's pricing is generally aligned with the estimate. The pricing team also advised the negotiating team to address several issues, such as adjusting the milestone payment schedule and clarifying discounts on spare part prices and technical advisor rates. The issues have since been addressed as noted in the introduction to Exhibit 10.

4.2.3 Alstom Benchmarking Data

Alstom has provided a benchmarking report that is included as Exhibit 11. Alstom's report shows that OPG's prices are competitive when compared to prices charged to other customers for similar work on a cost per unit of electrical output basis. Alstom's report also provides additional justification for project management and project support costs as requested by the OPG pricing evaluation team.

4.2.4 OPG Benchmarking Data

F&G's estimate included input from historical pricing information stored in OPG's Asset Suite software system.

Once specific part numbers were identified in Alstom's comprehensive submission of January 31, 2013, the prices for parts identified the submission that OPG has previously purchased were compared with prices in Asset Suite. The results of the comparison show that Alstom's proposed part prices are, on average, lower than the prices that OPG has paid in the past. This represents an expected discount that is justified by the volume of work included in this agreement. See Exhibit 12.

Prices for parts purchased from Alstom by OPG's Hydro/Thermal Division as recorded in the SAP system were also reviewed. The review determined that there were no relevant comparable parts between the Thermal database and Alstom's proposal. See Exhibit 12.

Recent agreements and competitive proposals for services similar to the services provided by Alstom's Technical Field Advisors (TFAs) were reviewed. The TFA rates are relatively high but are in line with the rates charged by other manufacturers of complex engineered equipment. See Exhibit 12.

5.0 CONCLUSION

Single sourcing with the OEM mitigates compatibility risk and eliminates reverse engineering risk. Project management, oversight, and technical support risks are further mitigated by bundling the engineering service and equipment supply scope, rather than unbundling the scope which would result in increased compatibility and integration risk.

The remainder of the Darlington Turbine Generator Refurbishment scope will be competitively sourced. The remainder of the scope includes engineering integration work and installation of the equipment supplied by the OEM.

6.0 EXHIBITS

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CONCENTRIC ENERGY ADVISORS

ASSESSMENT OF COMMERCIAL STRATEGIES DEVELOPED FOR THE DARLINGTON REFURBISHMENT PROJECT'S TURBINE GENERATORS WORK PACKAGE

PREPARED FOR ONTARIO POWER GENERATION

SEPTEMBER 2013

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CONCENTRIC ENERGY ADVISORS

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I. EXECUTIVE SUMMARY

On September 9, 2011, Tory's LLP retained Concentric Energy Advisors, Inc. ("Concentric") to review the commercial strategies and contracts developed and implemented for the refurbishment of four CANDU heavy water reactors at Ontario Power Generation, Inc's ("Ontario Power Generation's" or the "Company's") Darlington Nuclear Generating Station ("Darlington" or the "Plant").[1] The Darlington Refurbishment Project (the "Project") will include the removal and replacement of the reactor calandria tubes and pressure tubes from each reactor, the replacement of all feeders, the refurbishment of the existing fuel handling equipment, the refurbishment of the existing turbine generators (referred to herein as the "Turbine Generators work package"), and the refurbishment of the existing steam generators, among many other tasks. The plant modifications are currently planned to be made during overlapping 36-month outages for each of the four Darlington units between October 2016 and 2024.[2] However, the Company is currently conducting an evaluation of the business case for un-lapping the refurbishment execution of the first two units. Under this scenario, the first refurbishment outage would be conducted on Unit 2 between Fall 2016 and Fall 2019. The remaining outages will occur between Fall 2019 and Fall 2025 with approximately 17 to 19 months of overlap between each successive outage. The Company expects to reach a decision on whether to proceed with this revised Project calendar in November 2013.

Prior to commencing the execution phase work, Ontario Power Generation has committed to undertaking significant planning activities, which include working to develop and implement appropriate commercial strategies for the Project, to better prepare for a project of this magnitude. Concentric was engaged to review the Company's commercial strategies and how these strategies are being implemented. This report summarizes Concentric's review and opinion of the current Turbine Generators work package commercial strategy.

The Project is following a standard megaproject progression that includes the following phases: (1) project initiation; (2) definition; (3) execution; (4) commissioning; and (5) project closeout. In the project initiation phase, a project is evaluated for its initial feasibility based on relatively high-level information that is readily available. Should a project prove feasible during the project initiation phase, it will proceed into the definition phase. During the definition phase, the project team undertakes more detailed reviews of the project's anticipated scope, cost, and schedule to begin to define the activities that must be completed during the project, when those activities must be completed, and how much those activities are expected to cost. Concurrently, the project team begins to define the commercial strategies expected to be employed. Later during the definition phase, the project team is responsible for: (1) identifying, procuring and fabricating all long lead materials, components and tooling; (2) executing all of the necessary agreements to proceed with the major work packages; (3) completing the detailed scope and project schedule; and (4) developing a "release quality" cost and schedule estimate from which the project's performance can be measured. The release quality estimate and the integrated schedule available at the conclusion of the definition phase are more defined than prior iterations of the cost estimate and integrated schedule, yet both still contain uncertainty. Following the definition phase, a project enters the execution phase during which the actual plant modifications will take place. This stage is followed by the commissioning and project closeout phases.

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1 As used in this context, commercial strategies refers to the processes by which Ontario Power Generation will procure goods and services for the Darlington Refurbishment Project.

2 As a practical matter, initial planning for the Project began in 2006 with the initiation of feasibility studies and plant technical assessments. Thus, from the Project's initiation to closeout, the Project will span nearly 20 years.

During these phases, the project team brings the project online and completes all of the recordkeeping associated with the project.

The initiation phase of the Project began in late 2007 with the preparation of a business case that evaluated, at a high level, the overall feasibility of completing the Project. In November 2009, the Project sought and received authorization from the Ontario Power Generation Board of Directors to proceed with the planning portion of the definition phase. In February 2010, the Ministry of Energy concurred with the Board of Directors' decision. To execute the work, Ontario Power Generation will retain multiple contractors for discrete portions of the Project work known as work packages. Consistent with this approach, Ontario Power Generation has proposed dividing the work into multiple major work packages, of which the Turbine Generators work package is one.

As part of that process, the Company is currently pursuing contracts with qualified vendors for two separate scopes of work related to the Turbine Generators work package. The first scope of work, for Engineering Services and Equipment Supply, has been negotiated on a single-source basis with Alstom, the Original Equipment Manufacturer ("OEM"). The remaining scope, which will primarily involve additional engineering and on-site construction, is being pursued through a bundled, reduced-scope Engineering Procurement and Construction ("EPC") arrangement sourced through a competitive process that began in May 2013. Throughout the balance of this phase of the Project, the Company and its vendors will complete planning and design for the Turbine Generators work packages, execute project agreements, and develop a release quality cost estimate, among many other activities.

II. SUMMARY OF CONCLUSIONS

As discussed below, Concentric concluded that, based on activities that have taken place between late 2009 and August 1, 2013, the commercial strategy Ontario Power Generation is employing for the Turbine Generators work package is appropriate and reasonable and meets the regulatory standard of prudence.

Concentric's opinion is not without certain caveats and limitations, which are discussed in the sections that follow. Similarly, the basis for our opinions are described throughout the remainder of this document.

III. STANDARD OF REVIEW

To conduct our review of the commercial strategy selected by Ontario Power Generation for the Turbine Generators work package, Concentric sought to answer three primary questions:

1) Is the commercial strategy selected by Ontario Power Generation for the Turbine Generators work package reasonable?

2) Is the Company executing that commercial strategy in a reasonable manner?

3) Do the selected commercial strategy and the execution of that strategy meet the regulatory standard of prudence?

To answer these questions, Concentric adopted a definition for the regulatory standard of prudence based on Concentric's work before state, provincial and federal energy regulators in both Canada and the United States. The definition utilized by Concentric is consistent with decisions rendered by the Ontario Superior Court of

Justice,[3] the Court of Appeal for Ontario,[4] the Ontario Energy Board,[5] and the U.S. Supreme Court,[6] among other jurisdictions. Specifically, Concentric defined the prudence standard as examining the range of actions that a reasonable manager would take given the facts or circumstances that were known or knowable at the time of the decision or action. That definition rejects the use of hindsight as a basis for determining the prudence of a decision or action. In addition, that definition relies on an evaluation of decisions or actions. Project costs are neither prudent nor imprudent; instead, costs are prudently or imprudently incurred as a consequence of the decisions and actions of management.

In this report, Concentric provides its assessment of the Company's development and execution of its commercial strategy for the Turbine Generators work package in the context of the above-described standard of prudence review. In particular, Concentric is providing its opinion on the prudence and reasonableness of Ontario Power Generation's decisions to:

1) Initially concentrate its efforts on a single-source EPC agreement with the Turbine Generator OEM for the full scope of work ("Plan A");

2) Transition to an alternative, "Plan B," contracting strategy; and

3) Concentrate its efforts on a bundled, reduced scope EPC-style arrangement with a single vendor through a competitive process, but with considerable involvement of the OEM in an "Engineering Services and Equipment Supply" arrangement.

These decisions are discussed in greater detail in the sections that follow.

IV. INFORMATION SOURCES

Our review and the development of our opinions relied on three primary information sources. First, Concentric submitted multiple rounds of data requests for information related to the Turbine Generators work package. Second, Concentric performed independent research on topics including lessons learned and the experiences of other CANDU operators performing similar projects, the Canadian nuclear safety regime, and industry trends and practices for other large nuclear refurbishment projects that included major modifications to turbine generators. Third, Concentric conducted in-person and telephone interviews with members of the Turbine Generator refurbishment project team.

V. GENERAL LIMITATIONS OF CONCENTRIC'S OPINION

The following are general limitations regarding the scope of our review:

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3 2005 CanLII 4941 (Ont. Div. Ct.).

4 Court of Appeal for Ontario Decision, Docket: C55602, C55641 and C55633, June 4, 2013.

5 Decision with Reasons, RP-2001-0032, December 13, 2002. This Decision deals with Enbridge Gas Distribution Inc.'s (formerly Enbridge Consumers Gas or ECG) application for a Board Order approving rates for the 2002 Test Year.

6 Separate, concurring opinion of Justice Louis Brandeis, Missouri ex. Rel. Southwestern Bell Telephone Co. v. Public Service Commission, 262 U.S. 276 (1923).

- First, our review is limited to Ontario Power Generation's actions and documents prepared between late 2009 and [August 1, 2013].[7] Concentric did not review Ontario Power Generation's actions related to the Project prior to or after that time period.
- Next, Concentric did not independently verify the appropriateness, sufficiency, or correctness of the project schedules, cost estimates, scope, or, from an engineering perspective, the division of responsibilities. However, Concentric was informed of the processes used to develop these items, and we reviewed assessments from outside experts that were engaged by the Company specifically to evaluate whether the Project and commercial terms with key vendors are consistent with similar projects throughout the industry.
- Concentric evaluated the division of responsibilities between the two key vendors at a high level, but is not providing an opinion on the appropriateness of the division of those responsibilities from an engineering perspective. We understand that the OEM will provide Engineering Services and Equipment Supply, and that the scope of work to be completed by a separate vendor under the EPC contract will include the original scope of work with equipment and technical oversight work removed.

  Concentric's opinion does not consider whether this division of responsibilities is practicable from the perspective of vendors that may respond to the Request for Proposals ("RFP") for the construction-oriented balance of work. We do note, however, that the Company received multiple expressions of interest from potential third party vendors to work with the OEM on the Project.
- In addition, Concentric assumed Ontario Power Generation will retain adequately qualified personnel to complete the Project generally, and the Turbine Generators work package specifically. Those resources are critical to the success of the project, and may be sourced internally, hired directly, or engaged through contracts with third parties.
- Concentric did not perform a compliance audit to determine whether Ontario Power Generation and the Project were in compliance with Ontario Power Generation's internal policies, procedures, instructions and guidelines, or applicable provincial and federal regulations. Similarly, Concentric did not conduct a legal review of Ontario Power Generation's agreements or proposed agreements with any contractors. Notwithstanding that limitation, Concentric did review relevant Ontario Power Generation internal policies and procedures, and relevant provincial and federal laws and regulations when developing our opinion.
- Finally, Concentric's review is not an assessment of the Project's likelihood of success. Successful execution of the Project generally and the Turbine Generators work package specifically will require the efforts of many entities and individuals over many years, and the development and implementation of the Project's commercial strategies is only one contributor to project success.

[7] The beginning of the period Concentric reviewed is roughly concurrent with Ontario Power Generation's completion of the Economic Feasibility Assessment of Darlington Refurbishment dated November 13, 2009. However, portions of the operational experience material reviewed by Concentric were prepared prior to this time.

VI. TURBINE GENERATORS WORK PACKAGE COMMERCIAL STRATEGY

A. OVERVIEW

Ontario Power Generation's Turbine Generator project team was established in March 2011 and included representation from a broad array of groups within the Company, including Engineering, Execution, Supply Chain, and Contract Management. In addition, input for the Turbine Generator refurbishment work was gathered from Law (internal and external), Finance, Darlington Refurbishment Planning and Control, and the Hydro Supply Chain organization. The team's progress in developing a commercial strategy was communicated on a regular basis to the appropriate members of the Ontario Power Generation corporate and Refurbishment Project leadership teams.

As is documented in the Contracting Strategy for Turbine Generators, the Project team was focused on achieving an additional 25-30 years of operations at Darlington through a Turbine Generator refurbishment project that minimizes risks to the degree feasible while ensuring optimal value for money.

The Darlington Turbine Generator sets were custom designed and are unique to the Darlington site. The units were initially designed, manufactured, and installed by Brown Boveri Canada Inc. ("BBC"), which later became a subsidiary of Asea Brown Boveri ("ABB") following a merger between BBC's parent company and ABB in 1989. The turbine generator segment of ABB was subsequently purchased by Alstom in 2000, which, by virtue of its exclusive ownership of intellectual property ("IP") and design basis engineering, is considered the OEM for the Darlington turbine generator units. Alstom, or its antecedents, has provided engineering, ongoing maintenance, and outage support services on the units since the Plant was commissioned in the early 1990s.[8]

Refurbishment of the turbine generators involves a combination of retrofits, repairs of hardware and hydraulics, and a full control-system upgrade.[9] The project consists of five discreet components:

- Steam Turbines and Turbine Auxiliaries: inspections, repairs and/or replacements of high pressure and low pressure turbine components and auxiliaries;
- Generator and Generator Auxiliaries: inspections, repairs, and /or replacements of generator components and generator auxiliaries;
- Moisture Separator Reheater: inspection, overhaul and/or replacements of Moisture Separator Reheater internals and auxiliaries;
- Turbine Controls Upgrade: Replacement of the analog Turbine Generator electronic control system with a new digital system; and
- Generator Excitation Upgrade: replacement of the Generator Excitor control system with a new digital system.

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8 Contracting Strategy for Turbine Generators, NK38-REP-09701-10021(R000). August 31, 2012, page 8.

9 *Ibid.,* page 5. Concentric understands that for Unit 2 (*i.e.,* the first unit to undergo refurbishment) the Project is considering deferring replacement of the turbine generator digital controls upgrade until a later routine outage. This proposal is still under evaluation, but is expected to lower the risk on completing the first outage schedule and cost estimates by reducing the scope of the initial refurbishment outage and the new technology introductions during that first outage.

B. INITIAL STRATEGY DEVELOPMENT

In Ontario Power Generation's evaluation of the experiences of other utilities throughout North America that have undertaken similar refurbishment projects, it became clear that there are several material advantages to maintaining the involvement of the OEM. In particular, the Company attempted to mitigate the risk of an extended outage or poor reliability of the turbine generator equipment. An event at the DC Cook Nuclear Generating Station ("DC Cook") in September 2008 is a specific example of this risk. In the DC Cook event, the plant's Unit 1 was manually tripped when the control room experienced simultaneous high vibration readings on all main turbine bearings. The ultimate damage from the event was extensive and led to a lengthy forced outage and what was at the time the highest insurance claim in the history of the US nuclear industry. The cause of the event was ultimately determined to be a design error in systems and components that were replaced by a non-OEM vendor during the refurbishment of the turbine generators. The Company also cited problems that arose at the Koeburg Nuclear Power Station, which operated for ten months prior to a failure that was the result of "shortcomings in the reverse engineering process and material receiving process."[10] Finally, Ontario Power Generation consulted Exelon Corporation ("Exelon"), which has extensive and recent experience with large retrofit, uprate, and refurbishment programs at its sites. The Company learned that Exelon considers it a best practice to engage the OEM for work on all major nuclear system components. In fact, Exelon recommended engaging a non-OEM only when conducting a full replacement of major components as opposed to retrofitting or refurbishment. Finally, in its analysis of industry experience, Ontario Power Generation learned that the recent turbine generator refurbishment work at the Point Lepreau Generating Station in New Brunswick was completed by the OEM.

In addition to concerns with safety and reliability, Ontario Power Generation was aware of the significant costs related to the IP rights and design basis engineering in the event that a non-OEM vendor were to be selected to complete the refurbishment.[11] The Company commissioned a study from Faithful & Gould, which concluded that obtaining restricted rights could cost from $22.9 to $39.1 million,[12] while reverse engineering the system specifications could cost from $26.3 to $61.5 million.[13] Intent on mitigating risk and cost to the Turbine Generator work, the Company elected to seek an agreement with Alstom, the OEM.

Ontario Power Generation initially considered unbundling the Turbine Generator refurbishment based on the scope or type of work. To assess the impact of different approaches on key project objectives and risk impacts, the Company commissioned a Kepner-Tregoe ("KT") analysis[14] of the following competing options for packaging the Turbine Generators scope of work:

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[10] *Ibid*, page 14.

[11] It is unclear whether Ontario Power Generation or Alstom owns the IP rights and design basis engineering.

[12] Obtaining unrestricted rights, which would permit a party to manufacture and sell components, would raise the range to $40.5 million to $62.1 million.

[13] This figure includes both the additional cost to the Company to allow reverse engineering, which Faithful & Gould estimate would cost from $11.7 million to $39.0 million, and the reverse engineering itself, at a cost of $14.6 million to $22.5 million. Contracting Strategy for Turbine Generators, NK38-REP-09701-10021(R000). August 31, 2012, page 14.

[14] Kepner-Tregoe, Inc., is a management consulting firm that specializes in the processes of strategy development. The KT analysis conducted for the Turbine Generators work package consisted of identifying a wide array of objectives and classifying them into two broad categories of "want" and "need." Each contracting strategy was first assessed by whether it was compatible with each "need" objective. The strategies that achieved all *need* objectives

- Unbundled scope (5 packages), competitively bid;
- Bundled scope, single-source process (OEM);
- Bundled scope, competitively bid; and
- Unbundled scope, selective sole source and competitive processes

The analysis concluded that technical integration of components and work elements from multiple vendors creates technology, reliability, project management, and operational risks that do not justify the potential benefits of using multiple vendors with specific expertise. In addition, while unbundling may provide Ontario Power Generation flexibility with respect to sourcing and procurement, it would introduce a large administrative and project management burden on the Company, and would introduce additional schedule risk. The KT analysis concluded that a bundled scope of work using a sole-source agreement with the OEM resulted in the least risk while meeting each key project objective. Ontario Power Generation also conducted an analysis of benefits and risks of contracting approaches including traditional Design-Bid-Build, EPC, and Turnkey[15] delivery and determined that the EPC approach is most effective. While there is the potential that an EPC arrangement can be more costly because of the risk-transfer to the vendor, this model reduces interfaces, significantly lowering the technology and implementation risk. Interface risk arises when work products from multiple vendors are required to work seamlessly together in combinations that have not been thoroughly tested in operational settings. For instance, there would be significant risks involved with the installation of turbine generators from one vendor and digital turbine controls from an independent vendor. The EPC model mitigates this type of risk, while also removing significant implementation and project management risk from Ontario Power Generation by minimizing staff commitments from the Company. The EPC model also involves the shortest schedule because of concurrent design and construction activities and provides greater cost certainty for the project. Finally, an EPC arrangement provides a single point of accountability for quality issues.

The variety of analyses described above resulted in Ontario Power Generation electing to pursue a fully bundled, single-sourced EPC contract with Alstom, the OEM. As discussions between Ontario Power Generation and Alstom began to take place early in 2012, however, the Company recognized the possibility that negotiations with the OEM could fail to produce an agreement that achieves the Company's key contracting objectives. Ontario Power Generation began to prepare an alternative strategy, termed its "Plan B," in June 2012 while formal negotiations with Alstom were getting underway.

C. DEVELOPMENT OF AN ALTERNATE STRATEGY ("PLAN B")

The Company considered three contracting approaches in the formation of its Plan B contracting strategy: (1) a bundled EPC-oriented model; (2) five unbundled scopes of work competitively bid separately; and (3)

(*e.g.*, "meet technical requirements") were then scored on the ability to achieve the "want" objectives (*e.g.*, "minimize level of resources (staff) required by Ontario Power Generation"), which were weighted by priority.

[15] Under a traditional Design-Bid-Build arrangement, design engineering and construction are handled sequentially. Ontario Power Generation would contract separately for design and construction, and would maintain overall project oversight and management responsibility. Under the EPC model, these roles and all associated risks are transferred to the contractor, and the design and construction phases may have significant overlaps. Under a turnkey contract, the Company would define performance specifications for the contractor, which would have wide latitude in determining the most effective means of meeting the specifications.

unbundling the scope of work into separate Engineering, Procurement, and Construction portions, each competitively bid. Throughout the development of the Plan B strategy, Ontario Power Generation remained focused on working closely with Alstom, with the OEM serving either in a subcontractor role or as part of a joint venture arrangement with an EPC vendor in order to "mitigate risks associated with reverse engineering and contracting with a non-OEM vendor."[16]

The KT analysis commissioned during the assessment of the Company's Plan A approach supported the conclusion that a bundled scope of work using an EPC contracting model was the optimal alternative. The Company's decision to continue to seek involvement of the OEM was reinforced by the Faithful & Gould assessment of the costs of obtaining the Turbine Generator design basis engineering specifications. In addition, a Worley Parsons report from September 2012 validated the Project's scope definition.

The KT analysis was prepared before the development of Ontario Power Generation's Plan B strategy. As a consequence, it did not evaluate a contracting arrangement with significant involvement of the OEM through an Engineering Services and Equipment Supply contract. We have no reason to believe that a different approach would be selected if that option were to be compared to the alternatives, but we believe the Project should document the risks that are introduced by having two major contracts to complete the Turbine Generator scope of work. This recommendation is discussed later in this report.

D. TRANSITION TO THE PLAN B COMMERCIAL STRATEGY

Indications that Alstom did not fully understand Ontario Power Generation's expectations with regard to the commitments required of an EPC vendor in the Canadian nuclear industry began to surface during the summer of 2012. Members of Ontario Power Generation's Turbine Generator Negotiations Steering Committee had concerns with Alstom's ability to satisfy the EPC Qualification process, and with requirements related to the Engineering Change Control process in particular. The team had multiple interactions with Alstom through late summer, including a series of meetings and conference calls to ensure that Ontario Power Generation and the vendor were aligned on the nature and terms and conditions of a nuclear EPC agreement. Negotiations with Alstom concluded on July 24, 2012, and a formal request for pricing was sent to Alstom on July 26, 2012.

The pricing structure the Company received in Alstom's final bid in September 2012 was more than 50% higher than the indicative pricing Alstom had delivered during negotiations just two months earlier. In addition, Ontario Power Generation's concerns that Alstom would be unable to satisfy requirements for EPC contractors in the Canadian nuclear industry remained. The Company noted that while Alstom had developed preliminary plans for engineering Quality Assurance ("QA") programs during negotiations in the summer of 2012, there were strong indications that those QA plans would not be robust enough to execute the project, including supervision of construction trades in Ontario.[17] Additionally, Ontario Power Generation was not confident that Alstom could implement the plans on the schedule required to proceed with EPC contracting.

After evaluating Alstom's proposal, Ontario Power Generation concluded that it would not be possible to negotiate a satisfactory agreement in terms of value for money, commercial terms, and an appropriate

[16] Turbine Generator Refurbishment Project Alternate Contracting Plan, NK38-PLAN-09701-10112 (R000). November 11, 2012.

[17] Meeting Notes – Turbine Generator Negotiations Steering Committee Meeting #4 (September 10, 2012).

allocation of risk. As a result, Ontario Power Generation decided to pivot from its focus on a bundled EPC contract with the Turbine Generator OEM to an alternate contracting strategy. While that decision had significant implications for the Project (the secondary approach is expected to add approximately 18 months to the non-critical-path elements of the Turbine Generator procurement process) the additional time was contemplated in developing the overall schedule for the Turbine Generator work package, and is not expected to affect the overall Project schedule. Concentric has concluded that Ontario Power Generation's recognition of deficiencies in Alstom's Quality Assurance programs was appropriate. Many other organizations in the North American nuclear industry have struggled to recognize similar problems, and have experienced significant problems related to project oversight and technology integration.[18]

E. EXECUTION OF THE COMPANY'S PLAN B STRATEGY

Ontario Power Generation officially pivoted to the Plan B strategy in early October 2012. The Company issued a Request for Expressions of Interest in order to determine whether there was sufficient interest among qualified nuclear engineering and construction firms to bid for two potential types of work:

1) The remaining project work scope that would not be completed by Alstom through an Engineering Services and Supply Agreement; and

2) The full Turbine Generator refurbishment scope of work in the event that negotiations with Alstom for Engineering Services and Equipment Supply were unsuccessful.

In December 2012, Ontario Power Generation received positive indications from contractors interested in bidding on both approaches. Expecting that it would find sufficient interest in working closely with Alstom among potential vendors, and in order to minimize schedule impacts related to engineering and design of the turbine controls, in October 2013 Ontario Power Generation began to pursue a commercial arrangement with the OEM limited to Engineering Support and Equipment Supply. This approach was intended to alleviate the Company's concerns with Alstom's ability to meet the requirements of a nuclear EPC vendor while mitigating the cost, technology, and integration risks of moving forward on a project of this magnitude without the OEM. The Company and Alstom reached agreement on terms and conditions in December 2012, and pricing elements were put in place. Subsequently, by early March 2013, Ontario Power Generation's discussions with Alstom for the limited Engineering Support and Equipment Supply scope yielded a contract with several features that are favorable to the Company's interests and priorities.

The contract provides Ontario Power Generation with access to the OEM's IP resources for refurbishment and ongoing maintenance activities for the remaining life of the Plant. Furthermore, Ontario Power Generation obtained the authority to assign, in whole or in part, the contract or the Company's IP rights under a contract to the vendor selected to complete the balance of the Turbine Generator scope. This flexibility is expected to reduce administrative and Project Management responsibilities and transfer many vendor interface management risks from Ontario Power Generation to its EPC contractor. The contract also provides flexibility in redefining Project scope to accommodate Project economics.

[18] Southern California Edison was confronted with this challenge at the San Onofre Nuclear Generating Station, which has been closed permanently as a result of an engineering error with its recently-replaced steam generators. Xcel has faced similar circumstances with the feedwater pumps at its Monticello Nuclear Generation Plant.

The agreement with Alstom was formally executed in April 2013. Following the conclusion of negotiations with the OEM, Ontario Power Generation initiated plans for the construction-oriented EPC contract. The Company currently envisions three options for the form of this contract:

1) An EPC agreement with the OEM contract assigned to the EPC vendor;
2) A Joint Venture arrangement between the EPC contractor and Alstom; or
3) An EPC contract, with Ontario Power Generation managing the interface between the OEM and EPC-vendor.

Ontario Power Generation issued a formal RFP for this work to four companies[19] on May 31, 2013, with bids due on August 23, 2013. The Company plans to select a vendor and complete negotiation by the end of November 2013, and execute an EPC agreement for this work by January 31, 2014.

F. CURRENTLY UNDER REVIEW: REVISION TO FIRST-UNIT EXECUTION PLANS

In July 2013, the Company began to consider a departure from the initial project execution schedule. Under a revised approach, Ontario Power Generation would complete refurbishment of the first unit before initiating a schedule of overlapping construction on the remaining three units. This approach is intended to create an opportunity for the Company to collect, synthesize, and apply considerable operating experience to the refurbishment of the remaining units.

In addition to delaying the overlapping schedule of unit refurbishment, Ontario Power Generation is considering whether to defer the digital upgrade of turbine controls on the first unit, removing that scope of work from the Darlington Refurbishment Project. If this approach is approved by the Ontario Board of Directors, the Company would complete the controls upgrade for that unit during a scheduled refueling and maintenance outage after the conclusion of the remaining refurbishment work. A Board of Directors decision is expected in November 2013.

VII. CONCENTRIC'S OBSERVATIONS AND RECOMMENDATIONS

As stated above in the Summary of Conclusions, Concentric determined that the planning processes and activities completed by the Company between late 2009 and [August 1, 2013] were appropriate and reasonable, and meet the regulatory standard of prudence. In addition, we have made observations and identified opportunities for improvement that can strengthen the project management and supply chain functions going forward. Those observations and opportunities include:

1. Concentric agrees that a single-source agreement composed predominately of fixed, firm, and reimbursable pricing elements would allow Ontario Power Generation to obtain value for money in an arrangement that mitigates risk while achieving the long-term goals of enhanced reliability and maintainability of the Turbine Generators equipment. This was a reasonable and prudent initial strategy for the Turbine Generator scope of work.

[19] The RFP was distributed to Areva, AECON, and the two firms with which Ontario Power Generation has executed extended services master services agreement ("ESMSA") contracts for purposes of the Darlington Refurbishment Project. However, these two vendors, E.S. Fox and Black & McDonald, withdrew from the Turbine Generators EPC solicitation process in August 2013.

2. An Ontario Power Generation Internal Audit report from May 2012 made the recommendation that the Fuel Handling and Turbine Generators work package project teams clearly establish when justifications for single-source processes would be created and approved for significant portions of the two scopes of work. We agree with the audit's findings that there is a potential gap in the sequencing of supply-chain approvals, but stress that our concern is limited to the process for SSJ development and approval, not the basis for the SSJs themselves. Nothing Concentric observed in this regard has indicated imprudence on the part of Ontario Power Generation, nor did the process as implemented affect the outcome of the supply chain activities.

   We believe that it is in the Project's best interest to achieve internal alignment on a single-source approach at the outset of the development of plans to negotiate with single-source vendors. This is particularly true for agreements that will develop over the course of several months or for contractual arrangements that will exceed $10 million. This will ensure that the team is aligned on the strategic direction of the Project, and will mitigate the risk of committing significant resources to a procurement strategy that may not ultimately be approved by established Supply Chain procedures. It will also prevent unnecessary schedule extensions related to pursuing contracting strategies that are not ultimately approved. Recognizing that a structural solution may be too formal for what is an exceptionally dynamic process, we recommend that, at a minimum, clear lines of communication be established when new members of the Supply Chain organization are introduced to the Project, which will happen during a project of this scale and duration.

3. We recommend that Ontario Power Generation clearly document the risks introduced by executing an Engineering Services and Equipment Supply contract in advance of retaining an EPC vendor for the balance of work. Ontario Power Generation's selected contracting approach has minimized the number of interfaces and contracts, but still requires a collaborative arrangement between the OEM vendor and a yet-to-be-selected EPC contractor. Industry experience demonstrates that a successful interface between the OEM and the EPC vendor requires detailed scope definition, schedule coordination, and a clear division of responsibilities between the two.[20]

   There is material risk that the relationship between the vendors will be strained as contingent scope is identified and other possible scenarios emerge. From discussions with the Company it is clear that these risks are understood, and that certain mitigation efforts have been undertaken, including the integration of requirements for collaboration with the OEM in the RFP materials distributed to potential EPC vendors. However, we believe these risks must be thoroughly documented, and that monitoring and mitigation plans must be developed.

[20] This risk has arisen recently with other mega-projects, notably in the ongoing construction of Finland's Olkiluoto Unit 3. The challenges encountered coordinating Siemens and FANP (Areva) are documented by the Finnish nuclear safety regulator. See:
Stuk Nuclear Regulation, "Management of Safety Requirements in Subcontracting During the Olkiluoto 3 Nuclear Power Plant Construction Phase," Investigation Report 1/06, October 7, 2006 (page 51).

4. The Engineering Services and Equipment Supply contract that has been negotiated with Alstom contains many provisions that are advantageous to Ontario Power Generation, including warranty provisions that are superior to the industry standard 24-month warranty period, according to Ontario Power Generation's survey of industry experience with similar contracts. However, the contract with Alstom does not eliminate risk, and the Company should document and mitigate remaining risk to the degree possible. In particular, while the contract grants the Company authority and control over vendor-initiated change order requests, this does not eliminate the cost and schedule risk associated with scope disputes and resolution. Also, the warranty provisions of the contract do not eliminate the possibility the unit warranty period will expire before a given unit comes online. This possibility is certainly remote; it would require a four-year delay in the Project. However, Ontario Power Generation should be certain to document the risk and additional mitigating strategies.

5. Limited restrictions to Ontario Power Generation's IP rights to the control systems source code introduce a potential restriction to the Company's ability to fully assign the Engineering Services and Equipment Supply contract to the EPC vendor. Associated risk should be documented, and the Company should take steps to ensure that this limitation does not impede the EPC contractor's ability to complete its scope of work.

6. We note that Ontario Power Generation has documented the risk of contracting for equipment supply with a vendor (Alstom) reliant on an international supply chain network. The Company has documented its awareness of this risk and of concerns that have arisen with international manufacturing centers that are not currently expected to affect the Project. The risk has been mitigated through the material specifications contained in the scopes of work, quality program, and oversight plans.

7. Concentric believes that as Ontario Power Generation continues to develop its approach to the market for the EPC scope of the Turbine Generators work package, the Company should focus on assigning the Alstom contract to the EPC vendor rather than encouraging a joint venture structure. Industry experience, including the challenges that have surfaced at Olkiluoto Unit 3, as well as other projects,[21] indicates that a joint venture arrangement introduces material financial and interface risks.

8. Alstom has provided assurances that the Turbine Controls engineering will be complete within two years. This is an aggressive schedule and must be monitored and overseen by Ontario Power Generation. The Company has evaluated the schedule in detail and has

[21] Siemens and Areva were partners in a joint venture, Areva NP, to market nuclear services and equipment supply, including the construction of the new Olkiluoto Unit 3 in Finland. However, in 2009, Siemens exercised a put option to sell its one-third share of the joint venture to Areva, which is now the main contractor for the project. While Siemens has remained involved in the work as a subcontractor, the upheaval has had significant cost and schedule impacts on the construction of Unit 3. As with Joint Venture arrangements within other projects throughout the industry, problems at Olkiluoto involving ineffective communication between Joint Venture partners (Siemens and Areva), a lack of ultimate accountability for work execution, and a lack of authority to address changing circumstances have all contributed to schedule and cost challenges. See also footnote 15. Stuk Nuclear Regulation. "Management of Safety Requirements in Subcontracting During the Olkiluoto 3 Nuclear Power Plant Construction Phase." Investigation Report 1/06, October 7, 2006.

determined that it does not require a recovery plan or strategy at this time. Rather, schedule implications can be monitored and controlled through the risk register.

9. Concentric has not reviewed any analysis of the costs, benefits, and changes to Project or Turbine Generators work package risk that may result from a decision to change the sequencing of the Project so that the first two refurbishment outages no longer overlap. While there are benefits to focusing execution efforts on a single unit through commissioning, significant cost, efficiency, and vendor-related savings may be compromised. If the Ontario Power Generation Board of Directors chooses to un-lap the refurbishment of the first two units, Concentric would strongly advise the Turbine Generators project team to conduct a thorough assessment of the impact this change will have on the Company's relationship and contract with the Turbine Generators OEM, as well as the costs and risks of completing the remainder of the Project.

10. Concentric recognizes that execution risk would be diminished by the deferral of the Turbine Generator digital controls upgrade on the first unit to enter refurbishment outage (*i.e.,* Unit 2). However, if Ontario Power Generation chooses to defer the controls upgrade on Unit 2, we recommend that The Company undertake a risk-based review of the implications of removing that portion of work from the Darlington Refurbishment Project, and ensure that changes are reflected in the Turbine Generator work package's risk register, commercial strategy documentation, and in the overall Darlington Refurbishment Project execution plans.

VIII. CONCLUSIONS

Concentric was retained to review Ontario Power Generation's development and implementation of its commercial strategies for the Project. At a cost of $6 to $10 billion in 2009 dollars, excluding inflation and interest, and a duration of more than 18 years from the start of planning to the conclusion of commissioning and project closeout activities, the Project is clearly a major undertaking for Ontario Power Generation, and it is subject to financial, economic, regulatory, political, and execution risks. While effective commercial strategies are necessary to assist the Company in mitigating these risks, no commercial strategy can fully eliminate them.

To conduct our review of the Project's commercial strategies, Concentric undertook a detailed process to determine whether the strategies selected by the Turbine Generators Project team are reasonable, whether the strategies were executed in a reasonable manner and whether Ontario Power Generation's actions related to the selection and execution of those strategies meet the regulatory prudence standard. Our opinion of these strategies relied on information provided by the Company in response to our data requests, in-person interviews, our independent research and Concentric's experience advising other megaproject sponsors. Our review confirms the reasonableness and prudence of Ontario Power Generation's selected procurement strategies.

SEC Interrogatory #17

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/3/p.16]

With respect to the $284M Turbine Generator EPC contract for field work and engineering integration with SNC/AECON JV as part of the Turbine Generator work bundle:

a. Please provide a similar chart as that provided for the RFR Target Pricing (Chart 1-4, D2/2/3), for each of the following cost scenarios for the Turbine Generator EPC contract for field work and engineering integration:
   i. Contractor cost savings of 1%
   ii. Contractor cost savings of 10%
   iii. Contractor cost overrun of 1%
   iv. Contractor cost overrun of 10%
   v. Contractor cost overrun of 25%

b. Please provide a copy of the Memorandum of Agreement between OPG, Alstom, and SNC/AECON JV.

c. Please provide copies of all reports, analysis, opinion, evaluations and/or assessments undertaken by or for OPG regarding the Turbine Generator EPC contracting process, strategies, and contract structure, undertaken either before, during, and/or after the negotiating the final contract.

d. Was no RFP or similar competitive process undertaken for this contract because SNC/AECON JV had already been selected to undertake the RFR work? If so, please explain why this contract was not then part of the selection process for the RFR contract with SNC/AECON JV.

Response

a. OPG provides the requested scenarios below as illustrative examples to demonstrate how the Turbine Generators (TG) Engineering, Procurement and Construction (EPC) contract mechanisms, incentives and disincentives work. For all of the scenarios below, the following features and assumptions apply:
   - Cost estimates are based on Amendment 2 to the TG EPC.

- Once established, the Fixed Fee paid by OPG does not change as actual costs change, and is subject to the incentive/disincentive mechanism. In the examples, the "contractor cost" for the Fixed Fee varies with the scenarios to represent changes in contractor overheads and profits based on differing levels of actual costs.
- For simplicity:
    - An incentive or disincentive adjustment of 20 per cent is used for target cost savings or overruns outside of the neutral band. The actual percentage would be calculated using a graded approach.
    - The cost plus mark-up categories of work (Dynamic Commissioning Trades Work and Goods) assume the increased costs all include any contractor markups, and any cost savings or overruns are excluded from the Fixed Fee incentive/disincentives.
    - The target cost for Execution Phase Support Services and Equipment (SS&E) was added to the Execution Phase Target Cost, and the Execution Phase SS&E incentives/disincentives were calculated consistently with the Execution Phase Target Cost. Under the contract, the Execution Phase SS&E would be subject to its own neutral band and graded scale for incentives and disincentives.
- The amounts included for (1) the cost plus mark-up and (2) the reimbursable costs with no mark-up categories of work are estimates only.
- No schedule disincentives are applied.
- The numbers may not add due to rounding.

In the first scenario set out in Chart 1 below, the contractor achieves a 1 per cent cost savings. For the target cost portions of work, OPG shares in the contractor's cost savings as the contractor is reimbursed for only its actual costs incurred (Chart 1, lines 1 and 4). At 1 per cent cost savings, the $200K cost savings for the Definition Phase Target Cost are less than $700K, and falls within the neutral band. In addition, the cost savings of $1.6M for the Execution Phase Target Cost are less than 4 per cent of the Execution Phase Target Cost, and also falls within the neutral band set out in the contract. As a result, no incentive payments apply (Chart 1, Lines 3 and 6). There is no impact to OPG on any changes to the Fixed Fees. The remaining reimbursable items are paid at the lower, actual costs and OPG retains those savings.

Chart 1 – Illustrative Example of the TG EPC Contract (Contractor 1% Cost Savings)

			% Contractor Cost Savings of 1%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost	21.4	21.1	(0.2)	0	(0.2)	21.1
2	Definition Phase Fixed Fee	12.9	12.7	(0.1)	(0.1)	0	12.9
3	Definition Phase Fixed Fee Incentive/ Disincentive				0	0	0
4	Execution Phase Target Cost	161.3	159.6	(1.6)	0	(1.6)	159.6
5	Execution Phase Fixed Fee	52.9	52.4	(0.5)	(0.5)	0	52.9
6	Execution Phase Fixed Fee Incentive/ Disincentive				0	0	0
7	Dynamic Commissioning Work (Trades)	2.3	2.2	(0.0)	0	(0.0)	2.2
8	Goods	4.8	4.8	(0.0)	0	(0.0)	4.8
9	Reimbursable Costs with no-markup	11.5	11.4	(0.1)	0	(0.1)	11.4
10	Total	267.0	264.3	(2.7)	(0.7)	(2.0)	264.9

In the second scenario set out in Chart 2 below, the contractor achieves a 10 per cent cost savings. For the target cost portions of work, OPG shares in the contractor's cost savings as the contractor is reimbursed for only its actual costs incurred (Chart 2, Lines 1 and 4). At 10 per cent cost savings, the $2.1M cost savings for the Definition Phase Target Cost falls outside of the Definition Phase Target Cost neutral band of $700K. In addition, the cost savings of $16.1M for the Execution Phase Target Cost is more than 4 per cent of the Execution Phase Target Cost, and also falls outside the neutral band set out in the contract. As a result, OPG pays the contractor a cost incentive for coming in below both the Definition Phase and Execution Phase Target Costs (Chart 2, Lines 3 and 6). There is no impact to OPG on any changes to the Fixed Fees. The remaining reimbursable items are paid at the lower, actual costs and OPG retains those savings.

As the total demonstrates (Chart 2, Line 10), the contractor is incented to come in below target cost in order to take advantage of the cost incentive payments, and OPG benefits from significant cost savings even after payment of the cost incentives.

Chart 2 - Illustrative Example of the TG EPC Contract (Contractor 1% Cost Savings)

			% Contractor Cost Savings of 10%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost	21.4	19.2	(2.1)	0	(2.1)	19.2
2	Definition Phase Fixed Fee	12.9	11.6	(1.3)	(1.3)	0	12.9
3	Definition Phase Fixed Fee Incentive/ Disincentive				(0.3)	0.3	0.3
4	Execution Phase Target Cost	161.3	145.1	(16.1)	0	(16.1)	145.1
5	Execution Phase Fixed Fee	52.9	47.6	(5.3)	(5.3)	0	52.9
6	Execution Phase Fixed Fee Incentive/ Disincentive				(1.9)	1.9	1.9
7	Dynamic Commissioning Work (Trades)	2.3	2.0	(0.2)	0	(0.2)	2.0
8	Goods	4.8	4.3	(0.5)	0	(0.5)	4.3
9	Reimbursable Costs with no-markup	11.5	10.3	(1.1)	0	(1.1)	10.3
10	Total	267.0	240.3	(26.7)	(8.8)	(17.9)	249.1

In the third scenario set out in Chart 3 below, the contractor incurs a 1 per cent cost overrun. For the target cost portions of work, OPG reimburses the actual (allowed) costs of the contractor and pays the cost variance to the contractor (Chart 3, Lines 1 and 4). At 1 per cent cost overrun, the $200K cost overrun for the Definition Phase Target Cost is less than $700K, and falls within the neutral band. In addition, the cost overrun of $1.6M for the Execution Phase Target Cost is less than 4 per cent of the Execution Phase Target Cost, and also falls within the neutral band set out in the contract. As a result, no disincentive payments apply (Chart 3, Lines 3 and 6). There is no impact to OPG on any changes to the Fixed Fees, and the remaining reimbursable items are paid at actual costs.

Chart 3 – Illustrative Example of the TG EPC Contract (Contractor 1% Cost Overrun)

			% Contractor Cost Overrun = 1%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost	21.4	21.6	0.2	0	0.2	21.6
2	Definition Phase Fixed Fee	12.9	13.0	0.1	0.1	0	12.9
3	Definition Phase Fixed Fee Incentive/ Disincentive				0	0	0
4	Execution Phase Target Cost	161.3	162.9	1.6	0	1.6	162.9
5	Execution Phase Fixed Fee	52.9	53.4	0.5	0.5	0	52.9
6	Execution Phase Fixed Fee Incentive/ Disincentive				0	0	0
7	Dynamic Commissioning Work (Trades)	2.3	2.3	0.0	0	0.0	2.3
8	Goods	4.8	4.9	0.0	0	0.0	4.9
9	Reimbursable Costs with no-markup	11.5	11.6	0.1	0	0.1	11.6
10	Total	267.0	269.6	2.7	0.7	2.0	269.0

In the fourth scenario set out in Chart 4 below, the contractor incurs a 10 per cent cost overrun. For the target cost portions of work, OPG reimburses the actual (allowed) costs of the contractor and pays the cost variance to the contractor (Chart 4, Lines 1 and 4). At 10 per cent cost overruns, the $2.1M cost overrun for the Definition Phase Target Cost falls outside of the Definition Phase Target Cost neutral band of $700K. In addition, the cost overruns of $16.1M for the Execution Phase Target Cost is more than 4 per cent of the Execution Phase Target Cost, and also falls outside the neutral band set out in the contract. As a result, the contractor must pay to OPG a disincentive payment of $2.2M for coming in above both the Definition Phase and Execution Phase Target Costs (Chart 4, Lines 3 and 6). There is no impact to OPG on any changes to the Fixed Fees, and the remaining reimbursable items are paid at actual costs.

Chart 4 – Illustrative Example of the TG EPC Contract (Contractor 10% Cost Overrun)

			% Contractor Cost Overrun = 10%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost	21.4	23.5	2.1	0	2.1	23.5
2	Definition Phase Fixed Fee	12.9	14.2	1.3	1.3	0	12.9
3	Definition Phase Fixed Fee Incentive/ Disincentive				0.3	(0.3)	(0.3)
4	Execution Phase Target Cost	161.3	177.4	16.1	0	16.1	177.4
5	Execution Phase Fixed Fee	52.9	58.2	5.3	5.3	0	52.9
6	Execution Phase Fixed Fee Incentive/ Disincentive				1.9	(1.9)	(1.9)
7	Dynamic Commissioning Work (Trades)	2.3	2.5	0.2	0	0.2	2.5
8	Goods	4.8	5.3	0.5	0	0.5	5.3
9	Reimbursable Costs with no-markup	11.5	12.6	1.1	0	1.1	12.6
10	Total	267.0	293.6	26.7	8.8	17.9	284.8

In the fifth scenario set out in Chart 5 below, the contractor incurs a 25 per cent cost overrun. For the target cost portions of work, OPG reimburses the actual (allowed) costs of the contractor and pays the cost variance to the contractor (Chart 5, Lines 1 and 4). At 25 per cent cost overruns, the $5.3M cost overrun for the Definition Phase Target Cost falls outside of the Definition Phase Target Cost neutral band of $700K. In addition, the cost overruns of $40.3M for the Execution Phase Target Cost is more than 4 per cent of the Execution Phase Target Cost, and also falls outside the neutral band set out in the contract. As a result, the contractor must pay to OPG a disincentive payment of $7.7M for coming in above both the Definition Phase and Execution Phase Target Costs (Chart 5, Lines 3 and 6). There is no impact to OPG on any changes to the Fixed Fees, and the remaining reimbursable items are paid at actual costs.

Chart 5 – Illustrative Example of the TG EPC Contract (Contractor 25% Cost Overrun)

			% Contractor Cost Overrun = 25%				
#	Category ($ Million)	Contract Costs	Contractor Cost	Cost Variance	Impact to Contractor	Impact to OPG	OPG Payment to Contractor
1	Definition Phase Target Cost	21.4	26.7	5.3	0	5.3	26.7
2	Definition Phase Fixed Fee	12.9	16.1	3.2	3.2	0	12.9
3	Definition Phase Fixed Fee Incentive/ Disincentive				0.9	(0.9)	(0.9)
4	Execution Phase Target Cost	161.3	201.6	40.3	0	40.3	201.6
5	Execution Phase Fixed Fee	52.9	66.1	13.2	13.2	0	52.9
6	Execution Phase Fixed Fee Incentive/ Disincentive				6.8	(6.8)	(6.8)
7	Dynamic Commissioning Work (Trades)	2.3	2.8	0.6	0	0.6	2.8
8	Goods	4.8	6.0	1.2	0	1.2	6.0
9	Reimbursable Costs with no-markup	11.5	14.4	2.9	0	2.9	14.4
10	Total	267.0	333.7	66.7	24.1	42.6	309.5

As the total lines in Charts 4 and 5 demonstrate (Charts 4 and 5, Lines 10 respectively), the pricing mechanisms and disincentives discourage the contractor from incurring cost overruns as it will have to pay OPG cost disincentive payments for overruns it occurs on target price portions of work that fall outside of the neutral band. In addition, the

contractor's lost profit includes any loss associated with the requirement to pay any incremental overheads not originally contemplated by the Fixed Fee.

b. Please see Memorandum of Agreement between OPG, Alstom, and the SNC/AECON Joint Venture attached as Attachment 1.

c. OPG declines to answer this question. The question does not recognize proportionality considerations which underlie the interrogatory process, in that it is overly broad and all encompassing. The production of every document relating to the contracting process, strategies, and contract structure for the TG EPC would capture thousands of pages of documents. If the question was refined to reference specific materials relating to an issue on the approved issues list, OPG could undertake to find relevant materials.

Notwithstanding the above objection, OPG believes the below and attached key documents with respect to the request for the TG EPC contracting process documents are responsive to the question. Together with what OPG has already filed in evidence, OPG believes a set of key documents in response to the question has been provided:

- Turbine Generators Refurbishment Project (EPC) Negotiation Plan (Attachment 2)
- Turbine Generators Contracting Strategy (L-4.3-15 SEC-031, Attachment 3)
- Turbine Generator Refurbishment Project Alternate Contracting Plan (L-4.3-15 SEC-031, Attachment 4).
- Concentric Energy Advisor's Assessment of Commercial Strategies Developed for the Darlington Refurbishment Project's Turbine Generators Work Package (L-4.3-15 SEC-016, Attachment 2)

d. OPG did not intend from the outset to select the same contractor for the Retube and Feeder Replacement EPC contract and the TG EPC contract. The scope of work for the Turbine Generator is very distinct from the Retube and Feeder Replacement work and requires a different skill set and level of expertise.

As indicated in the Darlington Turbine Generator Equipment Single Source Justification (filed at L-4.3-15 SEC-016, Attachment 1, p. 8), the engineering integration work and installation of the equipment supplied by the Original Equipment Manufacturer was to be competitively sourced. The Turbine Generator EPC contract was in fact competitively bid to five proponents. Two proponents immediately declined, a third proponent declined to bid before the Request for Proposal closed, and the fourth and fifth proponents joined into a joint venture consisting of SNC and AECON and submitted a proposal.

MEMORANDUM OF UNDERSTANDING

For

TURBINE GENERATOR REFURBISHMENT PROJECT

April 28, 2014

among

ONTARIO POWER GENERATION INC.

and

AECON CONSTRUCTION GROUP INC. and SNC-LAVALIN NUCLEAR INC.

and

ALSTOM POWER CANADA INC.

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding ("MOU") is made as of April 28, 2014 among:

ONTARIO POWER GENERATION INC., a corporation existing under the laws of Ontario (**"OPG"**),

and

AECON CONSTRUCTION GROUP INC., a corporation existing under the laws of Canada, and **SNC-LAVALIN NUCLEAR INC.**, a corporation existing under the laws of Canada, acting jointly and severally (collectively, the **"SLN-AECON TG JV"**) doing business as a contractual joint venture known as "SLN-AECON TG, a Joint Venture",

and

ALSTOM POWER CANADA INC., a corporation existing under the laws of Canada (**"Alstom"**)

(each of OPG, the SLN-AECON TG JV, and Alstom is hereafter referred to as a **"Party"** and, collectively, the **"Parties"**).

RECITALS

A. OPG is the owner and operator of the Darlington nuclear generating station (**"DNGS"**) in Clarington, Ontario.

B. The DNGS is approaching its mid-life refurbishment. The refurbishment involves outages for the replacement of life limiting components as well as the refurbishment or replacement of other components.

C. The goal of the refurbishment project is to extend the service life of all four units at the DNGS (the **"Refurbishment Program"**).

D. The DNGS turbine generators refurbishment project (the **"Project"**) is one of the projects under the Refurbishment Program.

E. OPG entered into an Engineering, Procurement and Construction Agreement with the SLN-AECON TG JV dated as of January 22, 2014 (the **"EPC Agreement"**) whereby the SLN-AECON TG JV will provide certain engineering, procurement and construction activities associated with the Project as more particularly described in the EPC Agreement.

F. OPG entered into an Engineering Services and Equipment Supply Agreement with Alstom dated as of March 27, 2013 (the "**ESES Agreement**") whereby Alstom will provide specified engineering services and supply specified equipment associated with the Project as more particularly described in the ESES Agreement (the EPC Agreement and the ESES Agreement together, the "**Contracts**").

G. The Parties acknowledge that their active cooperation is essential in order for both Alstom and the SLN-AECON TG JV to effectively and efficiently manage and complete their respective workscopes to achieve the common goal and ensure the Project is executed safely, with quality and in accordance with the respective Contracts and within the allotted budget and schedule.

H. The Parties wish to document the mutually agreed cooperation principles, processes and tools that will frame the successful performance of their respective Contracts.

I. The Parties acknowledge that the recitals to this MOU form part of and are incorporated into the body of this MOU.

The Parties agree as follows:

SECTION 1 LIABILITY

1.1 The Parties acknowledge that nothing in this MOU will derogate from, or increase, the obligations and liabilities of a Party to OPG, or the obligations and liabilities of OPG to such Party, under the applicable Contract and that this MOU serves as a working guideline only to allow the Parties to enhance and better structure their ongoing interactions.

1.2 The Parties acknowledge that except as otherwise expressly set out in the ESES Agreement (as between Alstom and OPG) or the EPC Agreement (as between SLN AECON TG JV and OPG), no Party will have any liability to any other Party (whether in contract, tort, breach or statutory duty or under any other theory of law) under or pursuant to or in connection with this MOU.

SECTION 2 COOPERATION PRINCIPLES

2.1 General Cooperation Principles

(a) Alstom and the SLN-AECON TG JV acknowledge and agree that, for the Project to be successful, it is necessary that they work together cooperatively with OPG. The purpose and intent of this MOU is to outline the agreed upon cooperation framework.

(b) Each Party will strive to achieve the common goal of ensuring the Project is executed safely, on time and on budget, in accordance with their respective Contracts. To this end, the Parties will:

(i) work diligently to develop and keep current: (A) an integrated schedule for the Project in order to monitor the status and progress of deliverables between the Parties (the "**TG Integrated Schedule**"); and (B) a communication protocol for timely and effective exchange of information that the Parties reasonably need to perform their work under their respective Contracts (the "**TG Communication Protocol**");

(ii) act in good faith to implement the TG Communication Protocol;

(iii) refrain from materially interfering, obstructing or impeding one another's performance of their respective workscopes under the Contracts;

(iv) require their respective subcontractors or suppliers to cooperate in a manner consistent with this MOU;

(v) inform one another promptly of any work performed by the other that does not meet the needs of the Project, or to their knowledge, has not been performed correctly, is defective, or does not meet the specifications or standards required under the Contracts; and

(vi) work to resolve any issues affecting the Project, and respond to one another's requests, in a timely manner, and communicate any unresolved issues through the proper channels to the appropriate TG Work Package Representative (as defined in the outlined Cooperation Process set out in Section 3).

2.2 Specific Cooperation Principles

Without limiting the general principles set out in Section 2.1 or such other general or specific cooperation principles as the Parties may agree to from time to time, in accordance with the TG Integrated Schedule and TG Communication Protocol:*

(a) Alstom will, in a timely fashion having due regard to the schedule requirements of the TG Integrated Schedule, the Parties' respective Project schedules during the definition phase and the execution phase integrated schedule,:

(i) provide, the SLN-AECON TG JV through EDMS to OPG with all documentation, including, but not limited to drawings and calculations (and any document output list for each design element), as required by the SLN-AECON TG JV, acting reasonably;

(ii) cooperate and assist the SLN-AECON TG JV with the review of engineering and maintenance work packages by whatever means appropriate;

(iii) provide the SLN-AECON TG JV through EDMS to OPG with detailed instructions for material handling and storage related to the equipment supplied by Alstom;

(iv) supply, through OPG approval to SLN-AECON TG JV and/or in accordance with the TG Integrated Schedule and the execution phase integrated schedule, subject matter experts such as installation and commissioning technical oversight advisors (including Resident Technical Advisors and Technical Field Advisors) to the SLN-AECON TG JV for consultation and to assist the SLN-AECON TG JV with the development of all deliverables during the definition phase and with all field activities during the execution phase; and,

(b) the SLN-AECON TG JV will, in a timely fashion having due regard to the schedule requirements of the TG Integrated Schedule, the Parties' respective Project schedules and the execution phase integrated schedule,:

(i) develop all engineering work packages for Alstom supplied equipment in accordance with the EPC Agreement and with respect to documentation and information requirements will, where applicable, have due regard for the Alstom Vendor Owner Interface Requirements process set out in the ESES Agreement (the "**VOIR**") and the Alstom Project schedule to enable and facilitate the efficient exchange of information and effective progression of applicable work packages;

(ii) complete all receipt inspection and storage activities pertaining to Alstom supplied equipment in accordance with the SLN-AECON TG JV quality assurance requirements and Alstom supplied instructions;

(iii) assist with development of an overall refurbishment outage integrated schedule for the execution phase; and,

(iv) supply and train skilled trades to support all field execution related activities.

(c) OPG will, in a timely fashion having due regard to the milestones to be achieved in the TG Integrated Schedule, the Parties' respective Project schedules and the execution phase integrated schedule,:

(i) provide Alstom or the SLN-AECON TG JV with all documentation requested by Alstom or the SLN-AECON TG JV, both acting reasonably;

(ii) coordinate and resolve any issues that cannot reasonably be resolved between Alstom and the SLN-AECON TG JV;

(iii) supply, upon request by Alstom or the SLN-AECON TG JV and/or in accordance with the TG Integrated Schedule and the execution phase integrated schedule, subject matter experts to allow Alstom and the SLN-AECON TG JV to comply with their respective obligations under the respective Contracts;

(iv) ensure that all Parties comply with this MOU and the Communication Protocol;

(v) ensure an efficient, practical and reasonable integration of Alstom's and the SLN-AECON TG JV's respective Project schedules and the execution phase integrated schedule;

(vi) facilitate meetings among OPG, the SLN-AECON TG JV and Alstom; and,

(vii) facilitate site visits and provide site services that are not included in the scopes of work or supply under the respective Contracts.

*Note: EDMS is the repository for all formal communication and controlled revisions.

SECTION 3 COOPERATION PROCESS

3.1 Objectives of Cooperation Process

The objectives of the cooperation process (the "**Cooperation Process**") are to:

(a) facilitate agreement and cooperation at the work package level with all Parties regarding roles and responsibilities;

(b) determine the optimal timing for providing Interface (as defined below) information at the work package level; and

(c) identify critical Interfaces early in the Project and communicate them through the appropriate TG Work Package Representatives (as defined below),

so as to ensure the effective exchange of information between the Parties and minimize the risks associated with design development, project changes, and late or erroneous data.

3.2 TG Work Package Representatives

(a) SLN-AECON TG JV and Alstom will appoint a representative for each applicable work package identified by the Parties, and confirm such appointment in writing to the other Parties (each a "**TG Work Package Representative**"). On an as required basis, OPG will appoint a representative to assist the SLN-AECON TG JV and Alstom.

(b) A Party may, by written notice to the other Parties, change its TG Work Package Representative. Such change will have effect on the later of the date of delivery of such notice and the date specified in such notice.

3.3 Cooperation Process Outline

The Cooperation Process outline will be as set out in Schedule "A" and described below:

(a) the Parties will cooperate to identify and record, for each work package, elements of the work that will require input from multiple Parties, (each, an "**Interface**") and will assign one of the TG Work Package Representatives to be the lead for that work package;

(b) once an Interface has been identified, the Parties will either revise an existing Interface framework or create a new Interface framework for managing the Interface, and will issue such Interface framework to all of the Parties;

(c) if the Parties cannot agree on the final Interface framework, they will cooperate to make revisions until an agreed-upon Interface framework can be finalized, in the event such agreement cannot be reached the issue

will be raised to the steering committees under the Contracts for resolution;

(d) the Parties will monitor the status of the Interface framework with meetings and reports as appropriate, until all required information has been received;

(e) the Parties will finalize the Interface framework once all of the required information regarding the Interface has been received and the Interface framework is agreed upon and completely documented; and,

(f) where applicable, the VOIR process will be used for the effective Interface between the Parties and efficient exchange of information.

3.4 Counterparts

This MOU and any amendment, restatement or termination of this MOU in whole or in part may be signed and delivered in any number of counterparts, each of which when signed and delivered is an original but all of which taken together constitute one and the same instrument. Any counterpart signature transmitted by sending a scanned copy by electronic mail or similar electronic transmission will be deemed an original signature.

(Remainder of page intentionally left blank)

Each of the Parties has signed this MOU as of the day and year first written above.

ONTARIO POWER GENERATION INC.

By: _____
Name: Todd Josifovski
Title: Project Director

_____
Name: Mark Arnone
Title: Vice President

SNC-LAVALIN NUCLEAR INC.

By: _____
Name: Rabih Hafez
Title: Project Director

_____
Name: Rob Stewart
Title: Senior Vice President and General Manager

AECON CONSTRUCTION GROUP INC.

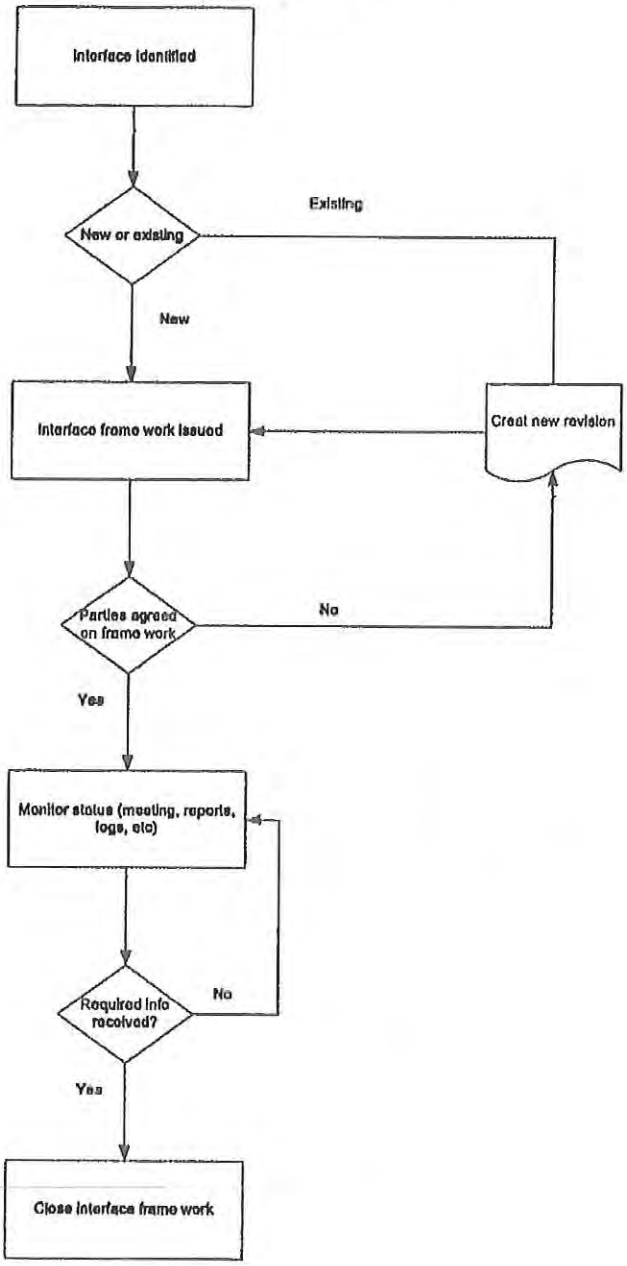
By: _____
Name: Ian Turnbull
Title: President, Aecon Industrial, a division of Aecon Construction Group Inc.

ALSTOM POWER CANADA INC.

By: _____
Name: Mike Winters
Title: Project Director

_____
Name: Richard Lake
Title: President

Schedule "A" – Cooperation Process Outline



ONTARIOPOWER GENERATION

Plan

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Document Number: NK38-PLAN-09701-10187	Usage Classification: N/A
Sheet Number: N/A	Revision: R000

Title:
TURBINE GENERATOR REFURBISHMENT PROJECT (EPC) NEGOTIATION PLAN

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Turbine Generator Refurbishment Project (EPC) Negotiation Plan

NK38-PLAN-09701-10187-R000
2013-09-30

Order Number: N/A
Other Reference Number:

Internal Use Only
Commercially Sensitive

Recommended by:
Andy Nelson — Date Oct 1, 2013
Senior Manager
Refurbishment Supply Chain

Concurred by:
Janice Ding — Date Oct 1, 2013
Director (Acting)
Contract Management

Concurred by:
Mark Arnone — Date 10 Oct 2013
Vice President,
Refurbishment Execution
Nuclear Refurbishment

Approved by:
Phil Reinert — Date Oct. 9/13
Vice President
Supply Services OPG Projects

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Revision Summary

Revision Number	Date	Comments
R000	2013-09-25	Initial issue.

1.0 PURPOSE

Capitalized terms used but not defined in this negotiation plan (the "**Plan**") have the meanings given to them in the RFP Documents for the TG Engineering, Procurement and Construction ("**EPC**") Project. This Plan describes the process for negotiating with one or more of the Proponents who have submitted Proposals for the TG EPC Project in preparation for making a recommendation to the Refurbishment Program Contracting Steering Committee (the "**Steering Committee**") as to whether to award a contract or exercise any other options, all as more particularly described in section 21 of the RFP Rules. It is intended that the negotiations will be commercial prudent and in accordance with OPG business practices. This process will achieve a commercially acceptable contract, deliver value for money and meet the requirements of the DR Program in accordance with established negotiation objectives. Included in this Plan are the responsibilities of the negotiation team members and an outline of the negotiation process.

2.0 NEGOTIATION OBJECTIVES AND STRATEGY

2.1 Overall Objectives

Achieve mutually acceptable terms and conditions ensuring achievement of the following objectives:

- Obtain appropriate allocation of risk between OPG and the Proponent;
- Achieve overall value for money;
- Achieve reimbursable cost transparency aligned with the Darlington Refurbishment processes; and
- Clearly understand the obligations of the parties involved.

2.2 Process Objectives

- Maintain a fair, equitable and transparent process;
- Fill information gaps quickly; and
- Maintain a productive dialogue and demonstrated collaborative approach – interest versus position.

2.3 Strategy

Following the completion of the Proposal evaluation, the evaluation team leads provided their recommendation to the Steering Committee for concurrence. The

recommended strategy is to commence negotiation with one Proponent with the intent to achieve the negotiation objectives.

Prior to commencing negotiations, the Negotiation Team will establish and discuss the following:

(1) Detailed negotiation objectives including strategy and talking points based on Proponents exceptions to any terms and conditions in the proposed EPC contract or RFP;

(2) Additional information or requirements of the Proponent;

(3) Engage subject matter experts (internal and external) for due diligence reviews; and

(4) Sub-team members and scope.

3.0 TIMELINES AND SCHEDULE

- Negotiation commencement date – October 7, 2013 (est)
- Completion of negotiations – November 22, 2013 (est)
- Contract award – January 30, 2014 (est)

4.0 RESPONSIBILITIES

The Vice President, Supply Services OPG Projects will have the overall responsibility for the negotiation process. The relationships among the teams or groups described in this section are shown in Appendix A.

4.1 Negotiation Team

If the recommendation from the Proposal evaluation process is that OPG enter into negotiations with one or more Proponents as more particularly described in section 21 of the RFP Rules, the following Negotiation Team (the "**Negotiation Team**") will represent OPG in such negotiations:

Negotiation Team	
Team Member	**Organization**
* Mark Arnone	VP, Refurbishment Execution
Andy Nelson	Refurbishment Supply Chain
John Kalm	Law Division

Todd Josifovski	TG Project Director
Peter Moore	TG Project Manager
Cameron MacLeod	Contract Manager
Mark Johnson	Blake, Cassels & Graydon LLP

The Negotiation Team lead (indicated by "*") may, with the concurrence of Supply Chain, determine that certain aspects of the negotiations can be advanced more effectively by creating a subset of the above Negotiation Team and/or establishing one or more parallel streams of discussion with a Proponent. The above Negotiation Team will be supplemented by the following negotiation support team (the "**Negotiation Support Team**"):

Negotiation Support Team	
Team Member	**Organization**
Jim Ferguson	TG Refurbishment Project
Dale Craig	TG Refurbishment Project
Marcel Fiterau	TG Refurbishment Project
Swaroop Puwar	TG Refurbishment Project
Bob Drummond	TG Refurbishment Project
Sharyn Donnelly	Refurbishment P&C
Peter Kukk	Refurbishment Supply Chain
Steve Harris	Refurbishment Supply Chain
Shirley McTeer	Refurbishment Supply Chain
Rob Priller	Investment Planning
Leo Saagi	Business Support Darlington
Tracey Smith	People and Culture
Matthew Prange	Contract Management
John Floras	Insurance
Anthony Guglietti	Enterprise Risk Management
Shamim Pabani Gail Anthony-Hokoror Maria Kwong	Tax

At the discretion of the Negotiation Team lead, members of the Negotiation Support Team may replace members on the Negotiation Team on an as required basis. Also, at the discretion of the Negotiation Team lead, other subject matter experts (whether internal or external) may be added to the Negotiation Team or Negotiation Support Team as required.

All Negotiation Team members are expected to attend all meetings with Proponents as well as all preparatory meetings and, if required, Steering Committee meetings. All Negotiation Support Team members are expected to attend applicable preparatory meetings and may be included in some or all of the Proponent meetings and, if required, the Steering Committee meetings. For each Negotiation Team member, it is expected that negotiations will take precedence over all other work and each member will plan their schedules accordingly.

The Negotiation Team lead is responsible for coordinating preparatory meetings and meetings with Proponents, developing and documenting the negotiating agenda, and providing status reports to the Steering Committee. The Steering Committee may, at its discretion or at the request of the Negotiation Team lead, meet with the full Negotiation Team during the negotiation period to provide oversight and direction. Members of the Negotiation Support Team may also be included in such meetings at the request of the Negotiation Team lead or the Steering Committee. The Negotiation Team is responsible for making a recommendation to the Steering Committee as to the path forward.

All formal documentation that results from negotiation meetings with a Proponent shall be provided to the Vice President, Supply Services OPG Projects or his/her authorized delegate for retention.

4.2 Steering Committee

The Steering Committee has the following responsibilities:

- Review the recommendation of the Negotiation Team;
- Request further information or changes if appropriate; and
- Endorse the final recommendation of the Negotiation Team.

The Steering Committee may elect to convene meetings of a subset of the Steering Committee in order to provide direction on a particular issue or aspect of the negotiation. This will not negate the role of the Steering Committee, which is expected to meet on a regular basis during the negotiation period. The Director, Contract Management will circulate an agenda prior to each meeting of the Steering Committee and ensure that minutes are prepared and approved for each meeting of the Steering Committee.

Steering Committee	
Member	**Position**
Dietmar Reiner	SVP, Nuclear Refurbishment
Don Power	VP, Investment Planning
Neil Mitchell	VP, Refurbishment Engineering
Stephun Cliver	Chief Supply Officer
Chris Ginther	SVP, Law and General Counsel
Dave Stiers	Director, Management System Oversight
Gary Rose	Director, Refurbishment Planning and Controls
Brian Duncan	SVP, Darlington
Stephen Mills	VP, Nuclear Commercial Development
Steering Committee Presenters	
Mark Arnone	VP, Refurbishment Execution
Phil Reinert	VP, Supply Chain Services OPG Projects

5.0 APPROVAL

The Senior Vice President, Nuclear Projects is responsible for obtaining the required Organizational Authority Register ("**OAR**") requisitioning approval from the President and CEO, approving the recommendation made by the Negotiation Team through the Steering Committee and obtaining any other approvals that may be required in order to carry out the recommendation. The Chief Supply Officer is responsible for obtaining the required OAR procurement contract approval from the President and CEO for the final version of the TG Project EPC Agreement with the successful Proponent.

6.0 CONFIDENTIALITY AND CONFLICT OF INTEREST

It is extremely important that the results of the negotiations, the recommendation to the Steering Committee and any negotiations be treated as highly confidential both during the process and after it is complete. All members of the Negotiation Team, the Negotiation Support Team and the Steering Committee are required to sign the Confidentiality Agreement attached as Appendix B and, if they have not previously signed a conflict of interest declaration in the course of the TG Project Proposal evaluations, the Conflict of Interest Statement attached as Appendix C. It must be stressed that there should be no communication with the Proponents, their Subcontractors or any other related or interested parties other than through the Vice President Supply Services OPG Projects or his/her authorized delegate.

Appendix A: Relationship Among Teams/Groups

Steering Committee

Dietmar Reiner
Don Power
Neil Mitchell
Stephun Cliver
Chris Ginther
Dave Stiers
Gary Rose
Brian Duncan
Stephen Mills

Steering Committee Presenters

Mark Arnone
Phil Reinert

Negotiation Team

*Mark Arnone
Andy Nelson
John Kalm
Todd Josifovski
Peter Moore
Cameron MacLeod
Mark Johnson

Negotiation Support Team

Jim Ferguson	Rob Priller	Shamim Pabani
Marcel Fiterau	Leo Saagi	Gail Anthony-Hokoror
Swaroup Puwar	Tracey Smith	Maria Kwong
Dale Craig	Mathew Prange	Peter Kukk
Bob Drummond	John Floras	Steve Harris
Sharyn Donnelly	Anthony Guglietti	Shirley McTeer

Note: * Denotes team Lead

Appendix B: Confidentiality Agreement

CONFIDENTIALITY AGREEMENT

To: Vice-President Supply Services OPG Projects (or his/her authorized delegate)

From: _____
Print Name

Re: Procurement Process – Turbine Generator Refurbishment Project (the "TG Project") at the Darlington Nuclear Generating Station

OPG is currently entering into a negotiation process with respect to Proposals for the TG Project. As part of the negotiation process, certain representatives of OPG (each an "**OPG Representative**") may be given access to: (i) all or parts of the Proposals; (ii) technical/project management, commercial and pricing information about the TG Project that is commercially sensitive and confidential; and (iii) information concerning the negotiation process itself (collectively "**Confidential Information**").

I, the undersigned, have agreed to participate in or support the negotiation process and, in my capacity as an OPG Representative, acknowledge and confirm as follows:

1) I shall not access or use the Confidential Information except for the purposes contemplated by and in accordance with the TG Project Negotiation Plan NK38-PLAN-09701-10187;
2) I shall not in any manner print, copy, reproduce, distribute, republish or otherwise provide access to or deliver the Confidential Information in any medium, print or electronic, without the express written consent of the Vice President Supply Services OPG Projects or his/her authorized delegate;
3) I shall maintain all Confidential Information in strict confidence and shall Vice President Supply Services OPG Projects or his/her authorized delegate; and
4) I shall not, without the express written consent of the Vice President Supply Services OPG Projects or his/her authorized delegate, discuss with any person or disclose to any person the Confidential Information (or information that is reasonably derived there from) except in strict compliance with TG Project Negotiation Plan NK38-PLAN-09701-10187.

CONFIDENTIALITY AGREEMENT (con't)

This Agreement is signed the_____ day of _____, 2013

_____

Signature

_____

Full Name (Print)

_____

Title/Position

Appendix C: Conflict of Interest Declaration

CONFLICT OF INTEREST DECLARATION

To: Vice President Supply Chain Services OPG Projects (or his/her authorized delegate)

From: _____
Print Name

Re: Procurement Process – Turbine Generator Refurbishment Project (the "TG Project") at the Darlington Nuclear Generating Station

I, the undersigned, understand that the entities listed in the attached Schedule A (the "**Disclosed Entities**", which term includes all directors, officers, employees and agents of such Disclosed Entities, whether or not such persons are listed in Schedule A) have been invited to participate in a procurement process for the TG Project (the "**Procurement Process**") and acknowledge and confirm as follows:

1) Pursuant to section 1.0 of OPG's Code of Business Conduct, it is mandatory for employees to declare to their manager and the Chief Ethics Officer any actual, perceived, or potential conflict of interest. To highlight the importance of identifying potential conflicts of interest, all members of the Negotiation Team, Negotiation Support Team and Steering Committee (as defined in Turbine Generator Refurbishment Project (EPC) Negotiation Plan NK38-PLAN-09701-10187) for the TG Project (each an "**OPG Representative**") are also being asked to disclose any situation where, in relation to the TG Project, such OPG Representative's commitments, relationships or financial interests, if any, with one or more of the Disclosed Entities, could or could be perceived to exercise an improper influence over the objective, unbiased and impartial exercise of independent judgment by such OPG Representative (a "**Conflict of Interest**"), including any perceived, potential or actual Conflict of Interest.
2) Other than as may be disclosed on Schedule B, I do not have any direct or indirect ownership interests (of 5 percent or more), activities or relationships, financial or otherwise, with any of the Disclosed Entities, nor am I providing any services to the Disclosed Entities, that create an actual, potential or perceived Conflict of Interest with completing the tasks that I may be asked to perform as an OPG Representative during the course of the Procurement Process. For greater certainty, I understand and agree that a financial interest may include employment, stock ownership (of 5 percent or more), a creditor or debtor relationship or a prospective employee/employer relationship with any of the Disclosed Entities.
3) I have listed on Schedule B, if applicable, all of the relationships that either I have or my spouse, partner or children have with the Disclosed Entities, each of which may be a Conflict of Interest or appear as a potential Conflict of Interest with completing the tasks that I may be asked to perform as an OPG Representative during the course of the Procurement Process.

4) I understand that Schedule B will be reviewed by the Chief Ethics Officer, with a copy to the Vice President Supply Services OPG Projects (or his Supply Chain authorized delegate), and that the Chief Ethics Officer may prescribe certain requirements to resolve any situations that the Chief Ethics Officer determines, in her sole and absolute discretion, create an actual or potential Conflict of Interest and/or exclude me from all or part of the Procurement Process.
5) I understand that the Disclosed Entities listed in Schedule A may be updated from time to time.
6) I agree to immediately disclose in writing to the Chief Ethics Officer, with a copy to the Vice President Supply Services OPG Projects (or his Supply Chain authorized delegate), any actual, potential or perceived situation that may be reasonably construed as constituting an actual or potential Conflict of Interest in connection with the Procurement Process, including a situation arising from the updated Schedule A, and to comply with any requirements prescribed by the Chief Ethics Officer to resolve such Conflict of Interest. I understand that the Chief Ethics Officer may, in her sole and absolute discretion, exclude me from all or part of the Procurement Process.

This declaration is signed _____ day of _____, 2013

_____
Signature

_____
Full Name (Print)

_____
Title/Position

Schedule A

DISCLOSED ENTITIES
Areva NP Canada Ltd.
Aecon Construction Group Inc
SNC-Lavalin Inc.

Schedule B

I declare that the following is a list of all the interests, activities or relationships which I, and or any member of my immediate family has with the entities listed in Schedule A or any director, officer, employee or agent of such entity.

COMPANY NAME	RELATIONSHIP

SEC Interrogatory #18

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/3]

Does OPG have its own model that calculates the effect of different cost overrun scenarios for any or all of the PRP contracts? If so, please provide a full electronic copy.

Response

OPG prepared and tested cost incentive/disincentive models during contract development and negotiation, but these models were working documents only, and were not kept updated.

OPG has also provided illustrative examples of cost overrun scenarios in evidence, in response to interrogatories (e.g., Ex. L-4.3-15 SEC-015), and in EB-2013-0321, in response to J14.1 and J14.2. However, these illustrative examples utilize a number of assumptions and simplifications to respond to the specific scenarios contemplated.

OPG does not have any models beyond the illustrative calculations that OPG would use to calculate the effect of different cost overrun scenarios for the Darlington Refurbishment Program contracts as they are today.

SEC Interrogatory #19

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2-2-11, Attachment 3] Does OPG have a management reserve for the DRP? If so, please provide details. If not, please explain why not.

Response

Please refer to L-4.3-2 AMPCO-103.

SEC Interrogatory #20

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/4, p.3-4] With respect to Lessons Learned:

a. For each project referenced, please provide the specific issues that were faced, the specific lessons OPG has learned, and the basis for those lessons.

b. Please provide all reports, analysis, opinion, evaluations and/or assessments undertaken by or for OPG, regarding lessons learned from other projects.

c. OPG states, "Insufficient front-end planning as a primary source of megaproject failures identified by statistical information based on benchmarking of 318 mega projects". Please provide the full source of this information including the benchmarking information referenced.

d. OPG identified as a lesson learned that "[n]uclear operating companies do not have the resources or the capabilities to manage and execute large projects." Please explain how retaining overall management responsibility and oversight is a reason to that lesson learned.

Response

a) Please refer to Ex. L-4.3-1 Staff-53 and Ex. L-4.3-2 AMPCO-52.

b) OPG declines to answer this question. The question does not recognize proportionality considerations which underlie the interrogatory process, in that it is overly broad and all encompassing.

The question contemplates the production of every report, analysis, opinion, evaluations and/or assessments undertaken by or for OPG regarding lessons learned from other projects. OPG's business includes an extensive quantity of documents that may be captured by the question asked in this interrogatory.

If the question were refined to reference specific materials relating to an issue on the approved issues list, OPG could undertake to find relevant materials. Please see Ex. L-04.3-2 AMPCO-52, Attachment 3 which provides a summary of the lessons learned library from the Risk Management and Oversight (RMO) tool for 2014-2015.

c) OPG was identifying that, based on the benchmarking referenced in the book, "Industrial Megaprojects: Concepts. Strategies, and Practices for Success", by Edward W. Merrow, published by John Wiley & Sons Inc (2011), inadequate front–end planning is a key lessons learned. Therefore, OPG took this lessons learned and ensured that an appropriate response was built into its planning activities during the Definition Phase to address this lessons learned. OPG did not intend to imply that OPG had itself done benchmarking of 318 megaprojects.

d) OPG interprets the question as "Please explain how retaining overall management responsibility and oversight is a *response* to that lesson learned".

OPG's focus since the early 1990s had been on operational excellence as, particularly after the completion of the Darlington nuclear station, there was expected to be a long period with no significant new megaprojects. As primarily an operating company, OPG's expertise and core competencies became focused on the skills needed to operate generating stations.

OPG is now entering a new phase of constructing new stations, primarily hydroelectric stations, and refurbishing existing stations or extending station lives, such as the Darlington Refurbishment Program and Pickering. Because OPG no longer has the in-house Project Management, engineering and skilled trades required for these significant construction projects, OPG must hire contractors to do the engineering and field execution. However, OPG has also learned through its own experience and that of other refurbishments that, particularly for nuclear refurbishment or restart projects, it must retain ownership and exercise stringent oversight of its contracts. As the owner, OPG retains the overall accountability for the project and must maintain a clear line of sight on the risks. Because of the complexity of integrating the design and construction work of multiple contractors, it is critical for the owner to have management control of the work in order to efficiently prioritize and resolve issues that could impact cost and schedule objectives.

As such, a multi-prime contract strategy was implemented to execute the refurbishment with OPG retaining ownership and control.

SEC Interrogatory #21

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2/4, p.3-4]

Please provide a table showing all individual capital projects previously undertaken by OPG (and its predecessor Ontario Hydro) with a final cost of at least $250M (in 2016 dollars) in the previous 30 years. For each of those projects, please provide the following information:

a. Name and description of the project.

b. Original forecast budgeted capital cost.

c. Final capital cost.

d. Capital cost variance.

e. Rationale for cost variance (if +/- 10%).

f. As applicable, lesson learned from the cost variance to the planning of the DRP project.

g. Original forecast project completion/in-service date.

h. Actual project completion/in-service date.

i. Schedule variance.

j. Rationale for schedule variance.

k. As applicable, lessons learned from the schedule variance to the planning of the DRP project.

Response

Since 2005, the Niagara Tunnel Project is the only capital project at OPG's regulated facilities with a cost greater than $250M (in 2016 dollars).

Consistent with OPG's conduct in EB-2007-0905, EB-2010-0008 and EB-2013-0321, historical information for the period prior to 2005 is not provided. The information from before 2005 is not relevant as OPG was not regulated prior to April 1, 2005.

In issuing an earlier version of the filing guidelines for OPG's prescribed facilities (EB-2006-0064), the OEB stated:

> *OPG, along with some other stakeholders, submitted that data should not be required for 2004 or earlier years, as proposed in staff's discussion paper. As the current payment regime was implemented in April 2005, these stakeholders questioned the relevance of 2004 and pre-2004 information. OPG, for its part, also indicated that providing the information would be a significant burden for it. The Board has accepted these submissions, and has not included information relating to 2004 or earlier years in the Filing Guidelines.*

OEB Cover Letter re: Setting Payment Amounts for Ontario Power Generation Inc.'s Prescribed Generation Assets, Filing Guidelines, EB-2006-0064, July 27, 2007, p. 3.

The OEB has, therefore, already made a determination that data from before 2005 is not relevant.

Below is the information for the Niagara Tunnel Project:

a. Name: Niagara Tunnel Project

b. Original forecast budgeted capital cost: $985M

c. Final capital cost: $1,464M (Note: The total OEB-approved value was $1,405M)

d. Capital cost variance: $479M

e. Rationale for cost variance (if +/- 10%): Project encountered sub-surface conditions that were significantly more adverse than anticipated based on pre-project geotechnical investigations.

f. As applicable, lesson learned from the cost variance to the planning of the DRP project: The specific lessons learned from the Niagara Tunnel Project that were provided to the DRP can be found in Ex. L-4.3-2 AMPCO-052, Attachment 4.

   With respect to the two lessons learned relating to cost specifically, DRP confirmed that it implemented project cost estimates broken out by month and by the work breakdown structure, and such estimates are provided at gate releases in advance of funding releases. In addition, DRP also implemented a forecasting model to allow timely forecasting of estimate-at-completion.

g. Original forecast project completion/in-service date: June 2010

h. Actual project completion/in-service date: March 2013

i. Schedule variance: 2 years, 9 months

j. Rationale for schedule variance: Project encountered sub-surface conditions that were significantly more adverse than anticipated based on pre-project geotechnical investigations.

k. As applicable, lessons learned from the schedule variance to the planning of the DRP project.

The specific lessons learned from the Niagara Tunnel Project that were provided to the DRP can be found in Ex. L-4.3-2 AMPCO-052, Attachment 4.

The Niagara Tunnel Project lessons learned with respect to schedule were based on its success with using a time-way (linear) schedule. As DRP is a megaprogram made out of many individual projects, each project schedule is developed individually and integrated into the overall program master schedule. The schedule is also resource loaded so that OPG can measure performance by hours and units as well as progress based on pre-defined earning rules. For more information on scheduling and the earning rules, please see Ex. L-4.3-1 Staff-057.

SEC Interrogatory #22

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
[D2/2] For each of the listed expert reports, please provide a list of all information and materials, including but not limited to, all documents, memorandums, notes of meetings with the OPG's employees, data requests and responses, and sources of research, that the consultant used or had access to, for the purpose of drafting their report. For all of this information and materials not already on the record in this proceeding, please provide copies.

a. [D2/2/2, Attach 1] Concentric Energy Advisors, *Assessment of the Commercial Strategies Developed For the Overall Darlington Refurbishment Projects and the Retube & Feeder Replacement Work Package* (September 2013)

b. [D2/2/11, Attach 1] Concentric Energy Advisors, *Updated Assessment of the Commercial Strategies Developed For the Overall Darlington Refurbishment Projects and the Retube & Feeder Replacement Work Package* (July 2016)

c. [D2/2/11, Attach 3] Testimony of Dr. Patricia D. Galloway, of Pegasus Global Holdings Inc. (July 2016)

Response

The following response has been prepared by Concentric Energy Advisors and Pegasus-Global Holdings:

a) A list of materials used to develop Concentric's September, 2013 report is provided as Attachment 1. The volume of documents captured by this list is very extensive. The production of the full documentary set may be of limited use, if any, to the OEB or intervenors. If after a review of the list, SEC expresses a desire to obtain production of any particular documents, OPG will be able to provide such documents.

b) Concentric's July 2016 report pertained only to the Retube and Feeder Replacement work package, not to the overall Darlington Refurbishment Program. The materials used to update and develop this report are provided in Attachment 2. Where the information has already been provided elsewhere in OPG's evidence, OPG has provided a cross-reference to where the information can be found.

c) The requested documents are voluminous and capture thousands of pages of documents. The materials referenced in this report are provided as Attachment 3. Where the information has already been provided elsewhere in OPG's evidence, OPG has provided a cross-reference to where the information can be found.

In addition, a list of all documents Pegasus-Global had access to is provided in Attachment 4. If after a review of the list, SEC expresses a desire to obtain production of any particular documents in addition to the documents already produced, OPG will be able to provide such documents.

L-4.3-15 SEC-022, Attachment 1

Documents Forming the Basis of Concentric's September 2013 Report

#	File Name	Description (if not clear from document title)
1	Report for Aug 15 Meeting with Gary R2	Staffing plans and estimates (draft as of August 2011)
2	Staffing Plan Assumption and Constraints 9 Sep 2011	Staffing Plan Assumption and Constraints 9 Sep 2011
3	DRP Project Charter	DRP Project Charter
4	DRP Project Execution Plan	DRP Project Execution Plan
5	NK38-PLAN-01060-10003	DRP: Scope Definition
6	Charter DR Management System	Managed Systems Quality Plan
7	N-PROG-LE-0002	Nuclear procedures (within Darlington Refurbishment)
8	DR_PROGRAM MILESTONES	Refurbishment milestone schedule
9	NROrg	Nuclear refurbishment organization chart
10	Project Playbook - June 6, 2011	DRP Project Plan
11	N-PROG-MP-0001	Engineering Change Control documentation
12	Nuclear Refurbishment Program Work Breakdown Structure Guide	Nuclear Refurbishment Program Work Breakdown Structure Guide
13	Nuclear Refurbishment Project Work Breakdown Structure Guide 18 July 2011	Nuclear Refurbishment Project Work Breakdown Structure Guide
14	Darlington Refurb Lessons Learned	Catalog of Lessons Learned
15	Project Status Reports	Project Status Reports: April 2010 through July 2011
16	Refurb Prgm Financial Summary - Dec 2010 Rev 2	Refurbishment Program Financial Summary
17	MK38-REF-09701-0394306_Advisory Committee 30 August 2010	Management Advisory Committee quarterly meeting materials
18	NK38-REF-09701-0394307_ AdvisoryCommittee _ Prelim Contracting Strategy v 12 R(07-08-10)	Preliminary Contracting Strategy
19	NK38-REF-09701-0394308_ Advisory Committee 16 September 2010	Management Advisory Committee quarterly meeting materials

20	NK38-REF-09701-0394309_ Advisory Commitee 22 October 2010	Management Advisory Committee quarterly meeting materials
21	NK38-REF-09701-0394310_Advisory Commitee 9 November 2010	Management Advisory Committee quarterly meeting materials
22	NK38-REF-09701-0394312_ Advisory Committee 23 November 2010 Key terms presentation	Management Advisory Committee - presentation on key contracting terms and conditions
23	NK38-REF-09701-0394313_Advisory Committee Jan 17 2011(3)	Management Advisory Committee quarterly meeting materials
24	NK38-REF-09701-0394314_Advisory Committee April 19 2011 KAH	Management Advisory Committee quarterly meeting materials
25	N-INS-00100-10000 (through 10006)	Nuclear Instructions
26	NK38-INS-09701-10001	Scope Review Instructions
27	NK38-PLAN-01210-10002	Outage Planning and Phase 1 Implementation Plan
28	NK38-PLAN-09701-10003	Scope Review Board - Terms of Reference
29	N-PROC-LE-0008 (through 0013)	Nuclear procedures (within Darlington Refurbishment)
30	N-PROG-AS-0005	Business Planning
31	N-PROG-LE-0002 (and 0003)	Program governance documentation
32	OPG-PROC-0050	Developing and Documenting Business Cases
33	OPG-PROC-0056 Post Implementation Review	Post Implementation Review
34	OPG-PROG-0006 Investment Management	Investment Management
35	OPG-STD-0062 Project Risk Mgt Standard	Project Risk Management Standard
36	RFR RFP Clarifications	Communications with bidders to clarify provisions of RFPs (re: DRP scopes of work)
37	Correspondence with bidders	(Various procurement correspondence re: RFP clarifications, conflicts of interest declarations, etc.)
38	Refurb Prelim Contracting Strategy v11 (02-12-10)	Refurbishment Preliminary Contracting Strategy (v11, 02-12-10)
39	NK38-REF-09701-0394336_CFST Feb 22 2011 Presentation(KAH)	Cross-functional sourcing team presentation
40	NK38-REF-09701-0394337_CFST June 9 2011 Presentation	Cross-functional sourcing team presentation
41	NK38-REF-09701-0394338_CFST June 22 2011 Presentation	Cross-functional sourcing team presentation

42	NK38-REF-09701-0394339_CFST July 22 2011 Presentation	Cross-functional sourcing team presentation
43	NK38-REF-09701-0394340_Refurb Mock-Ups - CFST UPDATE-14SEP10 (Peter Kukk)	Cross-functional sourcing team presentation
44	NK38-REF-09701-0394342_CFST_RFR Presentation to CFST Sept 14 2010 (Steve Harris)	Cross-functional sourcing team presentation
45	NK38-REF-09701-0394345_CFST Terms of Reference November 2010	Cross-functional sourcing team presentation
46	Appendix A_Contracting Strategy Team Meetings and Milestones	Contracting Strategy Team Meetings and Milestones
47	Darlington Retube and Feeder Mid Term Report 2 18 October 2010	Darlington Retube and Feeder Replacement Mid Term Report (October 2010)
48	NK38-09701-10009 Retube & Feeder Replacment Project RFP Submission Evaluation Plan R000	Retube & Feeder Replacement Project RFP Submission Evaluation Plan
49	NK38-09701-10011 Rev000 RFR Project RFP Submission Negotiation Plan	RFR Project RFP Submission Negotiation Plan
50	NK38-REF-09701-0394315_ Evaluation Steering Committee Presentations (3 total) _Feb 10 2011	Evaluation Steering Committee Presentations (Feb 2011)
51	NK38-REF-09701-0394317_Steering Committee_RFR RFP Evaluation Criteria_Mar30_2011	NK38-REF-09701-0394317 Steering Committee RFR RFP Evaluation Criteria (March 30, 2011)
52	NK38-REF-09701-0394323_Steering Commitee Tech Eval July 15th FINAL_July18Rev	RFR Proponent Evaluations and Recommendation (July 2011)
53	NK38-REP-00150-10001	DRP Commercial Strategy
54	nk38-rep-09701-10002 Mock-up Scope of Work R002	Mock-up Scope of Work
55	NK38-REP-09701-0379236 RFR Prequalificaiton Submission Eval Process - Recommendation report	RFR Prequalification Submission Evaluation Process - Recommendation report
56	NK38-SOW-31100-10016 Rev 000	RFR Scope of Work (March, 2011)
57	Procurement Activities OPG-PROC-0058	Procurement activities procedure
58	CSIP in Eng approval April,2008	Cost and Scheduling Project Improvement Project
59	N-PLAN-08130-10012 Refurb T Strategy	IT Management strategy
60	N-REP-09701-0353123 - Project C & PM GAP Analysis	Cost and Performance Management Gap Analysis
61	Classification, Protection and Release of Information OPG-STD-0030	Procedure
62	FIN-MAN-CM-001 Contract Management Process Manual	Contract Management Process Manual

63	Materials Management N-PROG-MM-0001	Materials Management documentation
64	NK38-PLAN-09701-10010 Darlington Refurbishment Management Plan	Darlington Refurbishment Program Management Plan
65	Nuclear Procurement Activities OPG-PROC-MM-0016	Procurement procedures for the nuclear organization
66	OPG Information Management Policy OPG-POL-0012	OPG information management policies
67	OPG-PROC-0019 Records and Document Management	Procedures related to document retention
68	Organization Authority Register OPG-STD-0017	Establish authorization levels for the organization
69	Purchasing Card OPG-PROC-0064	Purchasing Card procedures
70	NK38-INS-09701-10001 - DR Scope Review Instruction	Refurbishment Scope Review Instruction
71	RD-360_e_PDF	Life Extension of Nuclear Power Plants (CNSC Regulatory Document)
72	GE Hitachi RFP Agreement 7 March 2011	GE Hitachi RFP Agreement 7 March 2011
73	GE Hitachi RFP Process Document 7 March 2011	GE Hitachi RFP Process Document 7 March 2011
74	SNC Lavalin RFP Agreement 7 March 2011	SNC Lavalin RFP Agreement 7 March 2011
75	SNC Lavalin RFP Process Document 7 March 2011	SNC Lavalin RFP Process Document 7 March 2011
76	NR Program Cost and Cashflow 2011 E2 R13 Sep 20 2011	Refurbishment program cost and cash flow estimates (Sep 2011)
77	Approved Scope by Project-2.xlsb	Approved Scope by Project
78	11TP923 OPG DGNS Owners Support Services - Rev1	RFP for Owners Support Services ("OSS")
79	Bid Selection Summary Form 2 Rev2 - OSS RFP - Aug 3 2011	Template for proposal comparison
80	NK38-PLAN-09701-10066 OSS RFP Evaluation Plan R001	OSS RFP Evaluation Plan
81	OSS Evaluation - Credit Risk	OSS Evaluation - Credit Risk
82	OSS Evaluation - Team Two - non-pricing	OSS Evaluation - Non-price factors
83	OSS Evaluation - Team Two - Pricing Model Evaluation	OSS Evaluation - Pricing Model Evaluation
84	OSS Evaluation Meeting with Steering Committee - Notes (KH)	Notes from an OSS Evaluation Meeting with the Steering Committee
85	OSS Evaluation SCR	OSS Evaluation SCR

86	OSS Proponents Meeting - May 31 2011 R01	OSS Proponents Meeting - May 31 2011
87	OSS RFP - Team 1 2 - OSS Consensus Score - Aug 4 2011	OSS proposal consensus scores
88	OSS RFP - Team 2 - Commerical Scoring Summary - July 14 2011 R01	OSS Commercial Scoring Summary - July 14 2011
89	OSS RFP Evaluation - Team 1 - Technical Evaluation	OSS - Technical Evaluation
90	OSS RFP Evaluation Results	OSS - RFP Evaluation Results
91	OSS RFP Pricing Evaluation - Pricing Model Template	OSS RFP Pricing Evaluation - Pricing Model Template
92	OSS Scope of Services - Amendment _2	Amendment to the OSS Scope of Services
93	RFP Rules - OSS RFP - June 2 2011 - Amendment _2	OSS RFP Rules
94	RefurbDefnPhaseRR	Definition Phase Risk Register
95	OPG's Code of Conduct	OPG's Code of Conduct
96	NK38-PLAN-01060-10004	Condition Assessment Implementation Plan
97	NK38-GUID-09701-10000	Work Breakdown Structure Guide
98	OPG-FORM-0003	Single/Sole Source Justification (template)
99	RSC Projects List - Procurement Schedule -27 April 2011	Procurement schedule
100	AECL Scorecard Jul-Jun-09 final	AECL Scorecard Jul-Jun-09
101	AECL Scorecard Q3 Q4-2009	AECL Scorecard Q3 Q4-2009
102	AECL-DNGS D721 feeder replacement-441	Contract Final Inspection (documentation)
103	AECL-DNGS D811 feeder replacement-929	Contract Final Inspection (documentation)
104	AECL-Weld overlay-251 (2)	Contract closeout and evaluation
105	Potential Interferences Register	Risk evaluation
106	Suppliers DB	QA and scorecard data for a variety of vendors
107	09-002	INPO 09-002, Rev 0, Excellence in Nuclear Project Management
108	CEA 2-30	Staffing plan activities

109	CEA 2-32 Supply response	Description of approach to refurbishment work (Candu)
110	CEA 2-32 Supply response (attachment)	Description of approach to refurbishment work (Candu)
111	GE- 2009 Report _ RFR_Technical assessment- page 138 to 204	Exploration of manufacture option for pressure tubes
112	GE-2009 Report_Technical assessment- page 1 to 70	Exploration of manufacture option for pressure tubes
113	GE-2009 Report_Technical assessment- page 71 to 137	Exploration of manufacture option for pressure tubes
114	TD 38-01210-096-004 - Pages 1-100	Exploration of manufacture option for pressure tubes
115	TD 38-01210-096-004 - Pages 101 to 189	Exploration of manufacture option for pressure tubes
116	CEA 2-34 N-PLAN-09701-10002 DN Refurb Executive Oversight Team TOR	Oversight Team Terms of Reference
117	NOC - November 2009 Board Memo DN Refurbishment	Board-level approvals for Program
118	Gated Process N-INS-09701-10005	Nuclear instruction: Gated process (for phase progression)
119	N-MAN-08131-10000-S5-0121-R000	Role description: Director, Commercial Strategy
120	N-MAN-08131-10000-S5-0080-R002	Role description: Director, Engineering Programs
121	N-MAN-08131-10000-S5-0104-R001	Role description: Director, Refurbishment Supply Chain
122	N-MAN-08131-10000-S5-0102-R001	Role description: Director, Refurbishment Management System Oversight
123	N-MAN-08131-10000-S5-0116-R001	Role description: Director, Refurbishment Planning and Control
124	N-MAN-08131-10000-S5-0122-R000	Role description: Vice President, Refurbishment Execution
125	N-MAN-08131-10000-S5-0120-R000	Role description: Vice President, Refurbishment Engineering
126	N-DAI-00150-10000 Contractor Owner IR June 29 2011Signed	Contractor/Owner Interface Requirements for Nuclear
127	McKinsey Report - OMX005-20081182-Final Report	Organization Structure Review
128	RiskList-Oct20 NR	RADAR database
129	DOLLAR DATABASE	OPEX database
130	(Nov 2) TOR_2024-_12500314-v12-Darlington_-_RRF_EPC_agreement_-_draft_reflecting_discussions_with_SLN_AECON-TOR_2024-_12500314-v13-Darl	Draft (markup) EPC Agreement for RFR work package

131	BW EPC Contract (Blackline Oct 27)	Draft (markup) EPC Agreement for RFR work package
132	RFR EPC agreement for SLN-AECON - blackline of version 14 against version 13	RFR EPC agreement for SLN-AECON - blackline of version 14 against version 13
133	TOR_2024-_12516020-v1-BW_-_RFR_Poject_EPC_Agreement_-_Exhibit_2_9(a)	Draft (markup) EPC Agreement documentation for RFR work package
134	TOR_2024-_12516145-v1-BW_-_RFR_Project_EPC_Agreement_-_Exhibit_12_1(a)(1)	Draft (markup) EPC Agreement documentation for RFR work package
135	WS_BinaryComparison_TOR_2024-_12500314-v1-Darlington_-_RRF_EPC_agreement_-_draft_reflecting_discussions_with_SLN_AECON-TOR_2024	Draft (markup) EPC Agreement documentation for RFR work package
136	RFR White Paper Tooling Contingency Scenarios June 2011	RFR White Paper Tooling Contingency Scenarios June 2011
137	PDP STANDARD March 15 REV2 (2)	Project Development Plan standard
138	St Committee Meeting Minutes Oct 11 2011_R000	Steering Committee meeting minutes
139	St Committee Meeting Minutes Sept 28 2011_R001	Steering Committee meeting minutes
140	Nuclear Oversight Committee of the Board of Directors	Members of the OPG B.O.D. Nuclear Oversight Committee
141	CEA 2-64	List of standing executive management meetings in which DRP Procurement is discussed
142	CEA 2-65 DRP Economic Feasibility BCS	DRP Economic Feasibility Assessment
143	OPG RFR EPC Agreement (Consolidated with Exhibits)	OPG RFR EPC Agreement (Consolidated with Exhibits)
144	CAE 12-1	Updates to the scheduled start of the first refurbishment outage and the scheduled completion date
145	RFR Org Chart with Aug Staff and OSS	Organization Chart
146	RFR OSS PO-Task Request AMEC	Purchase Order revision
147	RFR OSS SOW	Scope of work for Owners Support Service
148	Blackline NK38-SOW-31100-10016-R003 Draft	Revisions to the RFR Scope of Work
149	CAE 12-7	Scope review process
150	Mock-Up Scope of Work_CompareResults_R004_vs_R003	Scope review processes related to the R&FR agreements and occurring from 2012 to August, 2013.
151	Memorandum - Change in Darlington Refurbishment Planning Assumptions June 6 2013	Memorandum - Change in Darlington Refurbishment Planning Assumptions June 6 2013

152	Memorandum - Preparation for Nuclear Refurbishment Release 4c Funding June 4 2013	Memorandum - Preparation for Nuclear Refurbishment Release 4c Funding June 4 2013
153	Execution Phase Schedule Change Contract Terms for RFR	Execution Phase Schedule Change Contract Terms for RFR
154	NR_CC_020_L1_Before_RO	DRP Schedule (as of 8/1/2013)
155	Basis of Estimate for RFR Waste Management R0	Basis of Estimate for RFR Waste Management
156	Estimate Waste Management for G2 2012	Estimate: Waste Management
157	RFR Contractor Optional Price from RFP	RFR Contractor Optional Price from RFP
158	Waste_Facility_Recommendation_Memo_11262012_signed	Waste Facility Recommendation Memo (November 2012)
159	PCD _2 Bulkhead Approvals	Procurement change directive: adding bulkheads and associated isolations
160	PCD _3 Waste Building Approvals	Procurement change directive: adding waste building
161	Tab 04 b) External Ovesight BMCD_MODUS_FULL FINAL_081313	MODUS and Burns & McDonnell report dated August 13, 2013

L-4.3-15 SEC-022, Attachment 2

Materials Reviewed in Preparation for Concentric Energy Advisors' July 2016 RFR Report

#	Category	Document Name	Filed Location
1	RFR, Miscellaneous	D2-02-08_Attachment 1 - Darlington Refurbishment Execution Phase Business Case Summary	Ex. D2-2-8, Attachment 1
2	RFR, Miscellaneous	Item 8 - Board Memo-DRP Program Contingency Management December 15 2015 _2_	Attachment 2, Tab 1
3	RFR, Miscellaneous	NK38-REP-09701-0548259 - RFR Report	Attachment 2, Tab 2 (contains confidential content as marked)
4	RFR, Miscellaneous	NR Program Change Management	Attachment 3-13
5	RFR, Miscellaneous	Nuclear Projects Risk Management	L-4.3-1 Staff 48, Attachment 24
6	RFR, Miscellaneous	RFR - R01 Execution Phase Class 2 Summary Report	Attachment 2, Tab 3 (contains confidential content as marked)
7	RFR, Miscellaneous	SCC document (Supreme Court of Canada Docket 35506)	Attachment 2, Tab 4
8	Functional Management Plan	NK38-GUID-09701-10023 (Darlington Refurbishment Functional Management Plan Guide)	Attachment 2, Tab 5
9	Functional Management Plan	NK38-PLAN-09701-10223 Sht 0007 (O&M)	Attachment 2, Tab 6
10	Functional Management Plan	NK38-PLAN-09701-10223 Sht 0008 (Project Planning & Controls)	Attachment 2, Tab 7
11	Functional Management Plan	NK38-PLAN-09701-10223 Sht 0009 (Program Support)	Attachment 2, Tab 8
12	Functional Management Plan	NK38-PLAN-09701-10223 Sht 0010 (Supply Chain)	Attachment 2, Tab 9
13	Functional Management Plan	NK38-PLAN-09701-10223 Sht 0012 (Construction Execution)	Attachment 2, Tab 10
14	Functional Management Plan	NK38-PLAN-09701-10223 Sht 0014 (Quality Management)	Attachment 2, Tab 11
15	Functional Management Plan	NK38-PLAN-09701-10223 Sht 004 (Nuc Refurbishment Engineering)	Attachment 2, Tab 12
16	Functional Management Plan	NK38-PLAN-09701-10223 Sht 005 (Nuc Projects Oversight)	Attachment 2, Tab 13
17	Functional Management Plan	NK38-PLAN-09701-10232 (Work Management)	Attachment 2, Tab 14
18	Functional Management Plan	NK38-PLAN-09701-10232 Sht 002 (Contract Management)	Attachment 2, Tab 15
19	Functional Management Plan	NK38-PLAN-09701-10235 RQE Estimate Plan (RQE Estimation)	Attachment 2, Tab 16
20	Oversight Reports	Attach 9.1 Expert Panel Review of RFR Est_Cov Let	Attachment 2, Tab 17
21	Oversight Reports	Attach 9.1 Expert Panel Review of RFR	Ex. D2-2-8, Attachment 4

		Estimate_Report	
22	Oversight Reports	BMCD Modus - DRC Report 3Q 2015 FINAL (Aug 20, 2015)	L-4.3-1 Staff 72, Attachment 10
23	Oversight Reports	BMCD Modus - DRC Report 4Q 2015 (Nov 12, 2015)	L-4.3-1 Staff 72, Attachment 11
24	Oversight Reports	BMCD Modus - Report to Nuclear Oversight Committee - Q1 2015	L-4.3-1 Staff 72, Attachment 8
25	Oversight Reports	BMCD Modus - Report to Nuclear Oversight Committee - Q2 2015	L-4.3-1 Staff 72, Attachment 9
26	Oversight Reports	BMCD Modus - Report to Nuclear Oversight Committee - Q4 2014	L-4.3-1 Staff 72, Attachment 6
27	Oversight Reports	BMCD Modus - Supplemental Report to Nuclear Oversight Committee - Observations Regarding 4d Cost Estimate - Q4 2014	L-4.3-1 Staff 72, Attachment 7
28	RFR Contract Amendment 1	Amendment_1_G14366-0006	Ex. D2-2-3, Attachment 6, starting at p. 1103
29	RFR Contract Amendment 2	Amendment Agt 2 to RFR - G14366-0020	Ex. D2-2-3, Attachment 6, starting at 1110
30	RFR Contract Amendment 3	RFR Amendment 3_FINAL	Ex. D2-2-3, Attachment 6, starting at p. 1238
31	RFR Contract Amendment 4	Early Works Letter_NK38-CORR-09701-0575487	Attachment 2, Tab 18 (contains confidential content as marked)
32	RFR Contract Amendment 4	Exhibit 6 1 Definition Phase Fixed Fee matrix - signed	Ex. D2-2-3, Attachment 6, p. 1630
33	RFR Contract Amendment 4	Exhibit_2 15 d_For Amendment No 4	Ex. D2-2-3, Attachment 6, starting at pp. 1486-1490
34	RFR Contract Amendment 4	MEMO - Jan 7 2016 - Execution Phase Amendment 4-RFR	Attachment 2, Tab 19 (contains confidential content as marked)
35	RFR Contract Amendment 4	RFR_Exhibit_16_1_Suspension_of_Work_Protocol_EXECUTION_COPY	Ex. D2-2-3, Attachment 6, pp. 1636-1637
36	RFR Contract Amendment 4	RFR_Exhibit_5_2(k)_Rad_Protection_Protocol_EXECUTION_COPY	Ex. D2-2-3, Attachment 6, pp. 1622-1626
37	RFR Contract Amendment 4	RFR_Exhibit_8_2(a)_EXECUTION_COPY	Ex. D2-2-3, Attachment 6, pp. 1632-1634
38	RFR Contract Amendment 4	RFR_Project_Execution_Phase_Amendment_EXECUTION_COPY	Ex. D2-2-3, Attachment 6, starting at p. 1475
39	RFR Contract Amendment 5	RFR EPC Agreement - Amendment Agt 5 to RFR	Ex. D2-2-3, Attachment 6, starting at p. 1638
40	RFR Contract Amendments: Summary memo	Contract_Summary_Updated_RFR_EPC_Rev2_March102016	This document is privileged and protected. The version Concentric Energy Advisors reviewed contained comments that constitute legal advice. The final version of the contract summary was filed at Ex. D2-2-3, Attachment 1.
41	Risk Management	Attachment 3.5(g) - RFR Contract Risk Register	Ex. D2-2-3, Attachment 6,

			starting at p. 1615
42	Risk Management	Cost Risks	Attachment 2, Tab 20
43	Risk Management	Global Risks	Attachment 2, Tab 21
44	Risk Management	Mapped Risks	Attachment 2, Tab 22
45	Risk Management	NR Risk Mgmt and Contingency Dev Guide R002	Attachment 2, Tab 23
46	Risk Management	Palisade Report to OPG re Contingency	L-4.3-15 SEC-026, Attachment 1
47	Risk Management	RFR OPG Owned Risks	Attachment 2, Tab 24

ONTARIO POWER GENERATION

FOR INFORMATION to the Darlington Refurbishment Committee

December 15, 2015

DARLINGTON REFURBISHMENT PROGRAM CONTINGENCY MANAGEMENT

REASON FOR REPORT

This report is in response to an action taken at the November 12th Darlington Refurbishment Committee (DRC) meeting and provides an update on the allocation and process to manage the $1.7 Billion contingency included in the Darlington Refurbishment Program (DRP) $12.8 Billion high confidence cost estimate.

HIGHLIGHTS

Management has implemented AACE (Association for the Advancement of Cost Engineering) recommended industry practices in the determination and management of contingency.

Initial Distribution of Contingency

As reported to the Board in November 2015, the total contingency included in the high confidence cost estimate is $1.7 Billion. The distribution of contingency, by type, source, and unit, is shown below:

Type	Source	4 UNIT RQE Estimate ($M)	Facility and SIO Projects ($M)	U2 ($M)	U3 ($M)	U1 ($M)	U4 ($M)
PROJECT	Discrete Risks – Specific to Project Bundles	564	42	202	135	101	84
	Estimating Uncertainty – Project Bundle Estimates and Resources	224	-	87	58	44	36
	Critical Path Schedule to Medium Confidence Duration (P50)	385	-	149	99	75	62
	Critical Path Schedule Medium Confidence Duration (P50) to High Confidence Duration (P90)	165	-	64	43	32	26
PROGRAM	Discrete Risks – Program (incl. Functional Risks)	310	-	120	80	60	50
	Estimating Uncertainty – Functional Resources	58	-	23	15	11	9
	TOTAL	**1,706**	**42**	**645**	**429**	**323**	**267**

Process for Releasing Contingency

The contingency management process for the DRP is incorporated in the project controls framework and focuses on early identification of risks and trends, active mitigation, forecasting, and contingency adequacy reviews in order to proactively manage the project estimate at completion.

Whenever possible, drawdown of contingency will be avoided by effectively managing and mitigating risks and trends including the use of favourable variances identified through project cost forecasting. When a risk or trend cannot be fully mitigated a drawdown of contingency will occur.

The following controls will be incorporated into the process for managing the drawdown of contingency:

- All project changes, including scope, cost, and schedule, will be documented, reflected in the risk register, and reviewed and dispositioned by a formal Change Control Board (CCB). The CCB is similar to the Scope Review Board that was in place in the planning phase and includes project staff, finance, project controls, and station and nuclear fleet staff.

- For changes that require a drawdown of contingency, the following escalation and approvals are required:

Project Level

Source	Approver	Approval Threshold	Unit 2 $M
Estimating Uncertainty – Projects	SVP Refurbishment Execution	100%	$87
Critical Path Schedule to Medium Confidence	SVP Refurbishment Execution	To 50% Consumption	$74
	SVP Nuclear Projects	50% to 100% Consumption	$75
Critical Path Schedule to High Confidence Duration	CNO and CEO	100%	$64
Discrete Project Risks	SVP Nuclear Projects	100%	$244(1)

(1) Includes $42 Million for Facility and SIO Projects

Program Level

Source	Approver	Approval Threshold	Unit 2 $M
Estimating Uncertainty – Functions	SVP Nuclear Projects	100%	$23
Discrete Program Risks	CNO and CEO	100%	$120

In addition to the above approvals, the following controls will be implemented:

1) Any discrete risk resulting in an allocation of contingency greater than $40 Million will require CNO and CEO approval. This aligns with the Organizational Authority Register (OAR) requirement for in-budget project investments. This is lower than the Darlington Aging Management OAR elements for requisitioning and contracts which is $100 Million.

2) Notification will be provided to the CNO and CEO on contingency drawdowns that impact multiple units.

3) Any contingency allocation requiring CNO and CEO approval also requires CFO approval.

4) Any low probability high consequence event that is outside the contingency determined for the project (e.g. Force Majeure, significant labour disruption, an international Fukishima Type Event) will be escalated to the DRC for approval. This may result in a revision to the DRP Business Case.

The contingency authorities for Unit 2 including the Facility & Infrastructure and Safety Improvement Projects, and for the overall 4-unit refurbishment, are as follows:

	UNIT 2 ALLOCATION		4 UNIT ALLOCATION	
APPROVER	**($M)**	**%**	**($M)**	**%**
SVP Refurbishment Execution	161	23%	416	24%
SVP, Nuclear Projects	341	50%	772	45%
CNO and CEO	184	27%	518	30%
	687		**1,706**	

Contingency Reporting

All contingency allocations are tracked and will be reported through the normal project reporting processes up to the CNO, CEO, and the DRC. This ensures that full visibility and awareness of all contingency drawdowns is maintained at all levels.

CONCLUSIONS

As part of the project cost performance report, management will provide the DRC with a contingency drawdown report. This report will identify the contingency that has been allocated to the project, major events resulting in the drawdown of contingency, and the amount of contingency remaining.

Management will also provide updates on contingency drawdowns affecting multiple units and the adequacy of contingency for the current and remaining units.

Submitted by:

_____
Dietmar Reiner
Senior Vice President, Nuclear Projects

APPENDICES

None

DARLINGTON REFURBISHMENT
Repowering Ontario

ONTARIO POWER GENERATION

Darlington Nuclear Refubishment Program

Release Quality Estimate (RQE)

Retube & Feeder Replacement Bundle Estimate Report

NK38-REP-09701-0548259

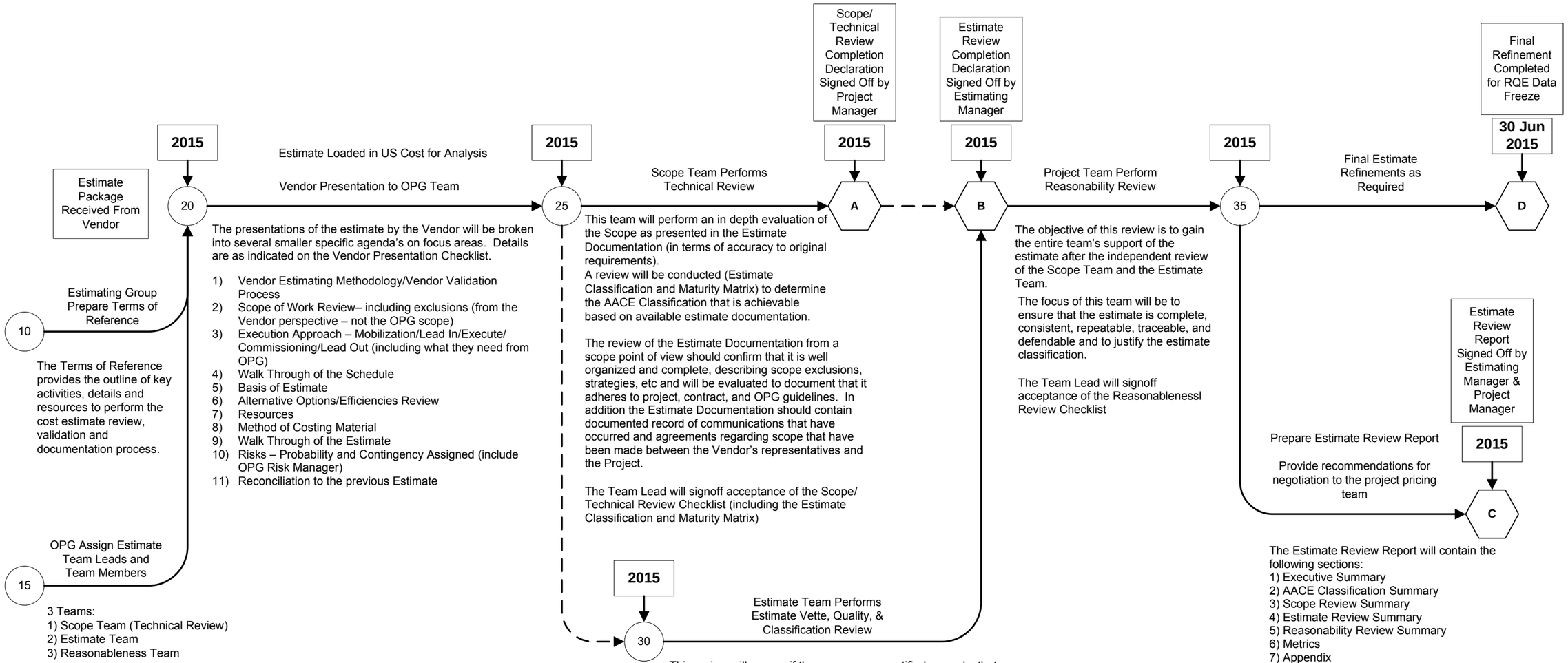
Date	December 12, 2015
Purpose	RQE Documentation
Source	Estimating Files

Confidential

27 March 2015
Rev 02

Estimate Vetting & Review Process Flowchart

- To ensure the quality of the estimate, this process is required to ensure the estimate meets Project and organization requirements in time for Release Quality Estimate (RQE).
- The objective is to initiate a formal Estimate Review process to support the execution of the RQE Cost Estimate Plan. This process will also facilitate Gate 3 GRB review requirements for the estimate (Submission Document Pre-Gate Review QA Checklist G3-3 per NK38-PLAN-09701-10227).



Class II Reasonableness Review Team Checklist

Project #: 73113 (U2), 73114 (U1), 73115 (U3), 73116 (U4)	**Bundle: RFR**
Project Name: Retube and Feeder Replacement	**Project Manager: Roy Brown**
Vendor: SNC-LAVALIN NUCLEAR, AECON JV	**Date Estimate Submitted: 5/11/2015**
Prepared By: Estimating team	**Date Review Completed: 10/1/2015**

Item	Project Process				Comments
1	Technical Review Completion Declaration (including checklist) reviewed	☒ Yes	☐ No	☐ NA	
2	Estimate Completion Declaration (including checklist) reviewed	☒ Yes	☐ No	☐ NA	
3	Presentation Checklist reviewed (including Estimate Classification and Maturity Matrix)	☒ Yes	☐ No	☐ NA	
4	Review Estimate AACE Classifications interpretations (target class, vendor rated class, achievable class, estimate actual class)	☒ Yes	☐ No	☐ NA	Class 2 Estimate with accuracy range of (-15% to +20%). OPG review team agree with JV's estimate classification proposal in Cost Basis section - refer to DNGS-RFR-Project-Class 2 - Milestone report section 4.1 (cost Basis)
5	Review vendor estimate strengths and weaknesses	☒ Yes	☐ No	☐ NA	Collaborative review sessions were held to address the strength and weakness. Change log files were created by review team to address the issues.
6	Reconciliation to Preceding Vendor Estimate (as available)	☒ Yes	☐ No	☐ NA	Estimates R0 & R1 were reviewed by OPG . Late changes after R01 have been identified by " RFR execution phase Class 2 - Late changes execution summary". Refer to DNGS- RFR-Project-Class 2 - Milestone report section 8
7	Reconciliation to the preceding available independent estimates	☐ Yes	☐ No	☒ NA	
8	Review available metrics	☐ Yes	☐ No	☒ NA	No metrics provided by Vendor
9	Provide dispositions for large discrepancies from the above reconciliation reviews and provide dispositions for large discrepancies from the above metric reviews	☒ Yes	☐ No	☐ NA	Refer to RFR Execution phase class 2 late changes execution summary- documented saving is $47M. In addition, general foreman rates need adjustment to align with contract agreement - exhibit 1.1._Rate Tables. The expected saving for this item is $10M, from base cost. This is considered as an area for improvement for future submission.
10	Perform check of prior revisions of estimates and traceability of changes based on review results	☒ Yes	☐ No	☐ NA	Estimates R0 & R1 were reviewed by OPG review team. Refer to change log sheet for details
11	Compare key OPG/Vendor/Industry key benchmarking ratios & factors, and vendor's benchmarking metrics report (unit rate tables) against vendor estimate (if available)	☒ Yes	☐ No	☐ NA	Vendor did not provide a metrics report. However, based on target cost summary report PMT= 18.7%, Training = 6% and DFL= 30% of target cost are reasonable, and within the range of industrial key benchmark.
12	Have efficiency gains with other project work been reviewed and incorporated	☐ Yes	☐ No	☒ NA	Unique project
13	Review acceptability of Material Purchase Strategy	☒ Yes	☐ No	☐ NA	By; RFR management team

Class II Reasonableness Review Team Checklist

Item	Project Process				Comments
14	Review acceptability of Construction Execution Method	☒ Yes	☐ No	☐ NA	Refer to ; DNGS - RFR project Class2 milestone report- section 9.3.4 series execution plans.
15	Review if Prime Contracting/Sub Contracting Strategy are in line with each other and review Contract Bid Types for mixture of types that could be in conflict with each other or with other projects.	☒ Yes	☐ No	☐ NA	
16	Did the vendor include a comprehensive list of deviations to the COIR requirements.	☐ Yes	☐ No	☒ NA	
17	Review vendor costs/expenses shared over various projects	☒ Yes	☐ No	☐ NA	There is potential save for sharing PMT staff with other projects like TG.
18	Review construction indirects and support services for reasonable costs	☒ Yes	☐ No	☐ NA	Support trades estimate is based on the schedule duration. Small tools cost is at 2% of DFL, Consumables cost is at 3% of DFL and PPE cost is at 1% of DFL , which are reasonable.
19	Review Vendor Estimating of Schedule Durations	☒ Yes	☐ No	☐ NA	Level-5 Schedule durations used for PMT & Support Trades. Estimate and project schedule window are aligned.
20	Has this estimate been aligned to the Vendor prepared schedule	☒ Yes	☐ No	☐ NA	The class 2 Rev01 estimate aligned with Level 5 project schedule.
21	Is Vendor using optimizing techniques for schedule of resource manpower loading	☐ Yes	☒ No	☐ NA	Resource leveling to be consider as an area for future improvement.
22	Has review included a check to ensure that the estimate is integrated with the schedule (Peak Period Review – Vertical Slice (up to 3 periods of complicated work)).	☒ Yes	☐ No	☐ NA	
23	Recap recommendations for risks and opportunities	☒ Yes	☐ No	☐ NA	As per risk Register
		☐ Yes	☐ No	☐ NA	
		☐ Yes	☐ No	☐ NA	

Signature: _____ Date: Oct 19, 2015

Estimate Reviewer

Prepared By: Nazar Al-Jasim

Signature: _____ Date: Oct, 19, 2015

Project Lead

Approved by: Nader Rahmaty

Darlington Refurbishment Class II Estimate Review RFR

Terms of Reference

Background:

- The Retube Feeder Replacement (RFR) Joint Venture (JV) is in the process of submitting their Class II Estimate for the Darlington Refurbishment Scope of Work.
- This Terms of Reference provides the outline of key activities, details and resources to perform the cost estimate review, validation and documentation process, in accordance with N-MAN-00120-10001-EST-03 - Nuclear Refurbishment -Estimate Oversight, Review, and Validation.
- To ensure the quality of the estimate, this process is required to ensure the estimate meets Project and organization requirements in time for Release Quality Estimate (RQE).
- The review will determine if the cost estimate:
    - reflects the project strategy, objectives, scope and risks.
    - is suitable for RQE.
    - ensures that all parties agree on and understand the estimate basis, scope, and cost.

Subject:

Per this Terms of Reference, perform a formal structured process to review the Estimate in accordance with AACE Recommended Practice # 31R-03 – Reviewing, Validating, and Documenting the Estimate.

The review will consist of 3 components:

- Scope (Technical Review)
- Estimate
- Reasonableness

Part of the Estimate Review will entail the review of the Basis of Estimate (BOE) in accordance with AACE Recommended Practice # 34R-05 – Basis of Estimate

The end result of this review is that the Cost Estimate is consistent, clear, and well documented and has the concurrence and understanding of the Project Team and the Estimating Team for submittal to and acceptance by the Darlington Refurbishment Senior Management Team for RQE.

1. Objective

The objective is to initiate a formal Estimate Review process to support the execution of the RQE Cost Estimate Plan.

2. Estimating Review Support Team Members:

Process Co-ordination:

- Estimating Team – John Haight

Support Member:

- Estimating Team – Lisa Ren
- To take notes during meeting, prepare Minutes of Meeting, Action Lists, Areas for Improvement, and document agreements.

RFR will create cross functional teams as required to perform the formal estimate review process (Scope & Estimate) of the various Comprehensive Work Packages (CWP) submitted by the JV.

Typical Cross Functional Team Member may include but not limited to:

- Team Lead –
- P&C Lead –
- Senior Advisor -
- Maintenance Lead -
- Engineering Lead -
- MTL –
- Refurb System Engineer –
- Station System or Components Engineer –
- JV
- OPG Estimator
- Project Director (optional)
- Estimating Manager (optional)
- 3rd Party Expert -

Reasonableness Team (as required):

- Team Lead (Project Director) – Roy Brown
- Project Managers
- Estimating Manager
- All members from Cross Functional Teams
- Scheduling
- Risk Manager
- Black Hat (external to the team)

3. Methodology

- Presentation of Focus Area with specific agenda's by the JV Estimating Team to the full OPG Review Team.
- Create cross functional teams to review the 2 components: Scope/Estimate Documentation, and Estimate (line by line computation – Peer Review).
- The 3rd component of the process will be a final Reasonableness review that will be performed with the Project Manager/Director and the Estimating Manager (panel review with schedule implications).
- Depending on the confidence of the preceding estimates (Vendor and 3rd Party) a decision will be made to leverage the review performed on the previous estimates including reconciliation/disposition of variances.
- Estimate Documentation review in accordance with AACE Recommended Practice # 34R-05 – Basis of Estimate.
- Findings will be recorded, and actions assigned to address any errors/deficiencies/ improvements identified.
- Report will be issued documenting the review process/recommendation

A. Presentations by JV:

The presentations of the estimate by the JV will be broken into several smaller specific agenda's on focus areas.

1) JV Estimating Methodology/JV Validation Process
2) Scope of Work – including exclusions (from the JV perspective – not the OPG scope)
3) Execution Approach – Mobilization/Lead In/Execute/Commissioning/Lead Out (including what they need from OPG)
4) Basis of Estimate
5) Alternative Options/Efficiencies Review
6) Resources
7) Method of Costing Material
8) Walk Through of the Schedule
9) Walk Through of the Estimate
10) Risks – Probability and Contingency Assigned (include OPG Risk Manager)
11) Reconciliation to the preceding estimates

A Presentation Review Checklist will be completed to document the review process.

B. Scope Review (Technical Review):

This review will be performed with the inclusion of technical support.

The OPG Technical/Scope review will entail an in depth evaluation of the Scope as presented in the BOE/Estimate Documentation (per N-MAN-00120-10001-EST-02). A review will be conducted (Estimate Classification and Maturity Matrix) to determine the AACE Classification that is achievable based on available estimate documentation.

This review shall evaluate in depth the BOE/estimate documentation and BOE in terms of accurately representing the project scope. This review will also ensure the estimate documentation meets project, contractual and OPG governance.

This review may include a cold eyes review for some scope areas.

The estimate review package submitted by the JV will be made available in a folder to allow all team members an advance review.

The review of the BOE/Estimate Documentation from a scope point of view should confirm that it is well organized and complete, describing scope exclusions, strategies, etc and will be evaluated to document that it adheres to project, contract, and OPG guidelines. In addition the BOE/Estimate Documentation should contain documented record of communications that have occurred and agreements regarding scope that have been made between the JV representatives and the Project.

The main outcome is to ensure that all scope has been included and the BOE/Estimate Documentation accurately reflects the basis/decisions regarding scope that served as input to the estimate.

A Scope Review Checklist will be completed to document the review process.

A Scope/Technical Review Completion Declaration will be completed to document completion.

C. Estimate Review:

The Estimate Review will assess if the scope was quantified properly, and that the estimate is consistent with the BOE/Estimate Documentation. This review may be conducted in parallel with the Technical Scope review. The Estimate Review will also include an assignment of an AACE Classification in accordance with N-MAN-00120-10001-EST-02 by the NR Estimating Manager.

The review of the BOE/Estimate Documentation should confirm that it is well organized and complete, sources of pricing, project strategies, factors, rates, hours of work, etc and will be evaluated to document that it adheres to project, contract, and OPG guidelines. In addition the Estimate Documentation should contain documented record of communications that have occurred and agreements that have been made between the JV's Representatives and the Project.

Depending on availability of resources and time the review process could factor in the 80/20 principal where 80% of the costs come from 20% of the estimate line items. The focus of the review will start with line items that have the most significant cost effects with a drill down into the details and estimating process applied to those line items (drill down into the quantity takeoff, basis for the

unit material price and labor hours, factors used, and adjustments made). As confidence is gained a review of less significant line items may be waived.

A check of values will be performed on the estimate to ensure extensions of pricing are correct, factors, pricing, rates, etc. are correct, and summaries add up accurately.

The estimate review will provide areas for improvement, and an assessment of the estimate (including rational why).

The main outcome is to ensure that scope has been quantified properly and the Estimate Documentation accurately reflects the basis/decisions that served as input to the estimate.

An Estimate Review Checklist will be completed to document the review process.

An Estimate Review Completion Declaration will be completed to document completion.

D. Reasonableness Review:

The objective of this review is to gain the entire team's support of the estimate after the independent review of the Technical/Scope and the Estimate.

The focus of this review will be to ensure that the estimate is complete, consistent, repeatable, traceable, and defendable and to understand the estimate classification.

Scope Review Lead and the Estimate Review Lead will summarize the findings/opinions (including rational why)/variances/corrections/areas for improvement from the independent reviews and present to the Reasonableness Team.

This review will include a check to ensure that the estimate is integrated with the schedule (Peak Period Review – Vertical Slice (up to 3 periods of complicated work)).

Reconciliation to Preceding Estimate(s) (if available) – This is to leverage the previous review performed on the previous submissions. Review all discrepancies but focus on the line items that are new or missing, or with a higher estimate. Identify the gaps between the 2 estimates and disposition the reasons for the gaps.

The main outcome is to ensure that the overall cost estimate is reasonable and that the Project Director and Estimating Manager have confidence in the JV's submission and can defend the estimate with Senior Management.

The proposed changes conclusions/areas for improvement to the estimate will be reviewed/dispositioned by the Reasonableness Review team. NR Estimating Group will prepare a comment/dispositions sheet for inclusion in the Final Report. These will be reviewed with the Vendor for agreement/disposition.

Products from this review will include a reconciliation of the previous estimates to the current estimate in the form of a variance report.

A Reasonableness Review Checklist will be completed to document the review process.

An Estimate Review Final Report will be completed by the Estimating Section Manager and approved by the Project Manager/Director to summarize the results of the project review process.

4. Schedule

- Reference NK38-PLAN-09701-10235-001 RQE Cost Estimate Development Roadmap
- Estimate R0 is anticipated from the JV – 08 May 2015.
- The timeline for this process is to be completed by 15 June 2015.

5. Approval

Prepared by: _____ Date: 02 APR 2015
Mike Van Hemmen
F&G

Reviewed by: _____ Date: 02APR 2015
Robert Obertries
Manager Estimating

Approved by: _____ Date: 8 MAY/15
Perrik LeDreff/Roy Brown
Deputy Project ~~Manager~~ Director/Director
Project Name: RFR

Darlington RFR Estimate Review Report

SECTION A: GENERAL INFORMATION

Project:	Retube and Feeder Replacement - Execution Phase
Project #(s):	73113 (U2), 73114 (U1), 73115 (U3), 73116 (U4)
Bundle:	RFR
Project Director:	Roy Brown
Vendor:	SNC & Aecon Joint Venture
Report Number:	

(1)	DNGS RFR Project – Class 2 Rev 01 – Summary Report: 509407-0000-00000-33RA-0174
(2)	Execution Phase Class 2 Rev 00 Milestone Report: 509407-0000-00000-33RA-0144
(3)	Schedule Report: 509407-0000-00000-33RA-0145
(4)	Owner Specified Materials (OSM): 509407-0000-00000-33RA-0146
(5)	DFL Summary Report- Series: 509407-0000-00000-33RA-0147
(6)	Pre-Requirements: 509407-0000-00000-33RA-0148
(7)	Feeder Removal: 509407-0000-00000-33RA-0149
(8)	Fuel Channel Removal: 509407-0000-00000-33RA-0150
(9)	Inspection: 509407-0000-00000-33RA-0151
(10)	Fuel Channel Installation: 509407-0000-00000-33RA-0152
(11)	Post-Requirements: 509407-0000-00000-33RA-0153
(12)	Waste Volume Reduction: 509407-0000-00000-33RA-0154
(13)	Supervision (EPSCA) and Project Management Team (PMT): 509407-0000-00000-33RA-0155
(14)	Trades Support: 509407-0000-00000-33RA-0156
(15)	Training - Series: 509407-0000-00000-33RA-0157
(16)	Training - Onboarding: 509407-0000-00000-33RA-0158
(17)	Preparations for Subsequent Units (Unitized Engineering, CWP's and Procurement): 509407-0000-00000-33RA-0159
(18)	Living Out Allowance (LOA) Craft and Staff and JV Travel: 509407-0000-00000-33RA-0160
(19)	Support Services & Equipment (SS&E): 509407-0000-00000-33RA-0161
(20)	Scope Change Control Issues: 509407-0000-00000-33RA-0162
(21)	Tool Management: 509407-0000-00000-33RA-0163
(22)	Demobilization and Project Closeout: 509407-0000-00000-33RA-0164
(23)	Risk Report: 509407-0000-00000-33RA-0165
(24)	Feeder Installation: 509407-0000-00000-33RA-0166
(25)	ALARA & Dose Analysis: 509407-0000-00000-33RA-0167
(26)	Labour Productivity Factors: 509407-0000-00000-33RA-0168
(27)	What If Scenarios: 509407-0000-00000-33RA-0169
(28)	PMT and DFL Manpower Levelling: 509407-0000-00000-33RA-0170
(29)	Commissioning Support: 509407-0000-00000-33RA-0171
(30)	Contingency Target Cost & Target Schedule Development: 509407-0000-00000-33RA-0172
(31)	Compliance: 509407-0000-00000-33RA-0173

Executive Summary:

1) Submitted estimate is a Class within	Class 2 as of AACE Standard
2) For the purpose of RQE this range of accuracy is	-5% to -15% on the low side, and +5% to +20% on the high side
3) For the purpose of RQE Quality and documented basis is	Acceptable
4) submitted estimate reviewed and found to be	Reasonable

Comments:	The class 2 Rev01 estimate is acceptable. The estimate developed based on high degree of deterministic estimating methods, using project management team organization charts, level 5 schedule, CWP's work levels to calculate DFL, and purchase orders for material. Factoring cost method is limited to specific items such as small tools, consumables, reworks, etc. The estimate reviewer used deep dives technique for selected cost items. Considering the size and uniqueness of the work, there are limited discrepancies between overall key benchmark ratios and factors compared to the industrial key benchmarks.

SECTION B: AACE CLASSIFICATION SUMMARY

Target Class	Class 2 as of AACE Standard
Vendor Declared Class	Class 2 as of AACE Standard
Achievable Class	Class 2 as of AACE Standard
Actual Class	Class 2 as of AACE Standard

SECTION C: SCOPE REVIEW SUMMARY

1) Scope Review Completion Declaration completed with:	No Exceptions
Exception Summary:	

SECTION D: ESTIMATE REVIEW SUMMARY

1) Estimate was accepted with:	Exceptions
Exception Summary:	The estimate exception; the estimate is accepted with saving opportunity related to late changes section, and expected changes related to the general foreman rate adjustment.

SECTION E: REASONABILITY REVIEW SUMMARY

1) For the purposes of RQE Estimate is reasonable as is	Reasonable with the following Areas for Improvement for the next estimate progression
Areas for Improvement:	The contractor identified additional saving of $47M, under late changes section. Late changes have not been captured in R01 submission. In addition, the estimate group team believe that the general foreman rates need adjustment to align with the contract agreement, exhibit 1.1_ rate tables. The Class 2 estimate R01 is reasonable. RQE estimate can carry the estimated cost minus the agreed late changes estimated cost. Opportunity for saving of $10M related to General foremen rate adjustment.

SECTION F: METRICS

Metric report:	Calculated From JV Class 2 Estimate Summary
Direct Cost (Vault + Training $) vs Total Project Target Cost ($)	[redacted]
PMT ($) vs Total Project Target Cost ($)	
Rework ($) vs Total Project Target Cost ($)	
Rework ($) vs Total Project Target Cost ($)	
Contingency ($) vs Total Project Target Cost ($)	
SSE ($) vs Total Project Target Cost ($)	
Reimbursable with mark-up ($) vs Total Project Target Cost ($)	

Reimbursable without mark-up ($) vs Total Project Target Cost ($)	[redacted]

SECTION G: APPENDIX

1) Vendor Presentation Checklist	Attached
2) Scope/Technical Review Completion Declaration (including	Attached
3) Estimate Review Completion Declaration (including Estimate Review Team Checklist)	Attached
4) Completed Comment, Diposition Form	Attached
4) Reasonableness Review Team Checklist	Attached
5) Estimate Review Terms of Reference	Attached

SECTION E: REPORT SIGNOFF

Prepared By: Nader Rahmaty **Date:** 23, oct, 2015
Team Lead /Estimating Section Manager

Reviewed By: Robert Obertreis **Date:** 23-Oct-2015
Estimating Manager

Accepted By: for R. Brown **Date:** Nov. 3, 2015
Project Director (Manager)

Class II Vendor Presentation Checklist

Project #: Retube and Feeder Replacement	**Bundle: RFR**
Project Name: RFR	**Project Manager: Roy Brown**
Vendor: SLN Aecon JV	**Date Estimate Submitted: 5/8/2015**
Prepared By: Preparer Name	**Date of Presentation: 5/15/2015**

Item	Project Process				Comments
1	Estimating Methodology/Validation Process	☒ Yes	☐ No	☐ NA	High level methodology used to prepare the Estimate has been provided in the presentation. Reference to the JV Estimate Plan, and Class II Compliance Chapter are provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
2	Evidence of how the estimate was produced	☒ Yes	☐ No	☐ NA	Scope of the project, basis of estimate, schedule development walkthrough/overview, PMT structure, dose uptake forecasts, details on how risk/contingency and fixed fee are applied to determine target cost, and details on compliance are provided. The presentation also refers to the Class II Chapters, Basis Sections and Estimate appendices for further information on Slide #46-48. These slides include a completed copy of this Checklist.
3	Evidence of independent reviews conducted by vendor	☒ Yes	☐ No	☐ NA	Reference to Class II Compliance Chapter provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
4	Key estimating members of the specific project team identified with levels of experience	☒ Yes	☐ No	☐ NA	Reference to Class II Compliance Chapter provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
5	Acceptable Scope of Work Review– including exclusions (from the Vendor perspective)	☒ Yes	☐ No	☐ NA	Reference to Class II Compliance Chapter and Class II Scope Change Control Chapter provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
6	Evidence of vendor's verification and review process of scope vs assumptions, inclusions, exclusions, exceptions, clarifications	☒ Yes	☐ No	☐ NA	Reference to Class II Compliance Chapter and Class II Scope Change Control Chapter provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
7	Acceptable Execution Approach – Mobilization/Lead In/Execute/ Commissioning/Lead Out (including what they need from OPG)	☒ Yes	☐ No	☐ NA	Reference to the Project Management Plan, Class II Supervision and Project Management Team Chapter, Class II Schedule Report and Class II Demobilization and Project Closeout Chapter provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
8	Walk Through of the Schedule Performed	☒ Yes	☐ No	☐ NA	High level walkthrough of the schedule, including inputs to the schedule, a schedule duration overview (base and contingency), unit overlap and sequencing, shift patterns, and methodology provided in presentation. Reference to Class II Schedule Report provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
9	Is Vendor using optimizing techniques for scheduling of resources/ manpower loading. Manpower Reports, Histograms presented	☒ Yes	☐ No	☐ NA	Histograms have been provided in the presentation. Also, reference to Class II Schedule Report, and Schedule Management Plan provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
10	Basis of Estimate Presented	☒ Yes	☐ No	☐ NA	Basis of Schedule, Cost and Risk and Contingency inputs provided. Reference to Class II Chapters, Basis Sections and Estimate Appendices and JV Estimate Plan provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
11	Key deliverables, assumption, exclusions and key cost drivers identified	☐ Yes	☒ No	☐ NA	Reference to Class II Scope Change Control Chapter and Class II Chapters, Basis Sections and Estimate Appendices provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
12	Alternative Options/Efficiencies Review	☒ Yes	☐ No	☐ NA	Alternative Options considered and implemented during the Definition Phase included in presentation. Also, reference to Class II Risk Chapter, and Class II "What-If" Chapter provided in the presentation on Slide #46-48. These slides include a completed copy of this

Class II Vendor Presentation Checklist

Item	Project Process				Comments
					Checklist.
13	Resource Review Performed	☒ Yes	☐ No	☐ NA	Histograms provided. Additionally, reference to Class II Schedule Report, and JV Resource Management Plan provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
14	Method of Costing Material - Did the estimate include material quotes from several different suppliers	☒ Yes	☐ No	☐ NA	Reference to reference to Class II OSM and Goods Report, as well as the JV Materials Procurement Plan provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
15	Review control accounts and work packages for completeness	☒ Yes	☐ No	☐ NA	Reference to reference to Class II Compliance Chapter has been provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
16	Walk Through of the Estimate Performed	☒ Yes	☐ No	☐ NA	The presentation provides a walkthrough of the Estimate Methodology and Schedule.
17	Cashflows Presented	☒ Yes	☐ No	☐ NA	Reference to the Class II Schedule Report has been provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
18	Evidence of any opportunity for the project future estimate refinement	☒ Yes	☐ No	☐ NA	Overview of Risks and Opportunities has been provided in the presentation. Additionally, reference to the Class II Risk Chapter has also been provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
19	Risks Identified – Probability and Contingency Assigned	☒ Yes	☐ No	☐ NA	Overview of Risks and Opportunities, and Contingency Development has been provided in the presentation. Additionally, reference to the Class II Risk Chapter and Class II Contingency Chapter has also been provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
20	Evidence of Reconciliation to previous estimates	☒ Yes	☐ No	☐ NA	Reference to the Class II Milestone Report has been provided in the presentation on Slide #46-48. These slides include a completed co of this Checklist.
21	Evidence of estimate benchmarking	☐ Yes	☐ No	☐ NA	Benchmarking of the Class II Estimate against Bruce Unit 1, Unit 2, Wolsong, and Point Lepreau actual durations scaled to a Darlington sized reactor included in presentation. Additionally, reference to Class II Compliance Chapter, and Class II Schedule Chapter provided in the presentation on Slide #46-48. These slides include a completed copy of this Checklist.
		☐ Yes	☐ No	☐ NA	
		☐ Yes	☐ No	☐ NA	

Scope/Technical Review Completion Declaration

SECTION A: GENERAL INFORMATION	
Project #: Retube and Feeder Replacement	**Estimate Classification:** ____
Project: RFR	**Project Manager:** Roy Brown
Vendor: SLN Aecon JV	
Date Vendor Estimate Submitted: 5/8/2015	
Date Vendor Presentation Completed: 5/15/2015	

Objective:

1) The review of the Estimate Documentation from a scope point of view should confirm that it is well organized and complete, describing scope exclusions, strategies, etc and will be evaluated to document that it adheres to project, contract, and OPG guidelines and that it is complete and it covers entire projects scope.

2) In addition the Estimate Documentation should contain documented record of communications that have occurred and agreements regarding scope that have been made between the JV estimators and the Project.

3) The main outcome is to ensure that all scope has been validated and included and the Estimate Documentation accurately reflects the basis/decisions regarding scope that served as input to the estimate.

Team Members (as required):

Title:	Name:
Team Lead/Project Manager	Perrik LeDreff
P&C Lead	Sudhakar Pulagam
Senior Advisor	Saumil Sabhaya
Maintenance Lead	Gerard Edison
Engineering Lead	David Kurpjuweit
MTL	N/A
Refurb System Engineer	N/A
Station System/Components Engineer	N/A
Vendor Representative	N/A
Project Director (optional)	Roy Brown
Estimating Manager (optional)	Robert Obertreis
Others:	

SECTION B: TECHNICAL REVIEW ACTIVITIES

In accordance with the attached formal Scope Review Team Checklist

1) Kick Off Meeting
2) Assignment of Tasks to Engineering Leads
3) Review of Findings for Class II Revision 00 Deliverables with Signatories
4) Sign-off
5) Review of Class II Revision 01 Deliverables and Update of Findings
6) Sign-off

SECTION C: REVIEW FINDINGS/OPINIONS/RATIONAL

Summarize the findings/opinions (including rational why)/variances/ corrections/areas of improvement.

1) Findings are documented in the attached "Class II Scope Review Team Checklist", "Supporting Comments" Spreadsheet. Both of these documents have been updated with findings following review of the Class II Revision 01 Deliverables.

SECTION D: DECLARATION OF COMPLETION

1) The Scope/Technical Review was completed in accordance with the attached Scope Review Team Checklist.
2) The findings were as listed in Section C.
3)

SECTION E: COMPLETION DECLARATION SIGNOFF

Date Completion Declaration Reviewed With Team:

Prepared By: N/A Date: N/A
MTL

Prepared By: [signature] Date: Sept 29, 2015
Engineering Lead

Reviewed By: [signature] Date: 30/09/15
Maintenance Lead

Accepted By: [signature] Date: 30-SEP-2015
Project Manager/Director

~~EDIS~~ EDISON WAS THE OPS+MTS LEAD FOR CWP REVISION WHICH FORMED BASIS OF ESTIMATE.

Class II Scope Review Team Checklist

Project: Retube and Feeder Replacement	**Bundle:** RFR
Project Name: RFR	**Project Manager:** Roy Brown
Vendor: SLN-Aecon JV	**Date Estimate Submitted:** May 8, 2015
Prepared By: S.Kasaai	**Date of Review:** September 24, 2015

Item	Project Process				Comments
The main outcome is to ensure that all scope has been included and the Estimate Documentation accurately reflects the basis/decisions for the estimate					
1	Full documentation review. Estimate Documentation is complete and it covers entire project scope	☒ Yes	☐ No	☐ NA	Documentation review was performed for example SOW and Estimate Documentation. Agreement and Exhibits have also been reviewed. Estimate Documentation is complete and covers entire project scope.
2	Document review confirms ability to achieve what AACE Classification. In accordance with Estimate Classification and Maturity Matrix.	☐ Yes	☐ No	☒ NA	OPG Nuclear Refurbishment Estimating Team (not Project Team) will determine whether the estimate is Class II.
3	Review of scope exclusions. Did the estimate state any exclusions/exceptions. If so cost needs to be captured for RQE in Project or with Functions.	☒ Yes	☐ No	☐ NA	Exclusions are listed in the Milestone Compliance Chapter and the Scope Control Chapter.
4	Collate all items – including vendor and sub contractors (assumptions, inclusions, exclusions, exceptions, clarifications) and review for validity/clarity/duplications/overlaps and review vs scope. Determine if required as a Basis/Assumption in OPG database.	☒ Yes	☐ No	☐ NA	Not all subcontractors are in place at the time of estimate submission. Costs are included in the estimate but may be quotations from sub-contractors only. The incorporation of sub-contractors is now presented in a consolidated manner (see "CWP Summary Spreadsheet- Class 2- Rev 01.xlsx" New Items Tab.
5	Did the vendor include a comprehensive list of deviations to the COIR requirements. If so cost needs to be captured for RQE in Project or with Functions.	☒ Yes	☐ No	☐ NA	The Basis for the Class II submission is Revision 2 of COIR- NK38-DAI-09701-10008 which is appropriate given that this is the latest approved revision. Reference to the document has been provided in multiple locations of the Revision 01 Estimate. The document is referenced in the Preparations for Subsequent Units Chapter, Scope Control Chapter and Compliance Chapter. During review of Revision 0 it was determined that the current revision of the COIR requires an update due to OPG completing MEC Packages. Generally speaking, revision numbers were not provided to the documents referenced in the CL2 submittal. The most current version of the documentation was the basis of the estimate.
6	Is Vendors interpretation of Estimate Scope accurate – ie. SOW, Drawings, Specifications, etc.	☒ Yes	☐ No	☐ NA	Milestone Compliance chapter has a scope traceability matrix that demonstrates a comprehensive understanding of scope. Review of the Milestone Compliance chapter indicates the compliance is to Exhibit 3.5 of the agreement. Review of other Exhibits was not completed in this exercise. NOTE: There is no scope traceability matrix for any other potentially relevant Exhibits or the rest of the Agreement.
7	Review record of communications regarding scope decisions between the vendor and the project	☒ Yes	☐ No	☐ NA	Review of Scope Control Chapter has been completed and content is as agreed upon with OPG Collaborative Review team.
8	Did vendor have a review & verification process and documentation (ie Scope Traceability Matrix)	☒ Yes	☐ No	☐ NA	The JV preformed review and approval of the document which contained the RTM.

Class II Scope Review Team Checklist

Item	Project Process				Comments
					Page 9 of the Milestone Compliance states that JV independent cold eyes peer review team, JV accounting validation review of calculation and data flow of estimate, and JV Corporate Review of the estimate. OPG Review of Milestone Compliance chapter has been completed, which includes the scope traceability matrix.
9	Is work duplicated elsewhere/overlap with other projects	☐ Yes	☒ No	☐ NA	No duplication of effort between the contractor and other projects was found by review team. Note that this risk is mitigated through the COMS process where these potential issues are identified and resolved.
10	Conduct sampling of critical items and trace scope from SOW through to lowest element of estimate.	☒ Yes	☐ No	☐ NA	Completed through review of chapters. Scope related comments obtained from chapter reviews. No issues found.
11	Did the contractor follow different Price Options identified by the Project Team?	☒ Yes	☐ No	☐ NA	Procurement of OSM and Goods has been completed for Unit 2 as part of the definition phase. Procurement activities for subsequent units were included in this estimate. Based on the procurement activities being conducted for Unit 2 for OSM and Goods, the Contractor has followed the agreed to Pricing Options and processes as laid out in the RFR Agreement, particularly Exhibit 2.11.
12	Review listing of all Vendor drawings, sketches, BOMs, and equipment lists against OPG lists. Confirm they are up-to-date.	☒ Yes	☐ No	☐ NA	ECC process ensures drawings, BOMs etc are up to date and any known discrepancies between field and paper are documented via SCRs. Where practical the discrepancies are incorporated into the design. NOTE at the time of estimate submission, the DEC's for the PMODs ie Feeders, FC, calandria vessel have not been completed.
13	Review if Eng processes/assumptions are correct	☒ Yes	☐ No	☐ NA	Processes: Engineering Processes used are in accordance with the agreement. There is a statement in the Milestone Compliance Chapter, page 32 that the OPG procedures to be followed are as per the original Agreement. Procedure revisions are dealt with in the contract which clearly states in Section 2.1 d (4) that procedures may be amended from time to time.
14	Review Vendor risk basis documentation. Review OPG risk register and assigned ratings and determine consistency to Vendor basis	☒ Yes	☐ No	☐ NA	A risk evaluation team has been formed in order to review both the JV risk register and the OPG risk register to ensure consistency.
15	Does the scope include for all required workplans, installation specs, instructions, final reports, etc	☐ Yes	☒ No	☐ NA	More clarity is required on what portions of the work are to be driven by workplan vs CWP's. The estimate as presented is a bounding case where all CWPs require work plans.
16	Does the scope include for initiating/assessing Work Orders/CWP's. Includes identification of OPG support tasks.	☐ Yes	☒ No	☐ NA	Estimate for initiating/assessing Work Orders/CWP's was found in Appendix C of the Preparation for Subsequent Units Chapter. A comprehensive list of OPG support tasks was not provided, however, OPG tasks are described throughout SOW.
17	Does the scope include for writing Work Reports and closing Work Orders/CWP's.	☒ Yes	☐ No	☐ NA	See item 16 above regarding use of asset suite. Closeout and commissioning is addressed in the milestone compliance chapter, commissioning and Engineering for Subsequent Units.
18	Does the scope include scaffolding (installation and supply?)	☒ Yes	☐ No	☐ NA	Covered in CWPs
19	Does the scope include insulation removal/re-install	☒ Yes	☐ No	☐ NA	Covered in CWPs
20	Does the scope include painting	☒ Yes	☐ No	☐ NA	Touch-up painting as required has been covered in CWPs. A general repainting of the vault at the completion of the work is not required. A general vault clean-up has been included at the completion of the

Class II Scope Review Team Checklist

Item	Project Process				Comments
					work as a post-requisite. The Estimated Scope has been reviewed and is appropriate.
21	Does the scope include temporary power supplies/lighting/water	☒ Yes	☐ No	☐ NA	ECC packages include installation of temp power and lighting. This scope is then included in CWPs.
22	Does the scope include specialized tooling costs	☒ Yes	☐ No	☐ NA	Specialized tooling is developed in the definition Phase. Lifting beams, customized flatbeds for flasks have been noted.
23	Does the scope include preparation of a Commissioning Plan	☒ Yes	☐ No	☐ NA	Commissioning specs are included as per the SOW Overall commissioning plan is OPG scope. Refer to the Commissioning Support Chapter.
24.	Does the scope include specific support requirements by others.	☒ Yes	☐ No	☐ NA	This question is not clear. In the PMT chapter, it is identified whether the support person is from JV, Candu, Subvendor or OPG. OPG tasks and labours are distinguished from JV tasks and labour in the rest of the estimate. Based on the above observations, we find the JV has met the intent of this question.
25	Does the scope include specific pre-conditions/pre-requisites that are required to be in place in advance of work being able to proceed and identifies who performs the work to meet the pre-conditions/pre-requisites?	☒ Yes	☐ No	☐ NA	JV specific pre-requisite work has been identified. CWP's have pre-requisites identified.
26	Construction completion/closeout plan provided?	☒ Yes	☐ No	☐ NA	Demobilization and Project Closeout Chapter is provided. Resources have been provided in the PMT Chapter to closeout Work Packages as they are completed.

Estimate Review Completion Declaration

SECTION A: GENERAL INFORMATION	
Project: 73113 (U2), 73114 (U1), 73115 (U3), 73116 (U4)	**Estimate Classification:** Class II
Bundle: Retube and Feeder Replacement - Execution Phase	**Project Manager:** Roy Brown
Vendor: SNC - Aecon JV	
Date Vendor Estimate (R0)Submitted: 5/8/2015	
Date Vendor Presentation Completed: 5/25/2015	

Objective:

1) This review will assess if the scope was quantified properly, that the estimate is consistent with the Estimate Documentation, and the Estimate Team will assign an AACE Classification.
2) The review of the Estimate Documentation should confirm that it is well organized and complete, sources of pricing, project strategies, factors, rates, hours of work, etc and will be evaluated to document that it adheres to project, contract, and OPG guidelines. In addition the Estimate Documentation should contain documented record of communications that have occurred and agreements that have been made between the Vendor's representatives and the Project.
3) The main outcome is to ensure that all scope has been quantified properly and the Estimate Documentation accurately reflects the basis/decisions that served as input to the estimate.

Team Members (as Required):

Title:	Name:	
Team Lead/Estimating Section Manager	Nader Rahmaty	
Estimating Subject Material Expert	Richard Pettet, Ali Al-Jasim Nazar, Rimon Sargees, Sandeep Desai, Krish Naidu,Kumar Sinnathamby, Nick Nica and Nicole Zhang	
P&C Lead	Sudhakar Pulagam	
Senior Advisor/SME	John Haight	
Vendor Representative	N/A	
Project Director (optional)		
Estimating Manager (optional)	Robert Obertreis	
Others:	Mike Van Hemmen , Cameron Macleod, Nica Liviu, Sadab Kamal, Sudhakar Pulagam , David Kurpjuwei, Dave White, Kai Jia, Saumil Sabhaya	

Estimate Review Completion Declaration

SECTION B: TECHNICAL REVIEW ACTIVITIES

In accordance with the attached formal Estimate Review Team Checklist

1) The target AACE Classification was Class: 2
2) The vendor rated AACE Classification submitted was Class: 2
3) The achievable AACE Classification as determined by the submitted documents was Class: 2
4) The actual AACE Classification as determined by the Estimate Team review is Class: 2

SECTION C: REVIEW FINDINGS/OPINIONS/RATIONAL

Summarize the findings/opinions (including rational why)/variances/corrections/areas of improvement.

Estimate review was assigned to groups in various expertises. Comments for some Risks and material cost estimate are not provided after couple of requesting emails. Estimating groups provided commented based on a brief review.

AFI: (1) verify trades labour rates change between Estimate R0 & R1

(2) Goods included in Estimate Summary aren't aligned with the numbers from the OSM estimates

(3) The LLW Container's costs value is 0 in Class 3, but its total cost in Class 2 estimate is $5.3M in Class 2 & Class 3 comparison table. As per project, the LLW containers are in the RFR scope from 2012. Need verification/confirmation.

SECTION D: DECLARATION OF COMPLETION

1) The Estimate Review was completed in accordance with the attached Estimate Review Team Checklist
2) The findings and all comments and disposition are attached
5) The defined AACE Classification is Class: 2

SECTION E: COMPLETION DECLARATION SIGNOFF

Date Completion Declaration Reviewed With Team:

Prepared By: Nader Rahmaty Date: 10/13/2015
Team Lead/Estimating Section Manager

Reviewed By: On behalf of Estimating Subject Material Expert, Ali Al-Jasim Nazar Date: 10/13/2015
Estimating Subject Material Expert (if included)

Accepted By: Robert Obertreis Date: 10/19/2015
Estimating Manager

Class II Estimate Review Team Checklist

Project #: 73113 (U2), 73114 (U1), 73115 (U3), 73116 (U4)	**Bundle:** RFR
Project Name: Retube and Feeder Replacement	**Project Manager:** Roy Brown
Vendor: Joint Venture	**Date Estimate Submitted (R0):** 5/11/2015
Prepared By: Estimating group, Cameron, Sudhakar,David, Saumil	**Start Date of Estimate Review:** 5/25/2015

Item	Project Process				Performed by
A	**General**				
1	Did the contractor identify which AACE Class was achieved in this estimate? Does estimate state range of accuracy percentage?	☒ Yes	☐ No	☐ NA	Lead: Estimating group; AACE Class-2 estimate
2	Is there sufficient detail in the estimate to support AACE class of estimate stated?	☒ Yes	☐ No	☐ NA	Lead: Estimating group Estimate is prepared by JV with sufficient details to support the AACE Class-2 estimate
3	Are all rates, factors and allowances appropriate?	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Lisa/Samad Most of lab. Rates were increased from Rev-00, factors were applied properly including bump factor, walking factor…etc.
4	Did the estimate include pricing for all Units. i.e. U2 cost estimate & a life cycle cost estimate, taking into account scope differences and learning factors?	☒ Yes	☐ No	☐ NA	Lead: Estimating group The detail estimate is for typical unit (unit-2). Total cost is for all four units
5	Did estimate follow the approved Contracting Strategy?	☐ Yes	☒ No	☐ NA	Lead: Cam MacLeod Comment: Estimate does not include significant portions of work including differences between subsequent units and Execution Phase Work prior to Breaker Open.
6	Has the vendor consistently used the agreed WBS coding system? Are all estimated costs coded appropriately?	☒ Yes	☐ No	☐ NA	Lead: Sudahker Pulagam Comment: WBS coding, Control Account Structure was reviewed and in consistent with the governance. Minor comments were made in CDS to make some corrections with respect to Milestone structure and deletion of empty fields.
7	Have Vendor's line estimates have been checked and reconciled?	☒ Yes	☐ No	☐ NA	Lead: Lisa/Samad ((no response after emails back and forth) Checked by Estimating group SME Support: Estimating group
8	Have Vendor's Cash Flow reports and histograms been reviewed?	☒ Yes	☐ No	☐ NA	Lead: Robert Obertreis SME Support: Sudahkar
9	Have Vendor's calculations been checked for correctness?	☒ Yes	☐ No	☐ NA	Lead: Estimating group Checked details in CWP estimates for correctness. The summary delta of Rev-00 vs Rev-01 is not aligned.
10	Are Labour Rate tables correct and current?	☐ Yes	☒ No	☐ NA	Lead: Estimating group SME Support: Lisa Cameron: Labour rates used include escalated rates not included in Contract labour rate table and additional PMT roles not included in Contract labour rate table. Lab rates have been verified for Rev00, most of labor rates have been increased by about 1% in Rev01 estimate
11	Did the estimate include for overtime cost, based on schedule?	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Lisa/Samad/Sudahkar Included within labor rates
12	Is it possible to perform a quick check estimate using Order of Magnitude Method? If so, is the Vendor estimate free of errors?	☐ Yes	☐ No	☒ NA	Lead: Jeff Palmateer (no input) Estimating group commented

Class II Estimate Review Team Checklist

Item	Project Process				Performed by
13	Have qualified Vender personnel prepared checked & reviewed the estimate?	☒ Yes	☐ No	☐ NA	Lead: Robert.Obertreis
14	Did the contractor follow a specific Pricing schedule/Cost Breakdown using a current OPG estimate template?	☐ Yes	☒ No	☐ NA	Lead: Cam MacLeod (not his area of expertise) Estimatign group: not following OPG estimating template
15	Were proper estimating method /techniques used in preparation of the estimate?	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Lisa JV has used the class-2 methodology and the JV estimate template.
16	Estimate documentation is complete & has: designing/planning/cost/risk basis?	☒ Yes	☐ No	☐ NA	Lead: Estimating group Estimate documents checked by Estimating group, other documents related to design, schedule…etc. by others
17	Is the method of pricing for: Lump Sum, Hourly Rates, Fixed Price, and Firm Price confirmed?	☒ Yes	☐ No	☐ NA	Lead: Cam MacLeod comment: not my area of expertise Estimating Group commented
18	Are Project Management Team costs reasonable?	☐ Yes	☒ No	☐ NA	Lead: Estimating group (site PMT is 54% of sirect Hire - craft)
19	Is Estimate quality acceptable? Examine in detail, selected sections that have significant impact of overall estimate.	☒ Yes	☐ No	☐ NA	As described in Deep Dive list
20	Does Estimate report include a metric report showing key estimate benchmark ratios?	☐ Yes	☒ No	☐ NA	Lead: Estimating group
21	Has reviewer performed an in depth review of significant cost drivers. (80/20 rule)?	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Richard/Saumil/Steve/Luca As per Deep Dive list
22	Material price, labour cost and all other costs reflect agreed assumptions and exclusions?	☐ Yes	☒ No	☐ NA	Lead: Cam MacLeod Basis missing from much of pricing. OPG has not agreed to significant portions/inputs to labour costs
23	Did the estimate specify Shift Patterns? i.e. 8 hrs/shift x 1 shift per day x 5 days / week (8x1x5), 8x1x7, 10x1x5, 10x1x7, 12x1x7, etc.	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Lonnie S. Different shift pattern have been used, specified at CWP task level
24	Has reviewer performed deep dive as per provided list?	☒ Yes	☐ No	☐ NA	As described in Deep Dive list
25	Did the estimate include contingency?	☒ Yes	☐ No	☐ NA	Lead:Ryan/Lisa SME Support: Estimating group (for range estimate) Cameron: Contingency + Rework included in Base estimate, contrary to contract terms
26	Is contingency included, if so, is it listed separately for each units, Multi-unit Contingency Quantification acceptable ?	☒ Yes	☐ No	☐ NA	As described in Deep Dive list
27	Did the estimate indicate equipment purchase vs. rental & is small tools strategy consistent and clear?	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Lonnie in SS&E
28	Did the estimate include for training, onboarding, etc?	☒ Yes	☐ No	☐ NA	As described in Deep Dive list
29	Did estimate include Vendors assumed Start Date? Is date aligned with schedule and histograms?	☒ Yes	☐ No	☐ NA	Lead: Sudahkar Pulagam
30	If estimate involves radioactive waste, does it detail packaging strategy and list quantities and costs?	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Kwok Tsang
31	Are the overhead costs/fees for sub-contractors captured in estimates?	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Bill/Cameron
32	Has estimate man-hour & schedule man-hour reports (summary, detail & histograms by discipline & totals) been reviewed for consistency? Identify if inconsistencies exists and document results.	☒ Yes	☐ No	☐ NA	Lead: Robert.Obertreis SME Support: Sudahkar/CSA
33	Vendor's verification reports on man hour totals within estimate and schedule have been reviewed?	☒ Yes	☐ No	☐ NA	Lead: Robert.Obertreis SME Support: Sudahkar/CSA

Class II Estimate Review Team Checklist

Item	Project Process				Performed by
34	Has method of estimating risk values been reviewed?	☒ Yes	☐ No	☐ NA	Lead: Ryan/Lisa (no response after several emails) Checked by Estimating group
B	**Materials**				
35	Did the estimate include shipping/freight to the site, storage at the site and and handling to the workface?	☒ Yes	☐ No	☐ NA	Lead: Bill Donovan (no response after several emails) Checked by Estimating group
36	Have materials been priced from a standard catalogues or have prices been established from actual "on-the-spot" faxes/email queries to Suppliers via a Vendors "Request for Price"?	☒ Yes	☐ No	☐ NA	Lead: Bill Donovan (no response after emails back and forth) Checked by Estimating group
37	Is the amount of Vendors overhead recovery being made to net material costs? What does this overhead include?	☒ Yes	☐ No	☐ NA	Lead: Bill Donovan (no response after several emails) Checked by Estimating group: 10% markup for Owner specified material, 5% for Goods.
38	Is the estimate based on Bill of Material?	☒ Yes	☐ No	☐ NA	Lead: Bill Donovan (no response after several emails) Checked by Estimating group

C	**Documentation/Assessing**				
39	Did the estimate include: initiating/assessing Work Orders & CWPs? Does it include identification of OPG support tasks?	☒ Yes	☐ No	☐ NA	Lead: Saumil/Richard Comment: Construction Work Packages have been Prepared for all aspects of the Work Estimate includes required Radiation Protection resources at a zero dollar costs Estimate includes durations for OPG specific operational tasks (defueling reactor, drain and Fill PHTS and Calandria, performing PHTS hydrostatic test)
40	Did the estimate include the cost for for writing Work Reports and closing Work Orders and CWPs?	☒ Yes	☐ No	☐ NA	Lead: Saumil/Richard Comment: Estimate includes PMT staff on a level of effort basis to close out CWPs and Work orders

D	**Construction**				
41	Did the estimate include scaffolding (installation and supply?)	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Lonnie/Richard/Saumil
42	Did the estimate include insulation removal/re-install?	☒ Yes	☐ No	☐ NA	As above
43	Did the estimate include painting?	☒ Yes	☐ No	☐ NA	As above
44	Did the estimate include temporary power supplies/lighting/water?	☒ Yes	☐ No	☐ NA	As above
45	Did the estimate include cost for FME requirements?	☒ Yes	☐ No	☐ NA	As above
46	Did the estimate include cost for Confined Space requirements?	☒ Yes	☐ No	☐ NA	As above Within factors

Class II Estimate Review Team Checklist

Item	Project Process				Performed by
47	Did the estimate include cost for WHMIS requirements?	☒ Yes	☐ No	☐ NA	As above
48	Did the estimate include cost for Work Protection requirements?	☒ Yes	☐ No	☐ NA	As above Within factors
49	Did the estimate include cost for custodial requirements?	☒ Yes	☐ No	☐ NA	As above
50	Did the estimate include specialized tooling costs?	☒ Yes	☐ No	☐ NA	As above Within tooling management estimate
51	Did the estimate include demobilization/restoration?	☒ Yes	☐ No	☐ NA	Lead: Estimating group SME Support: Lonnie/Richard/Saumil
52	Is Burden (in hourly rates) included in estimate as per contract?	☒ Yes	☐ No	☐ NA	As above Within chargeable labor rates
53	Have small Tools/Consumables %'s been reviewed for correctness?	☒ Yes	☐ No	☐ NA	As above Construction small tools and consumables (<$2000/item) are calculated as 2% of DFL for small tools and 3% of DFL for consumables. total $20M included in SS&E ($55M). $4M (1% of DFL) for PPE listed separately.
54	Have base factors: height, weights, productivity, schedules been reviewed?	☒ Yes	☐ No	☐ NA	As above
55	Are EPSCA travel & housing allowances addressed?	☒ Yes	☐ No	☐ NA	As above

E	Commissioning/Testing				
56	Did the estimate include Commissioning Support?	☐ Yes	☒ No	☐ NA	Lead: David Kurpjuwei SME Support: Lonnie Schofield Commissioning activities directly mentioned in the SOW are estimated as documented in the Commissioning Support Chapter. This addresses the Primary Heat Transport system only. Other modifications (PMODs & TMODs) that require commissioning activities are not discussed in the Chapter, and appear to be missing. Review of CWP's revealed that some commissioning activities are addressed in some CWPs but not in others (see comment 8 attached). Furthermore, it is known that the commissioning specs for the modifications are not completed and the estimate includes this scope for all 4 units. Without this input, it is not clear how the commissioning activities for the CWPs were derived. JV to provide the basis of estimate and quantify the risk due to the unavailability of key engineering inputs.
57	Did the estimate include the Welding NDE/Post Weld Heat Treatment requirement?	☒ Yes	☐ No	☐ NA	Spot check reviews of CWP's and ITP's indicate that NDE is considered in the estimate.
58	Did the estimate include Electrical & I&C calibrations and/or testing requirements?	☒ Yes	☐ No	☐ NA	Electrical testing requirements are considered in the CWPs. Eg the commissioning chapter considers calibration of FINCH and RTD's. CWP's include meggering, conductivity checks.

Class II Estimate Review Team Checklist

Item	Project Process				Performed by
59	Did the estimate include Civil testing requirements?	☒ Yes	☐ No	☐ NA	Discussion with OPG NR engineering indicates no scope of civil testing expected for the TMODs. Testing of the Bulkhead is included in the estimate.
60	Did the estimate include Post Maintenance Testing?	☐ Yes	☒ No	☐ NA	CWPs have been spot checked and post maintenance testing is not included in some procedures (see comment 7 attached). It is noted that several CWPs have a one line statement, "210.25 Operations/Aecon to **PERFORM** return to service Testing" with no further details. Further discussion and delineation of JV scope vs OPG Operations scope is recommended.

F	CLOSEOUT				
61	Is project close out (CCD) cost identified?	☐ Yes	☒ No	☐ NA	Lead: David Kurpjuweit The demobilization and closeout chapter appears to only consider decommissioning and demolition of onsite facilities. Note some items may be missed such as clean room. The Milestone compliance chapter considers mechanical completion as per the SOW. JV to provide evidence of costs associated with completion of packages with associated per package breakdowns. See comment 17 attached.
62	Is EC close out cost identified?	☐ Yes	☒ No	☐ NA	Lead: David Kurpjuweit Several chapters discuss engineering closeout but none of them have a detailed cost breakdown to provide evidence that this portion of the work is estimated to class II expectations. For example: Demobilization and Project Closeout Chapter: Detailed ECC breakdown and AFS is listed in the closeout chapter, however it is not clear whether any of these activities have been estimated. See comment 2 for more details. PMT Chapter Closeout activities in PMT Chapter were covered in Engineering and Construction Support Services, but no details were provided in the PMT Chapter or in the backing sheets to itemize the process or the breakdown of the cost See comment 23 for more details. Schedule: Review of the schedule concluded that a significant number of closeout activities are 160 hours raising concern that the estimate is not on a per package level of detail. JV to provide a breakdown see comment 17 for more details. Milestone Compliance Chapter: Milestone compliance chapter appendix A line 133 indicates that preparation of history dockets has been included in the estimate. JV to provide evidence of a cost breakdown per expected history docket. See comment 30 for more details.

Revision 00 Estimate Findings	Revision 01 Estimate Review Findings/Disposition.
Scope Exclusions	
The OSM chapter identifies more items as OSM than are identified in the contract. Discussion between OPG and the JV is required to obtain agreement on what is OSM and what are Goods.	Item Resolved/Scoping Appropriate. Covered in Revision 1 OSM and Goods Chapter Report.
JV confirm training has been identified in training chapter for contingency tools (e.g. CTSB Milling, GS Capture, etc.). In addition, training for EQ splices appears to be missing.	Item Resolved/Scoping Appropriate. CTSB Refurbishment, Contingency CT Removal, EF Seal Face Lapping, Contingency Cold Bending, Contingency Sealing Surface Repairs, and Broken/Seized Cap Screw Repair Contingency Training included. GS Capture Training included as part of FC Install Training. Gerard Edison clarified that training for EQ Splices will be covered as part of OPG Training that will be delivered to the JV. Covered in Revision 1 Series Training Chapter Report.
JV to confirm inspection services are included in the estimate (e.g. PAUT).	Item Resolved/Scoping Appropriate. Covered in "CWP Summary Spreadsheet- Class 2- Rev 01.xlsx" New Items Tab submitted with Revision 1 Estimate.
No mention of Debris Retrieval in the Calandria Vessel Inspection Scope. JV to confirm this is included in the estimate. Additionally, there should be some description included regarding what will be done if there is a finding during Calandria Vessel Inspection.	A decision has been made that if any debris is found in the Calandria Vessel during CVI, retrieval will wait until the FME Retrieval. All required effort has been included to complete removal of any debris discovered in the FME Retrieval Estimate. Covered in Revision 1 CWP2181 Estimate.
JV to confirm removal/vacating of the fuel channel and CT clean room, and the REFRESA is considered in the estimate.	Item Resolved/Scoping Appropriate. Demobilization of the DEC (which would include the JV Equipment in the FC and CT Clean Room) included in Demobilization and Closeout Chapter. Additionally, for RFRISA, all JV Equipment will be removed by the JV, all equipment that is OPG Installed (i.e. desks, office furniture etc.) will be left in place. Included in Revision 01 Demobilization and Closeout Chapter Report.
Commissioning Support - The commissioning chapter appears to only address the PHT system. JV to confirm the calandria vessel and moderator testing as well as other parts of the system that were modified as part of the retube process is considered in the estimate. Under the JV pressure boundary program the JV is responsible to do in service testing and sign off any ITPs or data reports. Mod packages also provide specifics to be completed.	Item Resolved/Scoping Appropriate. A table has been provided as an Appendix to the Revision 1 Commissioning Chapter showing scope responsibility for each item of work required to be completed as part of commissioning. This table is still under discussion, however Revision 1 is up to date as per most recent discussions.
DECs that were submitted later in the project appear to be missing (i.e. Moderator Dry). Also some DECs are still included in the list that should not be (i.e. DEC123342- Power to Channel Drain Tool). JB to demonstrate how it has been verified all DEC's have been incorporated and estimated appropriately.	Item Resolved/Scoping Appropriate. Covered in Revision 1 OSM and Goods Chapter Report.
JV to confirm if TS revisions for subsequent units has been included in the estimate. TS revision for next unit(s) are required because they were prepared for Unit 2 only.	Item Resolved/Scoping Appropriate. Covered in Revision 1 OSM and Goods Chapter Report.
JV to confirm that the estimate includes two clean rooms that are required for the period during the overlapping refurbishment of Unit 1 and 3 as they need to operate in parallel.	Collaborative Team has discussed. 2 Cleanrooms will not be required as, based on the current Execution Plan, two units will never be in the Installation Phase at the same time.
JV to confirm that PHT and MOD dry goods are included in the estimate. Please confirm there are no additional items that should be in this chapter.	Item Resolved/Scoping Appropriate. Covered in Revision 1 OSM and Goods Chapter Report.
Prep for subsequent units chapter Table 3 outlines scope that is currently excluded "which requires discussion with OPG and potentially an increase to the Class 2 estimate or PCD." If these items have not been included, the estimate is not complete. Some Units may be significantly different (e.g. feeder PMOD). It appears instead that the engineering effort for subsequent units utilizes a factor (e.g. 66%) of initial effort. Estimate to include known differences between units and adequate justification for any level of effort factors used.	Item Resolved/Scoping Appropriate. Covered in Revision 1 Preparations for Subsequent Units Chapter Report.
JV to confirm misc ILW flasks for filters and other disposable items are included in the estimate and that all flasks for all Items are accounted for.	Item Resolved/Scoping Appropriate. Covered in Revision 1 OSM and Goods Chapter Report.
Cost of the manufacture and provision of the new design of garter spring is missing. Omission is documented in milestone compliance chapter page A13.	Not mentioned in Milestone Compliance Chapter anymore, costs appear to be documented in the Revision 1 OSM and Goods Chapter Report. Confirmed with Angelo that the OSM and Goods Chapter now includes the cost of the new Garter Spring (ZrNbCu).
Goods for end fitting caps not included in goods list.	Cost for End Fitting Caps has been carried under Silflex Face Shielding Panels costs. Guy has confirmed this by Email. Covered in Revision 1 OSM and Goods Chapter Report.
JV to confirm the TS requirements for on reactor qualification for CT install and CTI release (31230-TS4 shock heat on 5 sites, remove CT, then proceed) is included in the estimate. A thorough review of TS requirements is recommended to ensure no items are missed.	Item Resolved/Scoping Appropriate as per all TSs. Covered in CWP Estimates (2175- CTI Release, 2228- Contingency CT Removal).
JV to confirm Reactor engineering support for execution is included in the estimate.	Item Resolved/Scoping Appropriate. Included in Revision 1 PMT Chapter Report.

There is a note that CWPs 2105, 2108, 2110, 2107, 2106, 2109 are on hold, Powerhouse and vault heating and ventilation. Is this scope included in the estimate? Why are they on hold?	Item Resolved/Scoping Appropriate. All of these CWPs are Estimated and are in scope.
Please confirm feeder I&C Cable spares (all units) are included in the estimate (this is in case the JV damages a cable or one is found damaged during the removal operations)	Item Resolved/Scoping Appropriate. These materials are included in the Revision 1 OSM Chapter Report.
JV to confirm the Design Registration (Units 1, 3 and 4) are included in the estimate (Since design registration is specific for Unit 2 only, there will need to be either some updates, or some reconciliations).	Item Resolved/Scoping Appropriate. Covered in Revision 1 OSM and Goods Chapter Report.
JV to confirm that procurement Engineering Support for Units 1, 3 and 4 is included in the estimate (support is required to review vendor procedures, ITPs, support NCR/DDR justifications, etc)	Included in Revision 1 Preparations for Subsequent Units Chapter. Item Resolved/Scoping Appropriate.
JV to confirm that the costs for feeder vision system (Feeder scanners) has been included for all 4 units.	Item Resolved/Scoping Appropriate. Included in Revision 1 OSM and Goods Chapter Report Appendix A4.
Please confirm that the estimate includes costs for I690 change to the feeder flow elements.	Feeder Flow Elements Procurement Costs included in the Revision 1 OSM and Goods Chapter for all Units in Appendix A4. According to Ed Nowakowski, material cost differences between I600 and I690 should be minimal. The only additional costs that need to be accounted for are costs for revision of the TS, and development/review of weld procedures. These are both Definition Phase work, so this item would not impact the Estimate.
JV to confirm that temp lighting is covered in Goods.	Item Resolved/Scoping Appropriate. Covered in Revision 1 OSM and Goods Chapter Report.
JV to clarify which version of the COIR has been used to produce this estimate. The working copy to be included in R1 of the estimate.	Discussion with Randy revealed that Revision 2 of the COIR (which is the latest revision of the COIR- NK38-DAI-09701-10008 in Asset Suite) is the basis for the Estimate. Reference to the document has been provided in multiple locations of the Revision 01 Estimate, but revision number has not been included. The document is referenced in the Preparations for Subsequent Units Chapter, Scope Control Chapter and Compliance Chapter. During review of Revision 0 it was determined that the current revision of the COIR requires an update due to OPG completing MEC Packages. The Basis for Class II submission is Revision 2 which is appropriate given that this is the latest revision.
The incorporation of sub-contractors is not presented in a consolidated manner. OPG is requesting JV to clearly present sub-contractor costs and scope.	Item Resolved/Scoping Appropriate. Covered in "CWP Summary Spreadsheet- Class 2- Rev 01.xlsx" New Items Tab submitted with Revision 1 Estimate.
JV to confirm that restoring the vault to as-found conditions including painting is included.	Part of Vault Inspections/Clean-up. Item Resolved/Scoping Appropriate. Included in Revision 1 Post-Requirements Chapter Report.
Assumptions/ Clarifications	
It is not clear what has been assumed/estimated for the level of effort needed for asset suite work management, assessing, config management and work history entries. Please provide additional information for clarity.	Part of the Revision 1 PMT Chapter Report. Item Resolved/Scoping Appropriate.
There is a statement in the Milestone Compliance Chapter page 32 that "OPG procedures to be followed in execution are as per the original Agreement". Is it understood by the JV that the current revisions of documentation must be used for work and that Asset Suite is to be used to ensure that current revisions of documentation are utilized?	These items are considered resolved because: A. This item/wording quoted in the original comment has been removed and does not exist in the Revision 01 Scope Change Control Chapter Report. B. The only wording relevant to this issue in the Revision 01 Milestone Compliance Chapter Report is "OPG is currently preparing a contract Amendment revising the reference document section. Until such time the Amendment is approved, the Project shall utilize the documents referenced in the original Agreement". OPG is in agreement with this statement.
Commissioning scope is based partially on letters/emails that are attached to the commissioning Chapter. Further clarification is required since a portion of this documentation is informal and needs to be formalized in order to be a basis for the estimate.	Item Resolved/Scoping Appropriate. See Appendix A and B of Revision 1 Commissioning Chapter Report.
For the statement in OSM chapter page 6, "It was further found that some items that meet the definition of OSM and are to be used in the Work, are not actually subject to purchase by the JV under the terms of the agreement. These items are not included in the estimate". Please clarify what items this statement pertains to.	Item Resolved/Scoping Appropriate. See Revision 1 OSM and Goods Chapter Report.
At the time of submission, the DECs for mod dry, PHT dry, vault ACU's, RWPB, Feeders, Fuel Channels, and calandria vessel have not been completed. Note this is contrary to the statement in the executive summary of the Milestone compliance chapter. What was assumed in preparation of the estimate if these DECs were not available?	The original comment is correct, some of the DECs were not completed at the time of Estimate Submission. For these DECs, the JV has used actuals up to the point where work has been completed to date, and has Estimated the forecasted amount of work remaining to complete the DECs. The total of actuals + forecasted to complete is the number that has been used in the Estimate for all DECs that were not complete.

OPEX was used for transportation costs based on 480/380. This is okay for big items, not practical for small items. Was this ratio used for small items and is this representative? What was assumed for the estimate?	This item cannot be traced in the R0, or R1 Estimate. Removed from list.
Inclusions	
CWPs to be checked: - 2073, 2074 - Installation of Feeder Platform – DEC was cancelled and should not be included. 2075, 2076 Installation of Monorails – DEC was cancelled and should not be included.	Item Resolved/Scoping Appropriate. CWP2073 and 2074 still included, however, as far as I know these are still required as we are still using the Feeder Platform. CWP2075 and 2076 also still included, these are also still required, as Feeder Monorails will be used during Feeder Install.

OPG - JV Class II Estimate R0 to R1 -Change Log

OPG Comment					WAR ROOM REVIEW		JV Disposition Results	Results - Break		
Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Chapter Report	1	9-Jun-15	Tool Management	Associated Infrastructure Planning has not been optimised: - Justification clean storage for location and size does not seem reasonable - The basis for space allocation for contaminated storage does not seem reasonable (i.e.. Contaminated tools are held for duration of 4 units prior to start of decontam) JV to explore various options for clean storage.	Tooling	JV to evaluate OPG recommendations for reduction of contaminated storage and associated costs. OPG to evaluate whether or not additional facilities not owned by the JV will be available for storage. 2015-07-22: Storing training tools at the mock-up area affects the safety around the training space, it also impacts the training schedule and presents a risk to the management of the storage and handling requirements of the tooling. 2015-07-22: It is generally accepted that an opportunity exists which may have significant impact to transportation, labour, and efficiency of work by the consolidation of all storage and maintenance facilities associated with Tooling Management within a single facility on the east side. The JV has submitted as part 3 of the standby plan the level of effort required to perform this work during the gap year. 2015-07-22: An optimization opportunity exists to store training tools in the warehouse side pending the final racking optimization. 2015-08-18: Final monetization inclusive of all items related to Clean or Contaminated storage monetizations.	Based on information we have received from our Materials Management group at Candu, month to month contract for storage are possible. It should be recognized that this approach has risks in that vendor may be reluctant to hold available space and depending on our space requirements we may find space previously available has been given to another customer. This will obviously increase the number of storage locations and increase our labour to manage our inventory. We have adjusted accordingly to reflect our month over month requirements. The update to the critical path schedule will have some impact on this change. (It should be noted that the dollar figure suggested in the OPG CDS is based on the May 9th critical path, the dollar value change will be based on the most recent critical path schedule and will therefore not match) RWSB has not been released for RFR use. There is no room at DEC for Clean Production or Training Tools. All Tools will be stored offsite in clean storage. As this cost element is under the target model contingency should be considered for this. Contaminated Storage = ($ 12,340,446), Clean Storage = ($4,629,654) 25 JUN Update: JV to provide floorplan analysis of DEC and RWSB floor space and provide justification . Provide material for OPG review prior to meeting prior to TM meeting of 02JUL2015. 6 JULY Update: Review NK38-REP-09701-0389446 to ensure content (where applicable) is incorporated into latest "DEC Warehouse Space Allocation". Perform reconciliation to ensure that all space (including Mock Up side) at DEC is used up. Follow-up walkthrough meeting to be booked. For purposes of the estimate, assume RWSB is not available. 10 JULY Update: Require JV procurement's final analysis of the DEC floorspace to determine if any tools, goods or spares can be stored temporally or permanently at the DEC. Training Tools footprint has been reduced after further review to 7,000 sqft. This square footage does not include the common tools (RTP, PDS, HWT, etc) that will already be installed at the DEC. We have continued to account this storage capacity within our clean storage facility until such time as analysis confirms that this footprint is available at the DEC. This analysis is being completed by the procurement group. **Cost Carried in ID9.**	$0	Verified Item	costs have increased and is included in id 9
Chapter Report	2	9-Jun-15	Tool Management	Various issues with TMS affecting class 2 risk estimate: - There is currently no centralised system to track configuration management in def phase. - Is licensing and implementation of TMS in definition phase or execution phase? - 12 people for 1 years to input items into the TMS seems unreasonable. 1) Is TMS part of fixed price? 2) Please provide a demonstration of the tracking system being used in the definition phase. 3) Please provide a timeline for TMS implementation and breakdown of effort required for TMS inventory input	Tooling	JV to take action to justify user quantity of licences and to remove gap year 1.645 million from estimate JV to also investigate about possible improvements to monthly licensing costs. 2015-07-22: No further actions on this item, all monetization reductions have been captured in the Rev 01 prime submission.	The JV have removed the one time configuration charge from the estimate, as these charges will be incorporated in PCD23. TMO has reviewed the number of licenses and after further review feel we can justify an increase in the total number required. Our current estimate of 38 licenses (previously 30) does not include any consideration for OPG. The chapter report will be revised to provide detail basis of the number of licenses required. The monthly fee has been reduced based on a further elimination of the vendor IT support hours included in the Rev 00 submission. Additional IT support will be carried within the SS&E estimate. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. 25 JUN Update: JV to provide breakdown of which how licences will be allocated (location/staff). Face-to-face meeting (02 JUL 2015) above will cover. Please also include 2 additional licenses for OPG for a total of 40. JV to provide breakdown of monetization listed, and how additional IT Support has been accounted for in SS&E. 6 JULY Update: Verbal basis was provided during face-to-face meeting. Buildup for number of licences (who and where) to be provided in Chapter report and backing sheet. 10 JULY Update: The following text and breakdown will be provided in the write-up and the build-up: Our estimate on the number of TMS licences is based on TMO staff at multiple locations, Management Team, Project Controls, Document Control and Quality. The TMO (37) will not all require access, however all Tooling Engineering and Tooling Technicals will. Material handling and Logistical staff including Warehouse personnel will as will the Admin, Lead Tooling Engineer and Tooling Operations Manager. Additionally not captured on the TMO Org Chart, we added 2 Project Controls, 2 Document Controls and 3 Quality licences. Individual access is required for change control, trip and tracking purposes in order to identify who creates and does what when. Additionally staff will be located at the DEC, RWPB, Clean and Contaminated Facilities, Zone 3 Maintenance facility and then on shift in the RCC. The amount of licences including the shift coverage numbers will total 38 plus 2 for OPG giving a grand total of 40. Reference Tool Management Org Chart in PMT Chapter # 509407-0000-00000-33RA-0155 for greater detail Licence Breakdown Qty Position 2 OPG 2 Doc Control 2 Proj Control 3 QA 1 Tooling Ops Mgr 1 Deputy Tooling Material Mgr 1 Tooling Sys Eng Lead 9 Tooling Engs 9 Tool Tech 2 Shipping/Rec 2 Warehouse Supr 1 Logistics Coord 4 Programmer 1 Tool Readiness Supr 40 Total Licences	$0	Verified Item	costs have increased and is included in id 9
Chapter Report	3	9-Jun-15	Tool Management	Tab- contaminated tool storage: line 35 Storage - Fdr Platform Tools : JV proposes to start storing this contaminated platform in Sep 2017. this may be too earlier. and a major error at $50 000 per month Please verify schedule	Tooling	Will be included in Rev 1. $3.9 M to be removed. 2015-07-22: This monetization was captured as part of the Rev 01' submission. No further action. 2015-08-18: Monetization rolled up into Entry ID 1.	The JV has reviewed the Feeder Platform storage schedule and that has been corrected for the revised estimate. The cost per month has also been corrected. The JV believes the Feeder Platform should still be stored in contaminated storage. 25 JUN Update: JV to provide justification for storing feeder platform in contaminated storage. Provide material for OPG review prior to TM meeting of 02JUL2015. 8 JULY Update: Review Infrastructure Plan (Rev 3) and store any non environmentally sensitive components in the IP2 Type A containers in the CES. JV to provide space utilisation plans for the CES (goods, tools, lifting equipment ect). Provide revised monetization. Provide the "schedule" breakdown of the use of the IP2 Type A containers. 10 JULY Update: After discussion with various SME's who were part of Bruce, PLR and Wolsong Refurbs, it was determined that the Feeder Platform can be stored in a Type A Container at the CES. Further analysis into other possible tools has determined that it is not feasible as there is a risk in breaking down tools and storing them in two separate location. The Feeder Platform was removed from the Contaminated Storage price build-up and trips revised for transportation The space utilization of the CES is covered by others. **Cost Carried in ID9.**	$0	Verified Item	3.69M reduction capture in U2 R1 unit 2 number. Total Tool Management reduction from R0 to R1 is $13,263,480
Chapter Report	4	9-Jun-15	Tool Management	Contingency of 10,000sq.ft = $1.32 million for the duration of the project. Isn't contingency not permitted as part of the base for class 2.	Tooling	Will be removed for Rev 1. 1.32 M to be removed. 2015-07-22: This monetization was already included in the Rev01' submission. No further action 2015-08-18: Monetization rolled up into Entry ID 1.	The JV has reviewed the space requirements again and determined there is no space available at DEC to store tools. Training Tools WILL NOT be stored at the DEC and this cost was already part of Clean Storage in REV 00 therefore no change. We had previously inappropriately labelled training tools stored at the DEC as contingency, this item, in fact, is required for the base estimate. 25 JUN Update: See item above re: face-to-face on DEC Square Footage. Meeting 02JUL2015. 10 JULY Update: Require JV procurement's final analysis of the DEC floorspace to determine if any tools, goods or spares can be stored temporally or permanently at the DEC. **Cost Carried in ID9.**	$0	Verified Item	Part of roll in ID1. Total Tool Management reduction from R0 to R1 is $13,263,480
Chapter Report	5	9-Jun-15	Tool Management	Why are the Clean Storage costs for each unit summed = $12,153,249 yet the actual Monthly Clean Storage Space Cost in the Clean Storage Worksheet even if factoring in MH = $9,198,803? Where is the difference?	Tooling	Configuration management issues with native files/chapter to be resolved. OPG's position is that DEC warehousing should be maximized and fully utilized before consideration of other clean storage locations. If other locations are required, JV to take action to examine if shorter term warehousing agreements are available for cost savings. This item to be added to Opportunities List.	Monetization included in ID 1. By changing to a month to month this issue was resolved. Therefore the savings for this ID is the same as ID 1 so it cannot be broken down further. **Cost Carried in ID9.**	$0	Verified Item	Part of roll in ID1. Total Tool Management reduction from R0 to R1 is $13,263,480
Chapter Report	6	9-Jun-15	Tool Management	Line 52 , AGV and buffer nests. The AGV's will be required to transition out the RTPs and should remain on site till then . the spread shows them leaving fully in Jul 2019, please verify the schedule as this appears to be incorrect.	Tooling	JV agreed to keep AGVs on site at all times. JV to remove $ 1.4 M. 2015-07-22: This monetization was already included in the Rev01' submission. The RWPB space will have to take into account the additional AGVs procured by Tooling. No further action on TMO 2015-08-18: Monetization rolled up into Entry ID 1.	The JV will store as requested the AGVs within the RWPB and the Infrastructure Plan will be updated accordingly, it should be noted that these pieces of equipment may or could be damaged given the traffic and multiple users in this area. This does not include any additional AGV type equipment, that maybe be purchased subsequent to the estimate submission. A risk item will be added to the risk register to account for potential rework and damage. 25 JUN Update: JV to review addition of this risk and eliminate if appropriate. **Cost Carried in ID9.**	$0	Verified Item	Part of roll in ID1. Total Tool Management reduction from R0 to R1 is $13,263,480
Chapter Report	7	9-Jun-15	Tool Management	For contaminated tooling storage, They also seem to count tools twice such as FC and CT Tools and then FC Installation Tools. The costs from the Contaminated Tooling Storage spreadsheet does not seem to flow in to the overall estimate.	Tooling	Will be removed for Rev 1; change log to specify changes to schedule. JV to remove $0.112 M. 2015-07-22: No further action required, this monetization was captured as part of the Rev 01 prime submission. 2015-08-18: Monetization rolled up into Entry ID 1.	Agreed. 8 JULY Update: Removed from Contaminated Storage but not contaminated storage. **Cost Carried in ID9.**	$0	Verified Item	Part of roll in ID1. Total Tool Management reduction from R0 to R1 is $13,263,480
Chapter Report	8	9-Jun-15	Tool Management	Uncrate & Test/Precomission Tooling in RWPB Extension - FC Drain Tools though that all FC drain tools have been de-scoped?	Tooling	Will be removed for Rev 1. JV to remove $0.325 M. In addition to removing five month block, JV to assess which tools require this specialized maintenance. Otherwise, tools can be sent directly to Contaminated Storage where more minor preventative maintenance can be done (Based on Embalse OPEX). There is potential addition savings to OPG from this assessment. 2015-07-22: The agreement is that the documentation with regards to the assessments of the tooling at the RWPB will include verbiage as to how opportunities can be made to reduce the number of trips or transportation costs.	Agreed. This FC Drain tool was removed from the estimate. The 5 month block was adjusted based on the revised schedule and the recommendation to hold off shipping the PHT Vacuum Dry tool to the maintenance facility to optimize the use of the facility. 8 JULY Update: Assess the requirement to send all tools (include install tooling) to the contaminated tool facility (Kinetrics) as opposed to the storage location (ESOL). Optimize the number of trips and square footage at contaminated storage. Investigate addition of a cost risk to capture potential incremental shipping/square footage cost (in case an item assumed to clean is not actually clean during execution). 10 JULY Update: The JV stands by the basis and methodology that tools coming out of the reactor will require assessments, preventative maintenance and testing. As such, tools will be sent to contaminated maintenance facility and then to storage. However, during execution if an assessment of a tool determines that it does not require maintenance at the Kinetrics facility then the opportunity will exist to send the tool to Contaminated storage directly. The JV has looked further into the OPG suggestion for performing maintenance on certain tools at the Contaminated Storage Location and it does not seem feasable.The benefit of the maintenance facility is that all of the necessary equipment (cranes), RP support, Work area, Test area, etc are already in some form of a fixed monthly price. The Storage facility is not set-up that way. Although the CRA is a one time cost, OPEX from the Embalse refurbishment showed we had very limited ability to refurbish any tools in the CRA – we had to be able to confirm 100% no possibility for lose contaminant or anything that could become airborn. We did some painting and mechanical checks, but mostly assessments of tools before they came into SP3/SP9. CRA cost about $25k per month to run by the time the RP and other charges were finished, not including disposal or lift costs. Although the Storage Facility may seem cheaper the flexibility for maintenance work is minimal. **Cost Carried in ID9.**	$0	Verified Item	Cost matching the record. Resolution unclear. Verbage indicates there is no cost reduction at this submission, cost reduction will indicated in REV 01.
Chapter Report	9	9-Jun-15	Tool Management	Please explain what would take 7 days and 8 trades to complete this RTP related task? 'Uncrate & Test/Precomission Tooling in RWPB Extension -RTP Tools Are these tools not modular and cannot be pre-assembled or tested until they are in the vault?	Tooling	JV to show revision of estimate to OPG prior to Rev 1 submittal and obtain OPG approval. 2015-07-22: Agreement has been reached with regards to the total number of hours for the TMO labour. Final estimates to be provided once labor rates are calculated. Action on Majid to provide the final monetization by EOD 23-07-2015 2015-08-18: Final monetization reveals an increase much less than what was agreed to in the draft monetizations attributed to a tighter schedule.	TMO has a buildup of hours developed using draft O&M manuals and OPEX from the Embalse refurbishment project. This data can be provided to OPG. However as previously explained we are changing the task based estimate to a crew based estimate. Action in progress to reviewing current basis sheets, P6 schedule and OM manuals and we will compare the task based vs. crew based methodology to determine the optimum estimate. 25 JUN: JV to present crew based TMO build up. JV to provide material for OPG review prior to JULY 2ND Meeting. 8 JULY Update: OPG to send the reviewed version TMO labour build up. JV to review and optimize crewing and/or task based approach. Follow-up walkthrough meeting to be booked. JV to provide wording in Chapter and TMP to distinguish between corrective and preventative maintenance. Corrective maintenance related to requirements in OM and DRs. 10 JULY Update: Will not be a part of the July 12th submission - In Progress **Item Carries All Cost Changes for Tool Management. Savings related to SS&E, Goods and Buildings as a result of changes made to Tool Management are captured in their corresponding relevant chapters (SS&E- ID23, Goods- ID392, Buildings- ID110).**	($14,851,196)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Chapter Report	10	9-Jun-15	Tool Management	What is the technical basis for the tooling weight distribution between clean, LLW and HLW? Specifically where is the justification behind 150 tonnes of high level waste from tooling	Tooling	Will be fixed for Rev 1. JV to remove $ 1.403 M. 2015-07-22: No further action required, the monetization reduction has been captured as part of the Rev 01 prime submission. 2015-08-18: Monetization is rolled up to include all reductions that relate to disposal costs.	Error corrected. Also note: LLW and HLW are terms provided by supplier in their quote and do not relate to contract terms. 8 JULY Update: JV agrees that there should be 60 tonnes of HLW, not 90 tonnes as per OPG's original comment resulting in additional $0.6 million deduction for HLW. JV agreed to correct. 10 JULY Update: July 8 action is complete. **Cost Carried in ID9.**	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Chapter Report	11	9-Jun-15	Tool Management	For clean tooling there would be some salvage value so how is this addressed in this estimate. Who gets the benefit?	Tooling	JV takes position of salvage not within JV scope. OPG takes position of JV evaluating salvage value for the purpose of cost savings. Still Outstanding 2015-07-22: JV and OPG agrees that based on today's industry standard for unsorted metals that the salvage price is 14 cents a pound. If all 1200 tonnes are considered salvageable at that rate it is equal to $370377. This item is to be added to the Opportunities List. It is at OPG discretion as whether salvage will be pursued.	Action, obtain a salvage quote. 25 JUN: JV to provide quote. JV to provide material for OPG review prior to JULY 2ND Meeting. 10 JULY Update: Will not be a part of the July 12th submission - In Progress **Cost Carried in ID9.**	$0	Verified Item	Cost Carried in ID9.
Chapter Report	12	9-Jun-15	Tool Management	Would suggest the flasks can be cleaned up so they do not have to be disposed of as contaminated. Has this been considered?	Tooling	JV takes position of salvage not within JV scope. OPG takes position of JV evaluating salvage value for the purpose of cost savings. Still Outstanding 2015-07-22: JV and OPG agrees that based on today's industry standard for unsorted metals that the salvage price is 14 cents a pound. If all 1200 tonnes are considered salvageable at that rate it is equal to $370377. This item is to be added to the Opportunities List. It is at OPG discretion as whether salvage will be pursued.	Action, obtain a salvage quote. 25 JUN Update: JV to provide floor plan analysis of DEC floor space and provide justification . Provide material for OPG review prior to meeting prior to TM meeting of 0 2JUL 2015. 10 JULY Update: Will not be a part of the July 12th submission - In Progress **Cost Carried in ID9.**	$0	Verified Item	Potential opportunity for salvage $s as OPG discretion post project
Chapter Report	13	9-Jun-15	Tool Management	It would appear that the tool is being shipped to contaminated waste facility and then being disposed of through ESOL Contract. If so, why are their Trades persons associated with the disposal of the tool? Would this not be handled by the Waste Disposal facility and their personnel?	Tooling	Will be removed for Rev 1. JV to remove $0.04 M. 2015-07-22: No further action, this monetization reduction has been included as part of the Rev 01 prime submission. Reduction has been covered in Rev 1. by switching from a Task Based to a Crew Based Estimate.	The Rev 00 submission included the reduced number of trips and therefore no reduction will be applicable to Rev 01. **Cost Carried in ID9.**	$0	Verified Item	No reduction

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Chapter Report	14	9-Jun-15	Tool Management	The First 4 months of clean storage (clean storage worksheet) has no material entering or leaving. Opportunity to delay receipt of tooling or drop ship to DEC or DNGS from vendor direct. The DEC is relatively empty right now.	Tooling	JV to investigate recommendations from OPG on this item (i.e., free space availability at DEC) 2015-07-22: Storing training tools at the mockup area affects the safety around the training space, it also impacts the training schedule and presents a risk to the management of the storage and handling requirements of the tooling.	Not applicable as there is no storage room available at the DEC for Tooling. 25 JUN Update: JV to provide floor plan analysis of DEC floor space and provide justification . Provide material for OPG review prior to meeting prior to TM meeting of 02JUL2015. 10 JULY Update: Require JV procurement's final analysis of the DEC floorspace to determine if any tools, goods or spares can be stored temporally or permanently at the DEC. **Cost Carried in ID9.**	$0	Verified Item	No reduction
Chapter Report	15	9-Jun-15	Tool Management	Errors in calculations noted low and high level waste disposal calculations are wrong	Tooling	Will be fixed for Rev 1. JV to remove $ 0.7 M. 2015-07-22: No further action, this monetization reduction has been included as part of the Rev 01 prime submission. 2015-08-18: Monetization included in Entry ID 10	Error corrected **Cost Carried in ID9.**	$0	Verified Item	Included in previous submission.
Chapter Report	16	9-Jun-15	Tool Management	Errors in calculations noted . Too many trips across the board. We believe only 3 hwy trips would be required per toolset / per unit.	Tooling	Will be fixed for Rev 1. JV to remove $ 0.881 M. 2015-07-22: No further action, this monetization reduction has been included as part of the Rev 01 prime submission.	Comment already incorporated in Rev 00 submission. An increase to the shipments is required due to insufficient storage at the DEC for training tooling. (resultant from ID 01). 25 JUN Update: JV to provide floor plan analysis of DEC floor space and provide justification . Provide material for OPG review prior to meeting prior to TM meeting of 02JUL2015. **Cost Carried in ID9.**	$0	Verified Item	costs have increased and is included in id 9
Chapter Report	17	9-Jun-15	Tool Management	All crating costs should be removed. All containers are re-useable as per the contract.	Tooling	Commercial positions to be determined on both sides OPEX basis of estimate numbers to be fleshed out by JV and detailed in report/basis sheets 2015-07-22: JV and OPG agree to further reduction of 300,000 based on disposal of tooling at the end of project and keeping a percentage of tooling for retention. Total reduction associated with this Change Log item is $2,650,000.	Crates are not part of the fixed price according to Exhibit 2.1 Section 3.7. We have included the cost of crate rebuild and replacements from the Embalse project and are waiting for some additional information from 3rd party contractors with previous experience crating tools for AECL. We believe assumptions are valid, the JV will also make minor changes in the language to reflect this approach. No further change. 25 JUN Update: JV to rationalize the cost of crates, number required and rate of failure to validate basis for replacement rate. 10 JULY Update: We have received data from TOPAX regarding crate replacement from previous projects. They range from 100%, 25%, 95% crate replacement for PLR, WIR and E02 respectively. This averages to 73% replacement, so we feel our 50% crate replacement is valid. The email is copied below but can also be submitted to support: "Hi Jeff, Following our conversation of June 9, 2015 we would like to share the following rough statistics: Point Lepreau / Wolsong Lepreau discarded all of the boxes and had 100% replacement of packing for furtherance to Wolsong. 75 % of the packaging was re-used for the return of tooling from Wolsong Korea to Canada If the packaging was properly stored and inventoried, we estimate that 90% could have been reused. Topax provided 668 boxes to ATS, for Lepreau and Wolsong combined. Topax, contracted by ATS, deployed workers to Korea to re-pack tooling for return to Canada Embalse We estimate that less than 5% of packaging was re-used from previous projects. To date we have completed 779 boxes. Our packaging order for Embalse is open and work is still on going. ***Please note that this information has been gathered by reviewing files and spreadsheets and interviewing workers. Topax was not hired at a Project Management level for any of these jobs. Therefore our information is limited to the work that we performed.***" **Cost Carried in ID9.**	$0	Verified Item	no cost adjustments shown as per comments
Chapter Report	18	9-Jun-15	Support Services	Scaffold and stairs budgets for 550K but also included on page 16, item 3.15. Is this a duplication?	SS&E	Communicated to JV. Yet to be resolved. **"Special initiative" is proposed to utilize existing surplus OPG scaffold currently located in Pickering A - Unit 2 & 3 laid up units. Opportunities team to contact Pickering Operations to explore path forward. If use of this scaffold cannot be gained then JV proposal and cost estimate to secure new scaffold for use on RFR/TGR project to be allowed. 27AUG: Based upon initial follow-ups with Pickering Operations, use of scaffolding appears to be feasible. This is to be maintained as an Opportunity on the Opportunities List for potential incorporation post Class II Revision 1.	JV disagrees with comment as this is a Reimbursable cost. 25 JUN Update: JV to provide email that documents agreement with OPG on inclusion/exclusion of staircase in fixed price (from design phase of definition). **No Cost Impact Until Post R1.**	$0	No Change yet, JV agreed to change in final Rev 01.	A future opportunity (not addressed in Class 2 Rev 01)
Chapter Report	19	9-Jun-15	Support Services	120 Type A 40' Storage Containers and 30 Type A 20' containers. What are these for? Why is the end user such as tooling or waste not budgeting or at least pointing to this document?	SS&E	JV to provide detailed basis on why IP2 ISO containers are required. Exact quantity and usage of containers to be provided.	Reduce quantity of 40 ft containers from 120 to 65 and 20 ft containers from 30 to 5. 50 containers are identified within the Infrastructure Plan to be situated within the CES area. The remaining containers will be used for the TMS group for tool handling. **Carried in Entry ID 23.**	$0	Verified Item	OK
Chapter Report	20	9-Jun-15	Support Services	Series training section. There are many tools listed in this section which are less than 2000 dollars. Why are they not covered under small tool allocation?	SS&E	JV agreed to remove. JV to remove $ 0.673 M.	Agree, all training tools over $2,000 removed from list **Carried in Entry ID 23.**	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Chapter Report	21	9-Jun-15	Support Services	Propane costs are greater than $5M. Diesel fuel for float tractors ($1.5M - possible double count 3x0.5M). Please provide justification for such high fuel costs and basis on how the totals are calculated.	SS&E	JV agrees to remove fuel costs based upon equipment reduction. Moving to Goods. JV to remove duplicated Diesel fuel line item in Nuclear Waste Handling. JV to remove $ 4.53 M.	Removed excessive propane costs but increased diesel to cover the correct quantity of vehicles. Company vehicle fuel to be left in SS&E according to CAT 6.9. Construction equipment fuel to be included in Goods per CAT 3.1. Item to be added to Scope Control for clarification in CAT Table. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. 25JUN Update: JV to provide breakdown of net costs and SS&E Items for review by OPG. **Carried in Entry ID 23.**	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Chapter Report	22	9-Jun-15	Support Services	SS&E lists a host of equipment that is not defined for use. It is unclear as to the intended use of each including duplication across activities and project in general (E.g. forklifts x 10). Please clarify.	SS&E	All Zoom Booms for RWPB Contaminated Equipment should be removed Demolition equipment to be resolved by action documented in 319. To be removed from OPG deduction AGV line item to be eliminated. JV to state any low scope development areas in Scope Control Chapter Trailers for Flask Handling are agreed to not being within Fixed Price Tooling. JV to justify basis for trailer quantity JV to ensure RWC/DSO lifting beams/assemblies exclusively featured in OSM JV to verify basis of use of 80 000 forklift. 27AUG: Class 2 Rev 1 Estimate to include the cost for rental of this equipment if it is required. Equipment will not be purchased. JV to consider using only one 25 000 forklift to be shared between RWPB and RWPB-E. 27AUG: This change will be incorporated into Class 2 Revision 1. JV to provide basis for eight Zoom Booms for RB Vault Area JV to remove 15 tn Broderson and Spider Crane. To be replaced with 8 tn Broderson, providing the two 8 tn Brodersons required in vault JV to remove Mules/Rhinos Bulkhead Counterbalance Beam to be removed from OPG deduction JV to remove Counterbalance Lifting Beam (RTP) Job Boxes accounted in Small Tools. Already deducted. Removed from OPG deduction Ball Screw R&R Tooling to be removed from OPG deduction	Remaining equipment list validated with Construction team. Adjustments made as applicable. Identification of "Quote" vs "Budget" listed. JV Quantification includes all items agreed upon with OPG on 12JUN. 25JUN Update: JV to provide a revised SS&E list for review by OPG. **Carried in Entry ID 23.**	$0	Verified Item	ok
Chapter Report	23	9-Jun-15	Support Services	Servicing Feeder warehouse/Contaminated and Clean Storage. The JV is budgeting for 200 computers and 5 printers. Many PMT staff will come with their own computers which should be covered by mark up and overheads. Why does the JV need 200 computers to just service these facilities? Seems to be excessive.	SS&E	JV to verify costs as being truly incremental and in compliance with RFR contract. Cost to be optimized if possible. 27AUG: Cost has been optimized, and incorporated into the Class II Revision 1 submission. JV to link 200 computer/cell phone requirements to PMT requirement in order to properly justify basis	Incremental costs only applied to the 200 laptops per JV split between SLN/Candu and Aecon. Note: JV supplied computers workstation (desktop PC or laptop) usage will be applied per PMT staffing levels. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. 25JUN: JV to provide basis for change in price per workstation and monetization quantification. **Includes all monetary changes for SS &E.**	($25,907,826)	Cost changed, more information required to properly validate the cost adjustment	Included in Sept 18, 2015 submission, Support Services estimate documentation.
Chapter Report	24	9-Jun-15	Support Services	OPG requires justification for the quantity and type of trailers specified in Appendix C.	SS&E	JV to provide basis and quantity justification for each type of trailer. OPG reduction to remain unaltered until this basis is presented. JV to remove $ 0.65 M.	(6) Custom 65 Ton quad axle trailer - required for RWC/DSO handling including vendor shipment to site with ramp grade restrictions at RWPB. Standard trailer heights will not clear the ramps. These will also serve as a buffer storage area and permit transporting through Sally Port during non peak hours instead of when vendor delivers to site. **(Qty 0 deleted)** (1) 50 Ton Flat Bed c/w retractable tarp to be used for transporting tooling outside route and to transport ISO Containers **(Qty 1 deleted)** (2) Shortened drop deck trailers c/w retractable tarps to transport vault flasks via outside route. Modified to fit under shortened gantry crane. Qty 2 are required to maintain FC Removal schedule. (3) 48 ft flatbed trailers required for OSM & Goods shipment from DEC and for shipping feeder from Feeder Warehouse to site. **(Qty 3 deleted)** (4) Customized in-station transfer of vault flasks, including spares used as a buffer **(Qty 2 deleted)** 25JUN: JV to provide basis for quantities of each piece of equipment listed above. **Carried in Entry ID 23.**	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Chapter Report	25	9-Jun-15	Tool Management	Goods listed are considered fixed priced tooling as per contract	Tooling	Commercial positions to be determined on both sides Revisions to be incorporated prior to Rev 1 and approved by OPG 2015-08-18: Final monetizations as agreed upon with OPG.	The JV has identified all what is believed to be under the scope of Tooling Fixed Price and removed it from the list of equipment/goods in the estimate. 25JUN: JV has provided revised list, OPG currently reviewing revised list. For discussion during the July 02 meeting. 10 JULY Update: The 3x3 Mockups and Mini Platforms have been removed Although not revised for this submission. The intent is that through succession planning and knowledge transfer our resources will be able to pick-up enough know-how to reduce the amount of Vendor support required. As such Vendor support will be as follows: 1st Unit - full vendor support 2nd Unit - Hybrid of Vendor and JV Personnel 3rd and 4th Units - 33% Vendor support, the rest is JV Personnel Not part of this submission - Aluminum Skids - Working on data for what we get for price We will also correct the vendor support rate and add it to the new submission change log A description as follows will be included in the Chapter write-up as one does not yet exist: GOODS The items that are used to support recomission and post maintenance are captured in the Goods section of the estimate. This list was validated using actual data from TPG as well as various deep dives with SME's **Cost Carried in ID9.**	$0	Verified Item	no cost adjustments shown as per comments
RFR L5 Schedule-Vertical Slice Analysis- 03 June 15	26	9-Jun-15	CWP 2060	**Fabrication in Vault** Estimate lists personnel fabricating staircase tower in the vault. Fabrication of Staircase and tower to be performed offsite. Fabrication man-hours to be removed which included bump shift and estimate should be provided for fabrication under goods.It is standard practice from a cost and ALARA perspective to perform all fabrication practical outside the vault. Note Fabrication man hours were 3873 install in vault 2412 per unit.	DFL - TMODS (Pre&Post)	Action JV: JV to revise fabrication strategy to align with contract and adjust the costs accordingly. It was noted that the intention to procure or self perform will be clearly stated in Rev 1. A similar issue is applicable to at least 15 other packages. JV to remove $1.23 M and any additional cost discovered in review of other affected packages. Action on JV July 23 2015 : Item was previously agreed to, Jv to ensure additional costs have been removed. July 31 2015: Confirmed costs were removed a part of REV 0 Prime.	The fabrication labour credit includes the following CWPs: 2037, 2039, 2041, 2042, 2057,2060, 2121, 2122, 2191, 2203 The credit is only for the bump shift portion within any applicable CWP. The fabrication cost. Subsequent changes tied to total DFL hours are not included in this credit, such as corresponding reductions in training, dose, SS&E, etc. These will be included in the Rev 01 submission. **All costs related to Fabrication is under CWPs listed above captured here and not included in other specific comments for those CWPs listed elsewhere.**	($2,524,042)	Verified Item	The CWP 2060 changes have been incorporated.
RFR L5 Schedule-Vertical Slice Analysis- 03 June 15	27	9-Jun-15	CWP 2060, CWP 2080, CWP 2062, CWP 2144	**Supervision ratio** (Foreman to DFL ratio) is high (over 20 %) on many packages (see samples below). JV to provide supervision plan and use of sub foreman • CWP 1060 Replace Staircase Towers and Platforms – 26 % • CWP1080 Restore Elec. Interferences related RA bridge motor-21 % • CWP 1062 Replace Misc. Steel Within tooling Env.-25 % • CWP 4144 Nozzle Inspection and Weld Prep-21%	DFL - TMODS (Pre&Post)	Action 1: JV to Prepare individual histograms for each resource type showing supervisor hours as a percentage of total hours for a given time period. TCD next week (week of Jun 8th). ACTION 1 is COMPLETE. Action 2 on JV: Provide an outline of the supervision model i.e. the rules for when a Forman is needed and why. Look at the stickout (high %) packages and provide rationale for supervisor hours in relation to Crew assemblies. Explore ways of optimizing these hours e.g. having one supervisor oversee multiple small crews, use of sub-foreman, etc,. Separate meeting to be set up to discuss once completed. August 7 2015: JV and OPG agreed 18.4% Foremen Supervisors shall be used for estimating purposes only during the Class II. Agreed to by Tommy Hansen, Todd Hamilton, Brandon Campbell, Amy Huellet, Jeff Palmateer, and Rick Pettet. The 18.4% will result in monetization changes to Onboarding, Series Training and LOA and captured in those chapters.	Action 2 - Prepare and present the foreman supervision model for CWPs and also support services. **No change to cost.**	$0	Verified Item	No change to cost
RFR L5 Schedule-Vertical Slice Analysis- 03 June 15	28	9-Jun-15	CWP 2224	**Resource Loading** :Review of Schedule depicts the driver of this day's peak is that the resources and costs are allocated to this day only despite the task is 7 days in duration. 4 Units -36% of all activities do not have resources or budget assigned. 4 Units- 25% of all critical path activities do not have resources or budget assigned. 4 Units- 22% of construction critical path activities do not have resources or budget assigned. 4 Units - 12% of all construction activates do not have resources of budget assigned. Resource loading is not done as per the contract (exhibit 3.5) and AACE recommended practice 37-R (resource loading for each task)	Schedule Quality	Action on JV - Allocate hours across other tasks in the series. Action on JV: Check other 0 hour items on P6 to see if this error is elsewhere. Sudhakar to close out with Justin- 28AUG.	Action - revise schedule allocation from "Y" row only to all rows. This is not a systemic issue and has no cost or schedule impact. Action is complete and will appear in Rev 01 submission. **No Cost Impact.**	$0	Verified Item	OPG-JV war room monetization is not available, no change to the estimate at this time except for the rate increase (Holidays). Estimated cost is increased by $2.54K for all units. The increased amount is entered in the CWPs changes to Rev-01
RFR L5 Schedule-Vertical Slice Analysis- 03 June 15	29	9-Jun-15	CWP 2249, CWP 2121	**LFD** :LFD does not depict all CWPs, this does not allow for correct assessing of crewing. Samples: CWP 1249,CWP4121	Schedule Quality	Action on JV: Correct any known problems with the LFD and issue revised version with Rev 1 of the estimate. Sudhakar to close out with Justin- 28AUG.	Action - LFD being revised from Rev 05 to rev 06. **No Cost Impact.**	$0	Verified Item	No change to cost
RFR L5 Schedule-Vertical Slice Analysis- 03 June 15	30	9-Jun-15	General	Pre-Job Hours :The first 25 min of bump shifts will have to include the pre job briefing otherwise a hot hand over cannot be achieved in the vault as planned. Also the bump shift includes a production factor of 1.675 to cover this item hence there should not be any Prejob manhours included in the CWP estimates.	DFL - TMODS (Pre&Post)	Action on JV: Correct as required. July 23 Update: JV to review monetization and ensure changes have been incorporated. July 31 2015: Confirmed costs were removed as part of Rev 0 Prime. Guy to ensure all CWP's with bump shift factor do not have Pre/Post Job hours, WA, or WP hours in estimate.	**Not captured in Rev 1. To be added to Post Rev 1 Errata List.**	$0	JV agreed but cost adjustment not implemented.	Included in Sept 18, 2015 submission, late changes (Errata) item #5
RFR L5 Schedule-Vertical Slice Analysis- 03 June 15	31	9-Jun-15	General	**RP Support** :9629 man hours are allocated for RP support which represents 19% of total CWP man hours of 50,217. Please confirm % of RP required for this CWP,as an example a reduction to 10% RP support would result in a reduction of Man hours and cost to OPG. Please identify the number of RP per day required, the shift pattern and work locations. Is this direct or indirect REP.	ALARA	Action on JV: To Identify all required RP support basis and provide resource profile (FTE) The Backing Sheet for ALARA & Dose Estimate Chapter provided the FTE profile of the RPC based on CWP. It was also agreed that this information together with a profile based on work schedule will be included in Rev 1 of the Chapter.	Action in progress. 25JUN Update: JV to clean-up and close out actions listed. 10 JULY Update: RP table to be added to the letter for the July 15 Submission. **No Cost Impact. All changes to be capture in R01 ALARA and Dose Estimate Chapter Report.**	$0	Verified Item	no cost impact
RFR L5 Schedule-Vertical Slice Analysis- 03 June 15	32	9-Jun-15	Schedule	**Activity Logic** : For CWP 4166 PT Severing Inc. Install HWT, Confirm the activity order, currently the tasks, east vs. west accumulate to 15 days	Schedule Quality	Action on JV: To check logic Sudhakar to close out with Justin- 28AUG.	Action closed 06-04-15 during OPG-JV face to face meeting. 25 JUN Update: Additional details on path forward/resolution required. **No Cost Impact.**	$0	Verified Item	no cost impact
RFR L5 Schedule-Vertical Slice Analysis- 03 June 15	33	9-Jun-15	General	**Float Management :** Provide the float management strategy. Create what if to demonstrate the float management	Schedule Quality	Action on JV: JV To provide what if scenario and float management strategy Sudhakar to close out with Justin- 28AUG.	Action in progress. 25JUN Update: JV to clean-up and close out actions listed. **No Cost Impact.**	$0	Verified Item	no cost impact
Basis Sheets	34	12-Jun-15	CWP 2164	(Trapped feeder removal - basis needed for added time and total impact) - OPG COMMENT - 24 trapped feeders x 30 min each = 12 hours (0.5 day) of critical path work. 40 additional sites, dandex, and cleaning are in parallel path	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agreed to leave this adjustment item in the base duration	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	no cost impact collaborative team agreed to leave this adjustment item in the base duration
Basis Sheets	35	12-Jun-15	CWP 2164	Narrow rows work efficiency (risk, mitigate with training and readiness activities)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agreed to remove this 0.5 day adjustment factor from base duration	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	the adjustment for the CWP duration shows less than 0.5 days through it is mentioned that this will be removed
Basis Sheets	36	12-Jun-15	CWP 2164	Activities not performed in TPG Testing - Helicoil replacement (risk handled by Agreement)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agreed to increase this adjustment factor by 1.87 days (Helicoil replacement basis and breakdown provided on revised basis sheet)	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	the adjustment for the CWP duration shows less than 0.5 days through it is mentioned that this will be removed
Basis Sheets	37	12-Jun-15	CWP 2164	(pre-soak of PA hardware for ease of removal, basis needed)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agreed to remove this 0.5 day adjustment factor from base duration. This is no longer in as an adjustment item, rather it is included in the base duration.	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	the adjustment for the CWP duration shows less than 0.5 days through it is mentioned that this will be removed
Basis Sheets	38	12-Jun-15	CWP 2164	Activities not performed in TPG testing - LLW containers movement (reject portion of basis -1 hr min to move platform, 20 minutes to move containers, 6 platform moves)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agreed to remove this 0.5 day adjustment factor from base duration	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	the adjustment for the CWP duration shows less than 0.5 days through it is mentioned that this will be removed
Basis Sheets	39	12-Jun-15	CWP 2164	Unique lattice sites (Grinding) (risk handled by Agreement)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agreed to leave this adjustment item in the base duration	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	the adjustment for the CWP duration will be left as it is
Basis Sheets	40	12-Jun-15	CWP 2164	Activities not performed in TPG Testing - platform movements (8 movements per face, 30 minutes used)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agreed to remove this 0.17 day adjustment factor from base duration	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	the adjustment for the CWP duration shows less than 0.5 days through it is mentioned that this will be removed
Basis Sheets	41	12-Jun-15	CWP 2164	Vault Learning Curve (mitigated with training and readiness activities, supervision)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agreed to remove this 0.15 day adjustment factor from base duration. No learning curve seen as part of TPG	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	the adjustment for the CWP duration shows less than 0.5 days through it is mentioned that this will be removed
Basis Sheets	42	12-Jun-15	CWP 2164	Activities not performed in TPG testing - browns (mitigated with training and readiness activities)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to leave in base duration	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 414)**	$0	Verified Item	the adjustment for the CWP duration will be left as it is
Basis Sheets	43	12-Jun-15	CWP 2141	(5 minutes per feeder basis)	DFL - Feeders	JV to provide justification on basis starting from TPG times. Recalculate TPG times if necessary. JV to review OPEX and minimize critical path time. Removed from Basis Sheet.	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **Includes all monetary changes within this CWP**	($97,254)	Verified Item	OPG-JV war room monetization is not available. The change in the estimate is implemented and entered in the CWPs changes to Rev-01 sheet
Basis Sheets	44	12-Jun-15	CWP 2141	(mitigated with training on mockup, supervision)	DFL - Feeders	JV to Remove "Vault Ramp-Up" from ALL basis sheets. Provide a consolidated list of removed items for discussion with OPG. Removed from Basis Sheet.	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	45	12-Jun-15	CWP 2141	(risk, rework handled by Agreement)	DFL - Feeders	This is contingency work. JV to Remove from base. Inclusion in risk register to be discussed (actual duration of activity is agreed upon between OPG and JV). Removed from Basis Sheet.	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	46	12-Jun-15	CWP 2141	(reject - bump shift premium is hot handoff)	DFL - Feeders	Document hot-hand turn over on RTP in DFL summary chapter. JV to ensure the math is consistent across all install/removal series. 10 mins on Basis Sheet.	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	47	12-Jun-15	CWP 2141	(risk, basis of 4 swaps per face?)	DFL - Feeders	Remove from the base estimate. OPG and JV to discuss how it can be incorporated into the risk. Removed to Risk.	8sa **(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	48	12-Jun-15	CWP 2141	(1.5 hours per transfer-basis needed)	DFL - Feeders	JV to Provide the basis for 1.5 hours per transfer. JV to reduce the 1.5 hours to take into account TPG RTP times, possible choking and other techniques to reduce critical path time. Provide the link between number of container transfers to ALARA requirements (dose rate limits and duration)/max weight limit of containers. Removed off Basis Sheet.	* These items are on hold pending global basis sheets review. JV to verify if this are in addition to the global basis sheets review and provide feedback. **(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	49	12-Jun-15	CWP 2141	(24 moves x 10 min per move, one movement allows access to 2 rows)	DFL - Feeders	Time is being changed from 0.2 to 0.1 . Moves reduced from 24 to 12. Check on validated RTP minutes in TPG. Action Complete. Changes as documented to be made.	This is agreed to and will be taken out for rev.0prime **(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	50	12-Jun-15	DFL - Feeders	(tooling use for one unit, maintenance to be performed in parallel and off critical path - basis needed)	DFL - Feeders	The CWP Lift plan to be updated by JV to ensure that the frequency of lifts are captured. Testing in mock up to validate. 21AUG: OPG and JV Agreement that this comment is no longer valid. No changes required.	* These items are on hold pending global basis sheets review. JV to verify if these are in addition to the global basis sheets review and provide feedback. **No Cost Impact.**	$0	Verified Item	No impact to Cost

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
EF Backward Pass	51	16-Jun-15	Support Services	Add details of iSEP and explain the contents of each estimate that makes up support services	Support Services & Infra	JV to link CWP0010 Class II Estimate Durations to the latest Basis Sheets submitted as part of CL2 for Reactor Face Removal Series. Transition In and Transition Out durations for Reactor Face Removal Series do not apply to RWPB work. Following completion of the action above, JV to match effort for Task TS-320 in the LOE Estimate with the duration where Waste Components will be processed in the RWPB. Additionally, RWC transfers to the RWSB will not be done in "Browns". JV to correct this error. (July 30) JV-OPG collaborative team reviewed and agreed upon following changes to LOE: *TS_LOE_R6 lines 59 to 63 durations changed to 3720 (155 days @ 24hrs/day) *TS_LOE_R6 line 64, dress changed to "Street"	COMMENT #8 FROM Jun-15-15 MEETING Operation number TS 320 RWC transfers to RWSB reduced to 3720 hours. Dress has been changed from brown to streets. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. **Carried in Entry ID101**	$0	Verified Item	carried in id 101 value not verified yet
EF Backward Pass	52	16-Jun-15	CWP 0010	JV to ensure transition data is consistent. JV action to ensure that total durations including transition times for WVR align with face series and provide basis for WVR durations. All waste durations are higher than face series due to incorporation of lead + lag times, transition, etc. What is the basis for the duration applied? From the removal operations the total duration is approximately 140 days. The waste volume reduction duration estimate is approximately 180 days. This represents an additional 40 days transition in/out for 4 major waste processing operations.	Waste/Volume Reduction	JV to link CWP0010 Class II Estimate Durations to the latest Basis Sheets submitted as part of CL2 for Reactor Face Removal Series. Transition In and Transition Out durations for Reactor Face Removal Series do not apply to RWPB work. 2015-8-7: JV and OPG agree that revised Removal duration is ~ 99 days per War Room meetings. Schedule to be adjusted accordingly.	COMMENT #11 FROM Jun-15-15 MEETING The duration to be adjusted to match the P6 schedule. Crew will be required fo r transition in and transition out durations. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. **Additional Action: Check Training Estimate for Impacts.** **JUN 26 update: JV to evaluate whether crew during reactor series transition times can be optimized based on revised critical paths. Not included in this Submission. Needs to be evaluated between TMO and Transition in and out resources to make sure there are no duplications.** **The price shown is inclusive of all changes for this CWP.**	($7,628,483)	Verified Item	OPG-JV war room monetization is not available. The change has been implemented and entered in the CWP changes to Rev-01.
EF Backward Pass	53	16-Jun-15	Support Services	The shipment of material is task based. The shipment of T-Mod Trench Covers and removal of the originals to the CES in Isep Window # 2 communicates separate material movement costs for the Bunker Room Trench, North Corridor Trench , AL # 1 Trench RB covers ,Shielding Door Trench covers and Floor Drain trench covers . Please consider consolidating the six individual shipments into 1 within Class 2 Estimate Rev 1 . Additionally, currently the multipliers for the Transfer Flask Movement tasks in ISEP Window #4 do not appear to match with the JV's proposal for transporting Transfer Flasks from the RAB to the RWPB in the Waste Management Plan. Please review and revise accordingly.	Support Services & Infra	JV to split the tasks for Transfer Flask wipe down and transfer to the RWPB and back into two parts: Part #1 - Wipe down of Transfer Flasks: hours for strictly the wipe down of the Transfer Flask to be removed from the second part of the task described below and applied to this task. Multiplier to be assigned equalling the total number of Transfer Flasks expected for each series. Part #2- Transport Transfer Flask to RWPB and Back: hours for moving the Transfer Flask to the RWPB and back should be assigned to this task with a multiplier applied that reflects the Waste Management Plan proposal (i.e. 4 EF/CTI Transfer Flasks per trip, or 2 PT/CT Transfer Flasks per trip). Additionally, JV to explain the basis and execution strategy relating to the Transfer Flask Logistics in the relevant Chapter Report. JV to provide a date when the engineering analysis of PCD19 will be completed to the point where a decision regarding adequacy of the Waste Management Plan proposal for movement of Transfer Flasks in the 100m corridor can be made. (July 30) JV-OPG collaborative team reviewed and agreed upon following changes to iSEPs: *Lines 91-95 of ISEP_W4_R3 for EFR now separate out the flask handling and flask transfer activities. *Lines 115-119 of ISEP_W4_R3 for PT Removal now separate out the flask handling and flask transfer activities. *Lines 183-187 of ISEP_W4_R3 for CTI Removal now separate out the flask handling and flask transfer activities. *Lines 209-213 of ISEP_W4_R3 for CT Removal now separate out the flask handing and flask transfer activities *Lines 91-95 of ISEP_W4_R3 for EFR wipe down multiplier 960 to reflect # of EF flasks. Transfer multiplier changed to 480 to reflect 2 EF flasks/transfer vehicle. *Lines 115-119 of ISEP_W4_R3 for PT Removal task multipliers are 480 to reflect # of PT flasks, and 1 PT flask per transfer vehicle. *Lines 183-187 of ISEP_W4_R3 for CTI Removal wipe down multiplier changed to 96 to reflect number of flasks. Transfer multiplier changed to 48 to reflect 2 CTI flasks/transfer vehicle. *Lines 209-213 of ISEP_W4_R3 for CT Removal task multipliers are 480 to reflect # of CT flasks, and 1 CT flask per transfer vehicle	COMMENT #34 FROM Jun-15-15 MEETING JV to revise ISEP_W4 OPN # W4-610 estimate to show as separate line items for cleaning flasks and transfers. JV to clearly state scope of work related PCD19 and define basis of estimate for flasks transfers down corridor from RAB to RWPB. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. JUN 26 Update: OPG to provide OPEX on cleaning times. JV to apply this action to all flasks transfers by support services. Note: July 10 - OPEX received by JV, but has not been incorporated. **Carried in ID57.**	$0	JV agreed but cost adjustment not implemented.	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
EF Backward Pass	54	16-Jun-15	Support Services	If there are one floater Operator per face to cover washroom breaks and lunch breaks then what do these operators do for the remaining of the 100% coverage? Or are the manpower numbers such that someone is always on break?	Support Services & Infra	RCC Relief Operators to be analysed and optimized where possible by the JV. For example, for all series that have 1 operator per face, the number of relief needs to be reduced to 1 relief person for both faces at a minimum. Additional reductions (where relief is removed completely and the Foreman covers breaks) are also to be analyzed. (July 30) JV-OPG collaborative team reviewed and agreed upon following changes to LOE: *TS_LOE_R6 lines 6-47, reduced RCC Operator Floaters to 1.	COMMENT #42 FROM Jun-15-15 MEETING JV agrees to reduce LOE estimate - RCC Operator check double coverage for vacation and washroom break, reduce from 2 floaters to 1. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. 10 JULY Update: For Jul-15-15 submission, equivalent of 1 floater removed from RCC LOE estimate based on Jul-8-15 meeting as agreed by OPG. Crew sizes will be increased for certain series due to joint revaluation of series specific RCC workstation activities to support the revised critical path. **Carried in Entry ID101.**	$0	Verified Item	carried in id 101 value not verified yet
EF Backward Pass	55	16-Jun-15	Support Services	Transportation of all Tooling will be done by Support Services not Tool Management. Tool Management only provides oversight according to their Chapter Report. In addition, Tool Management along with the execution team install and commission the tooling. This Chapter Report does not align with the Tool Management and Support Services chapters. They should not overlap scope. Please update as required. Additionally, it appears that scope Estimated in the Level of Effort Estimate may overlap with that Estimated under Tool Management for Waste Tooling Preventative Maintenance. Please clarify and confirm.	DFL - Remove/Inspect	Action on JV to ensure scope estimated in Tool Management Chapter Report is not duplicated in the Level of Effort Estimate. Also, if it is determined by the JV that this is not a duplication of effort, JV to provide clarification to OPG regarding what the scope of work is being addressed by the tasks estimated in both locations for OPG Review. (July 30) JV-OPG collaborative team reviewed and agreed upon following changes to LOE: *Description of Lines 59 and 60 changed to "RWPB Transfer Flask, LLWC and RWC handling". These are not duplicates from the TMO.	Comments #82 FROM JUN-15-15- MEETING This is not a duplication, error in task descriptions. Task descriptions will be revised in the next estimate, no change to LOE or TMO estimate. **No Cost Impact.**	$0	Verified Item	No cost impact; JV & OPG meeting; These are not duplicates from the TMO.
EF Backward Pass	56	16-Jun-15	DFL - Summary	Planned contingent operations are not agreed and transparent to OPG. The planned contingent operations are duplicated with risks identified in risk register to certain extent. The methods of how the cost and schedule are incorporated in CWP DWI, estimate and L5 schedule basis have not be presented to OPG despite repeated requests.	DFL - Summary	JV to link CWP0010 Class II Estimate Durations to the latest Basis Sheets submitted as part of CL2 for Reactor Face Removal Series. Transition In and Transition Out durations for Reactor Face Removal Series do not apply to RWPB work. This Change Log Item has not been signed off on as this is a duplicate comment covered off under other Waste Volume Reduction related comments and is covered by Basis Sheet development.	COMMENT #85 FROM Jun-15-15 MEETING (Action will be closed and monetized in Entry ID 52. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. **Carried in Entry ID 52**	$0	Verified Item	Included in Entry ID 52
EF Backward Pass	57	16-Jun-15	Window #4 ISEP	Currently for the majority of "Wipe down Flask and transfer Flask to RWPB and back" tasks show "Browns and Comfo" dress (aside from . 90% of the tasks will be completed in "Browns" dress. This is considered an Estimating Error	Support Services & Infra	JV to update dress, and Walk Time Factors applied in the estimate to "Browns" from "Browns and Comfo" for all "Wipe down Flask and transfer Flask to RWPB and back" tasks in the ISEP Window #4 Estimate. (July 30) JV-OPG collaborative team reviewed and agreed upon following changes to iSEPs: *Lines 91-95 of ISEP_W4_R3 dress changed to browns *Lines 115-119 of ISEP_W4_R3 dress changed to browns *Lines 183-187 of ISEP_W4_R3 dress changed to browns *Lines 209-213 of ISEP_W4_R3 dress changed to browns	JV will split this task into 2 tasks: wipe down and transfers in the ISEPS Estimate. June 26: JV Agrees. **Includes all monetary changes within this ISEP Window.**	($2,839,856)	Verified Item	Cost Impact shown.
EF Backward Pass	58	16-Jun-15	Window #4 ISEP	Based on OPG Station OPEX associated with Calandria Tube Replacements and Single Fuel Channel Replacements completed in the past, OPG feels that the time estimated of 2 hours per Transfer Flask trip from the RAB to the RWPB and back is inaccurate. Additionally, it is believed that the crew assigned of 3 trades (2 Boilermaker Journeymen, 1 Millwright Journeyman) is excessive. Based on OPEX, 2 trades, and 2 Greenmen can be used for these transfers and the transfer from the RAB to the RWPB and back should take no longer than 1.5 hours. The flasks used for CTR and SFCR are not as well designed as the Transfer Flasks for RFR and it takes the crew described above 1 hour to transfer a flask from the RAB to Unit 4 Extension, survey the flask and post it. Additionally, it is not clear why Operator Journeyman coverage is required for Transfer Flask Movements with the exception of EF Transfer Flask Movements.	Support Services & Infra	JV to adjust Estimate to match agreed upon Crew Mix consisting of a total of 2 trades for these tasks. Additionally, JV to investigate potential reduction from 2 hours per Transfer Flask movement from RAB to RWPB and back to 1.5 hours. (July 30) JV-OPG collaborative team reviewed and agreed upon following changes to iSEPs: *Lines 91-95 of ISEP_W4_R3 1 operator, 1 trade and 1 Greenman added for a duration of 0.5 hours. Total flask handling and transfer now equals 1.5 hours. *Lines 115-119 of ISEP_W4_R3 1 operator, 1 trade and 1 Greenman added for a duration of 0.5 hours. Total flask handling and transfer now equals 1.5 hours. *Lines 183-187 of ISEP_W4_R3 1 operator, 1 trade and 1 Greenman added for a duration of 0.5 hours. Total flask handling and transfer now equals 1.5 hours. *Lines 209-213 of ISEP_W4_R3 1 operator, 1 trade and 1 Greenman added for a duration of 0.5 hours. Total flask handling and transfer now equals 1.5 hours. *Lines 91-95 of ISEP_W4_R3 for EFR now separate out the flask handling and flask transfer activities. *Lines 115-119 of ISEP_W4_R3 for PT Removal now separate out the flask handling and flask transfer activities. *Lines 183-187 of ISEP_W4_R3 for CTI Removal now separate out the flask handling and flask transfer activities. *Lines 209-213 of ISEP_W4_R3 for CT Removal now separate out the flask handing and flask transfer activities.	COMMENT #90 FROM Jun-15-15 MEETING, OPG (Steve Allen to provide OPEX on cycle times in the station to substantiate the 1.5 hours X crew of 3). Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. Jun 25: Feedback on disposition is required from OPG. Completed see ID 53 for monetization **Carried in Entry ID 57**	$0	Verified Item	Completed see ID 53 for monetization
EF Backward Pass	59	16-Jun-15	Support Services	It appears as though WCC Operating Crews have been double counted both in CWP0010 Estimate and Chapter Report as well as in LOE Estimate. LOE Estimate Operators (TS-315) should be removed. See Excel Spreadsheet for calculation details.	Support Services & Infra	Action on JV to ensure scope estimated in the CWP0010 Estimate is not duplicated in the Level of Effort Estimate. Also, if it is determined by the JV that this is not a duplication of effort, JV to provide clarification to OPG regarding what the scope of work is being addressed by the tasks estimated in both locations for OPG Review. (July 30) JV-OPG collaborative team reviewed and agreed upon following changes to LOE: *TS_LOE_R6 lines 61-63 floater reduced to 1.	COMMENT #93 FROM Jun-15-15 MEETING JV agrees to reduce LOE estimate - WCC Operator check double coverage for vacation and washroom break, reduce from 2 floaters to 1. Note: This monetization is schedule dependent and subject to change should the Rev 00 schedule be revised. Jun 25: Feedback on disposition is required from OPG. Note July 10: Confirm there is a duplication between LOE and Volume Reduction crew. **Carried in Entry ID 101**	$0	Verified Item	carried in id 101 value not verified yet
Basis Sheets	60	17-Jun-15	DFL - Feeders	(OPG risk to manage)	DFL - Feeders	The wording in the basis sheet indicates that this is related to risk ("assumption", "in the event", "it is expected that", "emergent"). JV to remove from base. The quantification of within the risk register to be reviewed impact using the risk process. 21AUG: OPG and JV Agreement that this comment is no longer valid. No changes required.	These items are incorporated as per the rainbow list reviewed with OPG week of July 6th. **No Cost Impact.**	$0	Verified Item	No change to cost
Basis Sheets	61	17-Jun-15	DFL - Feeders	(risk)	DFL - Feeders	JV to remove from base. The quantification of within the risk register to be reviewed impact using the risk process. 21AUG: OPG and JV Agreement that this comment is no longer valid. No changes required.	These items are incorporated as per the rainbow list reviewed with OPG week of July 6th. **No Cost Impact.**	$0	Verified Item	No change to cost
Basis Sheets	62	17-Jun-15	DFL - Feeders	(risk, included in TPG basis/methodology use in TPG was different - why?)	DFL - Feeders	JV to provide the basis on the walking times. 21AUG: OPG and JV Agreement that this comment is no longer valid. No changes required.	These items are incorporated as per the rainbow list reviewed with OPG week of July 6th. **No Cost Impact.**	$0	Verified Item	No change to cost
Basis Sheets	63	17-Jun-15	DFL - Feeders	(included in transition in duration)	DFL - Feeders	This item to be updated in order to reflect actual execution methodology and duration. For example, - Additional RTP movements required? -RTP movements to be in line with TPG times. They are currently at 30 minutes. 21AUG: OPG and JV Agreement that this comment is no longer valid. No changes required.	These items are incorporated as per the rainbow list reviewed with OPG week of July 6th. **No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	64	17-Jun-15	Schedule	Calendar Assignments in P6 are inconsistent Example: – Class 2 RFR NCP 6 x 10 (2 Shift) -Non Critical Path activities, Stat holidays are included – Class 2 RFR (24 hours Storage)- Warehouse- Stat holidays included Provide the basis for Calendar usage in Schedule Chapter and assign appropriate Calendars in P6	Schedule Quality	The calendar assignments are being reviewed and corrected where necessary as part of the rev.1 submittal. The assignments will not impact the critical path or the cost - as the calendar in the P6 file is not allowed to determine the schedule duration of the critical path, this duration is fixed to the durations established through the basis sheet process, As such - these items are a "clean-up" in the schedule. No negative float currently in the schedule OPG/JV to verify before Rev 01 submission	The calendar assignments are being reviewed and corrected where necessary as part of the rev.1 submittal. The assignments will not impact the critical path or the cost - as the calendar in the P6 file is not allowed to determine the schedule duration of the critical path, this duration is fixed to the durations established through the basis sheet process, As such - these items are a "clean-up" in the schedule. **Calendar assignments corrected in P6 and documented in Schedule Chapter Report. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	65	17-Jun-15	Schedule	Bump Shift Hours are loaded into P6. This do not allow to analyse the productive resources Vs non-productive resources; The wrench time Vs non productive time hours to be loaded separately into P6	Schedule Quality	In order for the JV to load the bump shift hours allocated to working at the face separately from the bump shift hours allocated to time not working at the face two structural changes need to be made, one in the Timberline and one in the P6. In P6 "shadow" activities will need to be created for each activity that has bump shift hours, and in timberline a significant re-structuring of the estimate will have to be done to break out the two parts of bump shift hours. This is possible, but will be resource intensive and time consuming.	In order for the JV to load the bump shift hours allocated to working at the face separately from the bump shift hours allocated to time not working at the face two structural changes need to be made, one in the Timberline and one in the P6. In P6 "shadow" activities will need to be created for each activity that has bump shift hours, and in timberline a significant re-structuring of the estimate will have to be done to break out the two parts of bump shift hours. This is possible, but will be resource intensive and time consuming. **Rate tables have been loaded into P6 for DFL Hours.** **PMT Rate table has not been loaded into P6 PMT File. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	66	17-Jun-15	Schedule	P6 Rates against resources are not in consistent with contractual rate tables. P6 Rate Tables need to be consistent , JV need to update P6 rate tables	Schedule Quality	The rate shown in P6 is an artefact of the tool we are using to import data from Timberline, as the correct rate and calculation of dollars vs. hours is done in Timberline. As such, given the current toolset we have in place (the "P6 integrator software") it is not possible to put the labour rate into P6, as it is held in Timberline. In order for the P6 file to include the labour rates, we would have to re-structure the integrator software and we have to reach out to our supplier to find out if this is possible and how long it will take.	The rate shown in P6 is an artefact of the tool we are using to import data from Timberline, as the correct rate and calculation of dollars vs. hours is done in Timberline. As such, given the current toolset we have in place (the "P6 integrator software") it is not possible to put the labour rate into P6, as it is held in Timberline. In order for the P6 file to include the labour rates, we would have to re-structure the integrator software and we have to reach out to our supplier to find out if this is possible and how long it will take. **No Cost Impact.**	$0	Verified Item	No change to cost

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Schedule	67	17-Jun-15	Schedule	"Rate Source" assignment in P6 is not consistent in P6; Some activities are assigned "Override" and some are " Resource" . This needs to be fixed to have P6 driving the calculations	Schedule Quality	The rate shown in P6 is an artefact of the tool we are using to import data from Timberline, as the correct rate and calculation of dollars vs. hours is done in Timberline. As such, given the current toolset we have in place (the "P6 integrator software") it is not possible to put the labour rate into P6, as it is held in Timberline. In order for the P6 file to include the labour rates, we would have to re-structure the integrator software and we have to reach out to our supplier to find out if this is possible and how long it will take.	The rate shown in P6 is an artefact of the tool we are using to import data from Timberline, as the correct rate and calculation of dollars vs. hours is done in Timberline. As such, given the current toolset we have in place (the "P6 integrator software") it is not possible to put the labour rate into P6, as it is held in Timberline. In order for the P6 file to include the labour rates, we would have to re-structure the integrator software and we have to reach out to our supplier to find out if this is possible and how long it will take. **All activities using "override" function. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	68	17-Jun-15	Schedule	Resource Calculations in P6 are incorrect. Rate multiplied by units do not give the correct output. JV to fix this	Schedule Quality	The rate shown in P6 is an artefact of the tool we are using to import data from Timberline, as the correct rate and calculation of dollars vs. hours is done in Timberline. As such, given the current toolset we have in place (the "P6 integrator software") it is not possible to put the labour rate into P6, as it is held in Timberline. In order for the P6 file to include the labour rates, we would have to re-structure the integrator software and we have to reach out to our supplier to find out if this is possible and how long it will take.	The rate shown in P6 is an artefact of the tool we are using to import data from Timberline, as the correct rate and calculation of dollars vs. hours is done in Timberline. As such, given the current toolset we have in place (the "P6 integrator software") it is not possible to put the labour rate into P6, as it is held in Timberline. In order for the P6 file to include the labour rates, we would have to re-structure the integrator software and we have to reach out to our supplier to find out if this is possible and how long it will take. **Not captured in Rev 1. To be added to Post Rev 1 Errata List. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	69	17-Jun-15	Schedule	Variances against Budgeted Labor Units from P6 and Timberline (CWPs only-2042, 2066, 2170, 2174, 2228). Overall checks to be perfumed to ensure the data is aligned between TL & P6	Schedule Quality	This has been completed, alignment between Timberline and P6 was confirmed	This has been completed, alignment between Timberline and P6 was confirmed **No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	70	17-Jun-15	Schedule	Resource Loading is not consistent : 242 activities (This count is for Unit 2 only, overall to be reviewed) do not contain budgeted labor units . Overall checks to be perfumed on all 4 unit tasks and resource assignment to be done .	Schedule Quality	* These items are on hold pending global basis sheets review. There are a number of activities in the P6 that do not have budgeted labour units, and this is appropriate, as the tooling used to perform these activities is remotely operated. Below are the series identified by OPG that have not hours and the dispositions for each one: RF2227 FROBS and Dummy Bundles Removal 23 - this is a mistake and will be corrected in the next iteration of the P6. RF2017 Install RTP Columns / Decking c/w anchors / Structural Bracing & Stiffeners 4 - this CWP has a large number of activities, the activities with 0 hours will be reviewed, and hours apportioned to them if appropriate RF2124 Installation of Bulkheads/ Welding of Seal Plates and Remove Deflectors/ Install Shielding 2 - this CWP has a large number of activities, the activities with 0 hours will be reviewed, and hours apportioned to them if appropriate RF2166 PT Severing (includes Install of HWT) 25 - This series is remotely operated, and as such there is no in-vault manpower working during this series - so 0 labour should be expected on these activities RF2167 Bellows Severing 49 - This series is remotely operated, and as such there is no in-vault manpower working during this series - so 0 labour should be expected on these activities RF2175 CTI Release 48 - This series is remotely operated, and as such there is no in-vault manpower working during this series - so 0 labour should be expected on these activities JV/OPG to verify by Rev 01 submission	* These items are on hold pending global basis sheets review. There are a number of activities in the P6 that do not have budgeted labour units, and this is appropriate, as the tooling used to perform these activities is remotely operated. Below are the series identified by OPG that have not hours and the dispositions for each one: RF2227 FROBS and Dummy Bundles Removal 23 - this is a mistake and will be corrected in the next iteration of the P6. RF2017 Install RTP Columns / Decking c/w anchors / Structural Bracing & Stiffeners 4 - this CWP has a large number of activities, the activities with 0 hours will be reviewed, and hours apportioned to them if appropriate RF2124 Installation of Bulkheads/ Welding of Seal Plates and Remove Deflectors/ Install Shielding 2 - this CWP has a large number of activities, the activities with 0 hours will be reviewed, and hours apportioned to them if appropriate RF2166 PT Severing (includes Install of HWT) 25 - This series is remotely operated, and as such there is no in-vault manpower working during this series - so 0 labour should be expected on these activities RF2170 Bellows Replacement and LT Rework (Contingency) 96 - This is a mistake and will be corrected for the next iteration of the P6. RF2167 Bellows Severing 49 - This series is remotely operated, and as such there is no in-vault manpower working during this series - so 0 labour should be expected on these activities RF2175 CTI Release 48 - This series is remotely operated, and as such there is no in-vault manpower working during this series - so 0 labour should be expected on these activities **Resource Loading has been verified to be consistent. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	71	17-Jun-15	Schedule	EPC Codes are missing in XER version compared to the version in JV database. Coding to be fixed	Schedule Quality	This was in the OPG Database problem has since been fixed	These codes are in the JV P6, we will work collaboratively with OPG to find out how this file can be imported into OPGs databases without data and integrity loss, as this is currently a problem. The JV is not very familiar with OPGs database set-up, so we will need OPGs assistance to correct this issue. **No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	72	17-Jun-15	Schedule	Start, Finish, OD, Float variances are found when scheduling is done (F9) on XER version. Fix the variances	Schedule Quality	This was in the OPG Database problem has since been fixed	These variances are not in the JV P6, we will work collaboratively with OPG to find out how the .xer file can be imported into OPGs databases without data and integrity loss, as this is currently a problem. The JV is not very familiar with OPGs database set-up, so we will need OPGs assistance to correct this issue. **No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	73	17-Jun-15	Schedule	Start, Finish, OD, Float variances are found between XER version and JV database archived Rev 0 version.Fix the variances	Schedule Quality	This was in the OPG Database problem has since been fixed	These variances are not in the JV P6, we will work collaboratively with OPG to find out how the .xer file can be imported into OPGs databases without data and integrity loss, as this is currently a problem. The JV is not very familiar with OPGs database set-up, so we will need OPGs assistance to correct this issue. **No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	74	17-Jun-15	Schedule	Incorrect dates-Unit 4 WTS installation start date is showing 2016. Corrections required and overall validation checks on dates need to be done	Schedule Quality	The issue of the incorrect dates for the WTS installation has been corrected for the next submittal of the P6. This is complete OPG will verify	The issue of the incorrect dates for the WTS installation will be corrected for the next submittal of the P6. This is complete. **Verified that dates have been corrected. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	75	17-Jun-15	Schedule	Activities found with big Float - Example 7311351414-Open End . Overall checks to be performed on open end and high float activities and to be fixed	Schedule Quality	Overall float checks will be performed prior to the next submittal of the P6	Overall float checks will be performed prior to the next submittal of the P6 **High float items are found for engineering, procurement due to early starts. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	76	17-Jun-15	Schedule	Critical Path activities contain negative floats . To be reviewed and fix the issue and remove negative float	Schedule Quality	No Negative float will be in the Schedule for the Rev 01 Submission previous negative float was fixed, OPG will verify before Rev 01 submission	The concern of negative float on critical path activities is something the JV has been struggling with, as there is a trade off to be considered. The JV can remove the negative floats, but then the Unit 1 critical path will not show up in any critical path analysis of the schedule - which is misleading, as each unit's critical path is an important aspect of the retube schedule, alternately the JV can leave in the negative floats (which are very small - in the order of hours per activity) and this will force the Unit 1 critical path to clearly show. The negative floats can be easily removed by changing one constraint, and the JV will show OPG how to do this in the schedule. **Verified no negative floats. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	77	17-Jun-15	Schedule	Some of the LOE activities have 1 day duration. Overall Checks to be perfumed and durations to be fixed	Schedule Quality	There are a number of issues with the LOE activities that are being fixed in the schedule - some are short, and others have misalignment between the duration of the activity, and the calendarization of the hours in P6. both issues are being corrected. OPG/JV will verify before Rev 01	There are a number of issues with the LOE activities that are being fixed in the schedule - some are short, and others have misalignment between the duration of the activity, and the calendarization of the hours in P6. both issues are being corrected. **LOA Activities have been reviewed and corrected. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	78	17-Jun-15	Schedule	Lags and leads are found on activities ;As per exhibit 3.5 schedule should not contain lags and leads. To be removed	Schedule Quality	Lags and in the critical path will be removed before Rev 01 OPG/JV to review	Lags and leads will be annotated in the schedule and a description of why they are necessary will be provided **No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	79	17-Jun-15	Schedule	Empty WBS Summary activities were found (No Level 5 activities under summaries). WBS Summaries to be appropriately assigned to roll up activities	Schedule Quality	WBS summary activities will be scrubbed - JV and OPG will work collaboratively to ensure the WBS activities are appropriate. In the context of the estimate, the WBS activates are not a requirement anyway, so a first pass will be done for the next iteration of the P6 issued to OPG, but the final confirmation will be done after class 2.	WBS summary activities will be scrubbed - JV and OPG will work collaboratively to ensure the WBS activities are appropriate. In the context of the estimate, the WBS activates are not a requirement anyway, so a first pass will be done for the next iteration of the P6 issued to OPG, but the final confirmation will be done after class 2. **No Cost Impact.**	$0	Verified Item	No Cost Impact. Related to WB$
Schedule	80	17-Jun-15	Schedule	Window /Segment Coding incomplete. To be completed	Schedule Quality	JV requires OPGs final determination of the windows before the segments can be frozen. Once this determination is made, the window's will be frozen in the JV schedule. In the context of the estimate, the windows are not necessary, so this will be done post class 2	JV requires OPGs final determination of the windows before the segments can be frozen. Once this determination is made, the window's will be frozen in the JV schedule. In the context of the estimate, the windows are not necessary, so this will be done post class 2 **Segment Coding is complete. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	81	17-Jun-15	Schedule	Activities have duration longer than 30 days-not consistent with contract .	Schedule Quality	Critical path, and near critical path activities with more than 30 day durations are quite rare in the schedule. The JV will annotate each activity with a description of why it should be considered as an exception to the 30 days rule If it is a construction activity These are all LOE type activities	* These items are on hold pending global basis sheets review. Critical path, and near critical path activities with more than 30 day durations are quite rare in the schedule. The JV will annotate each activity with a description of why it should be considered as an exception to the 30 days rule if it is a construction activity **Activities over 30 days duration are LOE, storage and procurement and some of the engineering packages. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	82	17-Jun-15	Schedule	Control Account and Work Packages are missing on sampling check. Overall checks to be done and fixed appropriately	Schedule Quality	The JV will review and complete by Rev 01/ OPF and JV will review prior to submission	* These items are on hold pending global basis sheets review. If OPG could list the control accounts and work packages missing this would be helpful. The JV did identify that one Work package was in the wrong place and this has now been fixed **This error has been corrected. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	83	17-Jun-15	Schedule	No Activities found on "Series Training". Series Training Activities to be included in the schedule	Schedule Quality	Series training activities will be included in the schedule, and the JV is currently working on this and almost complete	Series training activities will be included in the schedule, and the JV is currently working on this and almost complete **Series Training activities have been included and resource loaded. No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	84	17-Jun-15	Schedule	Wrong WBS Grouping - FC Removal for U2- Complete assessment to be done and fix if any found out in overall schedule	Schedule Quality	This item has now been fixed and verified by OPG	This item has now been fixed **Corrected. No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	85	17-Jun-15	Schedule	Titles are inconsistent between the activities and WBS Summaries: eg 7311340505. Titles to be fixed and to be consistent with activities and roll ups	Schedule Quality	Title corrections are done OPG to verify	Title corrections are low priority and will be done post class 2 when resources are available to perform this **Corrected. No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	86	17-Jun-15	Schedule	Some of the Contract milestones are missing as per exhibit 3.1(b) .eg Common . Overall checks to be done and milestones are to be included and tied appropriately	Schedule Quality	These missing milestones will be included in the schedule. OPG to verify	These missing milestones will be included in the schedule. **Contract Milestones are included in the schedule. No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	87	17-Jun-15	Schedule	Project management activities are showing up on critical path . Need a check and fix.	Schedule Quality	LOE activities will inadvertently show up on critical path, due to the way P6 functions. They will not drive critical path thought.	LOE activities will inadvertently show up on critical path, due to the way P6 functions. They will not drive critical path thought. **Corrected. No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	88	17-Jun-15	Schedule	OSM Materials Delivery Activities (For Unit 1 & 3) finish dates on same day, Schedule Logic needs reviewed and fixed	Schedule Quality	This was a description error and has been fixed. Unit 3 activities had Unit 1 descriptions	We will review this and correct if appropriate. **No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	89	17-Jun-15	Schedule	LFD Boxes /Logic and P6 Schedule not aligned completely . P6, LFD to be aligned	Schedule Quality	P6 is in the process of being coded to show a box number of every activity. This will not impact the critical path logic. Also - LFD changes have been made to non-critical path activities which will be implemented by the JV to ensure complete alignment to upcoming rev.6 LFD. Will be updated with current LFD for Rev 01 submission	P6 is in the process of being coded to show a box number of every activity. This will not impact the critical path logic. Also - LFD changes have been made to non-critical path activities which will be implemented by the JV to ensure complete alignment to upcoming rev.6 LFD. July 10 Update: Completed for July 15 submission. **LFD verified for critical path. Box numbers in P6 have not been verified. Not captured in Rev 1. To be added to Post Rev 1 Errata List. No Cost Impact.**	$0	Verified Item	No change to cost
Schedule	90	17-Jun-15	Schedule	Critical path activities (and parallel) for east & west vault are combined as one activity. These tasks must be broken into two independent tasks to allow a proper critical path duration	Schedule Quality	Please provide an example of critical path activities that are not appropriately broken down between east and west vault? There are a number of series where this breakdown is not possible - for example - CT install, where East and West Vault work together on the same row - so tracking each independently is not appropriate. JV has reviewed this item and does not believe there are any remaining series where further breakdown is necessary. JV is adding new activities for Transition In and Transition Outs OPG to identify any other CWP's	Please provide an example of critical path activities that are not appropriately broken down between east and west vault? There are a number of series where this breakdown is not possible - for example - CT install, where East and West Vault work together on the same row - so tracking each independently is not appropriate. JV has reviewed this item and does not believe there are any remaining series where further breakdown is necessary. **Completed. No Cost Impact.**	$0	Verified Item	No cost impact
Schedule	91	17-Jun-15	Schedule	Each closeout activity has the same duration and is not weighted by the complexity of the EC package. Assess the close out activities and logic	Schedule Quality	A generic logic waterfall was used for EC packages. Review will be completed and changes required made before Rev 01	A generic logic waterfall was used for EC packages. An individual review will be completed. **Durations are different, some dates are adjusted. No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	92	17-Jun-15	Schedule	Start and finish dates are not reflecting the actual dates required to have the packages closeout to allow work to be commissioned in the field. Needs to be reviewed and fixed	Schedule Quality	JV will meet with OPG to identify what CWP's need to be closed prior to Commissioning	JV will meet with OPG to understand the concern better, and implement improvements to the schedule **Activities have been verified. No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	93	17-Jun-15	Schedule	The closeout activities are not integrated with the milestones giving very large amount of float. OPEX is that the paperwork closeout extended critical path substantially because of lack of tracking and oversight. JV to assess the close out activities.	Schedule Quality	JV approach is that history docket preparation for critical path series will be performed in parallel with the series. The package closeout activities are for lessons learned and CWP updates, which are not on critical path - so adding these activities to the critical path would not be appropriate. JV will add history docket activities for critical path separately to clearly show the key documents. JV Completed OPG needs to review	JV approach is that history docket preparation for critical path series will be performed in parallel with the series. The package closeout activities are for lessons learned and CWP updates, which are not on critical path - so adding these activities to the critical path would not be appropriate. JV will add history docket activities for critical path separately to clearly show the key documents. **History Docket Activities have been added for major packages. No Cost Impact.**	$0	Verified by OPG Scheduling	
Schedule	94	17-Jun-15	Schedule	Currently there is no critical path activities for paperwork closeout in support of the Partial AFS, AFS and CCD process; for example to allow surrender of the permits for commissioning. JV to review the close out process and update the schedule accordingly	Schedule Quality	JV approach is that history docket preparation for critical path series will be performed in parallel with the series. The package closeout activities are for lessons learned and CWP updates, which are not on critical path - so adding these activities to the critical path would not be appropriate. JV will add history docket activities for critical path separately to clearly show the key documents. JV Completed	JV approach is that history docket preparation for critical path series will be performed in parallel with the series. The package closeout activities are for lessons learned and CWP updates, which are not on critical path - so adding these activities to the critical path would not be appropriate. JV will add history docket activities for critical path separately to clearly show the key documents. **No Cost Impact.**	$0	Verified by OPG Scheduling	
General	95	17-Jun-15	General	This is a placeholder for action resulting from the Third Party Expert Panel CL2 Report	N/A		(NO COMMENT TO BE ENTERED. THIS IS A PLACE HOLDER). **No Cost Impact.**	$0	Verified Item	N/A
General	96	17-Jun-15	General	This is a placeholder for action resulting from the Berkely Research Group	N/A		(NO COMMENT TO BE ENTERED. THIS IS A PLACE HOLDER) **No Cost Impact.**	$0	Verified Item	N/A
General	97	17-Jun-15	General	This is a placeholder for action resulting from the JV Peer Team Review	N/A		(NO COMMENT TO BE ENTERED. THIS IS A PLACE HOLDER) **No Cost Impact.**	$0	Verified Item	N/A

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
General	98	17-Jun-15	General	This is a placeholder for action resulting from the changes pending from the final review of Tech Specs	N/A		(NO COMMENT TO BE ENTERED. THIS IS A PLACE HOLDER). **No Cost Impact.**	$0	Verified Item	N/A
General	99	17-Jun-15	General	Incorporate stat holidays into working schedule.	Schedule Quality	Monetization Duration = 120 DAYS. Monetization $ to be provided by JV. Sudhakar to close out with Justin- 28AUG. This is to cover stat holiday changes for CWPs not included	This only covers CWPs with no other change besides the Stat Holiday wage increase. All remaining Stat Holiday wage increases will be included with the individual CWP changes. **Carries all cost associated with the incorporation of statutory holidays into the working schedule for CWPs NOT mentioned in other line items of this log.**	$650,765	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
General	100	25-Jun-15	General	All Rework and Risk to be moved based on Basis Sheet review spreadsheet (Rainbow List). Discrete items to be added.	DFL - Summary		Still used to cover the following CWPs that did not have a comment on this list CWP 2143 - Lower Feeder Prep - ($4,034,909) CWP 2145 - Upper Feeder Installation - ($1,854,137) CWP 2177 - CT Removal - $44,062 CWP 2178 CV Inspection - ($2) **Carried in ID105.**	$0	Verified Item	carried in id 105 values
Support Services (Trades Support) DD	101	24-Jun-15	Level of Effort Estimate	Review of task-based manpower and associated hours for LOE resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Total manpower required - Excessive Task Duration It should also be noted that the durations for RCC operators were 167% (5/3) that of the durations indicated in the basis sheets for each series. For Civil Maintenance Site and Supervision should be based on total schedule duration of 844 days or lower, not 1082 days. When is the start of DEC Warehouse Support ramp-up? Please explain how the manpower and hours for FME Coordinators and HORs were estimated. For RCC Operator deductions, the assumption is that foreman will cover operators on breaks. However, a put was given to extend RCC operator shifts to 12.5 hrs to allow hot handoff. This constitutes a boon of 0.21 million for one unit. All line items with monetized reductions were highlighted in red in TS_LOE_R5 - OPG Monetization.xlsx	Support Services & Infra	Basis to be provided for the holder of record ,FME coordinator, vault coordinator and Civil maintainer. JV agrees. OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling.JV agrees. Durations for RCC operators were 167% (5/3) that of the durations indicated in the basis sheets for each series. JV agreed to align duration to critical path durations.JV agrees. Line 39-41: CTSB is missing from LOE. JV to add CTSB to LOE. JV agrees. JV to investigate using the foreman as the relief for RCC coverage during PA/CP removal. JV agrees. PA and CP are shown as separate line items on Row 4 to 11. This is a single series; eliminate redundant items. JV agrees. Provide a solution for turnover coverage in RCC. JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. (July 30) JV-OPG collaborative team has agreed upon final disposition of LOE. See LOE native file for specific details	**This item carries all costs associated with changes to the LOE Estimate.**	($35,648,471)	Cost changed, more information required to properly validate the cost adjustment	Included in Sept 18, 2015 submission, Support Services estimate documentation (Excel sheets for qty-8 ISEPs and qty-1 LOE estimates)
Support Services (Trades Support) DD	102	24-Jun-15	Window #1 ISEP	Review of task-based manpower and associated hours for ISEP 1 resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Excessive manpower estimates (i.e., SS foremen) - Excessive Task Duration - Erroneous multiplier	Support Services & Infra	OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling.JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. Add "work location" to the iSEP excel backing sheets. JV agrees. (July 30) JV-OPG collaborative team has agreed upon final disposition of iSEP. See iSEP native file for specific details	8 JULY Update: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. **This line carries all cost associated with Window #1 Estimate.**	($24,344)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Support Services (Trades Support) DD	103	24-Jun-15	Window #2 ISEP	Review of task-based manpower and associated hours for ISEP 2 resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Excessive manpower estimates (i.e., SS foremen) - Excessive Task Duration - Erroneous multiplier	Support Services & Infra	OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling.JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. Add "work location" to the iSEP excel backing sheets. JV agrees. (July 30) JV-OPG collaborative team has agreed upon final disposition of iSEP. See iSEP native file for specific details	8 JULY Update: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. **This line carries all cost associated with Window #2 Estimate.**	($378,832)	Verified Item	comments incorporated
Support Services (Trades Support) DD	104	24-Jun-15	Window #3 ISEP	Review of task-based manpower and associated hours for ISEP 3 resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Excessive manpower estimates (i.e., SS foremen) - Excessive Task Duration - Erroneous multiplier	Support Services & Infra	OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling. JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. Add "work location" to the iSEP excel backing sheets. JV agrees. (July 30) JV-OPG collaborative team has agreed upon final disposition of iSEP. See iSEP native file for specific details	8 JULY Update: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. **This line carries all cost associated with Window #3 Estimate.**	($1,650,829)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Support Services (Trades Support) DD	105	24-Jun-15	Window #4 ISEP	Review of task-based manpower and associated hours for ISEP 4 resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Excessive manpower estimates (i.e., SS foremen) - Excessive Task Duration - Erroneous multiplier	Support Services & Infra	OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling. JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. Add "work location" to the iSEP excel backing sheets. JV agrees. (July 30) JV-OPG collaborative team has agreed upon final disposition of iSEP. See iSEP native file for specific details	JUL 8: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. CWP 2143 - Lower Feeder Prep - **Carried in ID286** CWP 2145 - Upper Feeder Installation - **Carried in ID415** CWP 2177 - CT Removal - $44,062- **Carried in ID347** CWP 2178 CV Inspection - **Carried in ID198**	$0	Verified Item	cost have been updated and cost adjustments shown as per comments
Support Services (Trades Support) DD	106	24-Jun-15	Window #5 ISEP	Review of task-based manpower and associated hours for ISEP 5 resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Excessive manpower estimates (i.e., SS foremen) - Excessive Task Duration - Erroneous multiplier	Support Services & Infra	OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling. JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. Add "work location" to the iSEP excel backing sheets. JV agrees. (July 30) JV-OPG collaborative team has agreed upon final disposition of iSEP. See iSEP native file for specific details	8 JULY Update: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. **This line carries all cost associated with Window #5 Estimate.**	($21,661)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Support Services (Trades Support) DD	107	24-Jun-15	Window #6 ISEP	Review of task-based manpower and associated hours for ISEP 6 resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Excessive manpower estimates (i.e., SS foremen) - Excessive Task Duration - Erroneous multiplier	Support Services & Infra	-Row 113: Description does not clearly describe the movement of TT. Provide additional detail in description. JV agrees. -Section 2.5 of chapter report to be expanded to include execution approach (for example demonstrate handoff points between SS and other work groups as detailed in iaep). Work location to be included the iSEP excel spreadsheet.JV agrees. - JV to review Pickering OPEX (to be provided by OPG) for utilization rate of "off-crew" and incorporate into estimate. JV agrees. OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling. JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. Add "work location" to the iSEP excel backing sheets. JV agrees. (July 30) JV-OPG collaborative team has agreed upon final disposition of iSEP. See iSEP native file for specific details	8 JULY Update: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. **This line carries all cost associated with Window #6 Estimate.**	($1,099,830)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Support Services (Trades Support) DD	108	24-Jun-15	Window #7 ISEP	Review of task-based manpower and associated hours for ISEP 7 resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Excessive manpower estimates (i.e., SS foremen) - Excessive Task Duration - Erroneous multiplier	Support Services & Infra	- Remove duplication in the feeder movements. Actuals should be 100 and 300 movements between storage, RFRISA and laydown area. The estimate shows 200 and 600 movements. JV agreed to confirm duplication and remove. - Correct clerical error on labeling of ACUs. JV agrees. - Removal all decontamination for cabling by incorporating use of layflat. Execution strategy should be defined for use of reels and layflat and incorporate into the estimate. JV agrees. -Line 230-240: Excessive hours for movement of cabinets. Review and revise. 10 hours for movement and 12 hours for decontamination is not in alignment with mechanical (movements). JV to conduct line by line review of the electrical estimate to refine (OPG to support where required). JV agrees. - Correct error of including two ACU install sequences (CWP2230). Currently, removal is labelled as install. OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling. JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. (July 30) JV-OPG collaborative team has agreed upon final disposition of iSEP. See iSEP native file for specific details Add "work location" to the iSEP excel backing sheets. JV agrees.	8 JULY Update: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. **This line carries all cost associated with Window #7 Estimate.**	($831,305)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Support Services (Trades Support) DD	109	24-Jun-15	Window #8 ISEP	Review of task-based manpower and associated hours for ISEP 8 resulted in cost savings which all appeared to be overestimated due to a number of issues being: - Excessive manpower estimates (i.e., SS foremen) - Excessive Task Duration - Erroneous multiplier	Support Services & Infra	OPG to provide iSEP excel sheets with areas of concerns identified for JV review (DONE). JV to revise iSEP, load P6 with the raw estimate, then generate P6 manpower profiles and assess manpower for reasonability and perform leveling. JV agrees. Provide additional description to clarify tasks in iSEP spreadsheets. Add "work location" to the iSEP excel backing sheets. JV agrees. (July 30) JV-OPG collaborative team has agreed upon final disposition of iSEP. See iSEP native file for specific details	8 JULY Update: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. **This line carries all cost associated with Window #8 Estimate.**	($364,329)	Verified Item	all comments have been incorporated and cost savings applied
Support Services (Trades Support) DD	110	24-Jun-15	Support Services	SS&E cost should not be a part of the Support Services Trade Support chapter (See Table 6 in Section 5 of handout). The lifecycle of feeders from manufacturer to vault is not detailed. These costs also require estimate basis.	Support Services & Infra	JV to provide response on SS&E cost in support services. JV to provide cost of build up of offsite feeder warehouse. JV agrees. (July 30) JV-OPG collaborative team has reviewed this item and agreed to keep costs of feeder warehouse within estimate. It will be properly allocated in Rev 01	8 JULY Update: JV to provide dispositions to the OPG comments for Support Services DD (these have not been provided to date). Some notes are captured below. JV to present an optimization to the crewing and supervision model for SS,DFL and TMO for review by OPG (July 16th). JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. iSEP spreadsheet tasks start/stop and durations to be linked to schedule. Provide a column for which activities are schedule dependant. 20 JULY Update: Wrong disposition shown above. JV to provide corrected disposition, and validate and backup the $7.9mm July 15 price change OPG does not agree with the $7.9mm change). **Cost of feeder warehouse captured here.**	$7,899,789	Cost changed, more information required to properly validate the cost adjustment	Cost entry missed in Class 2 Rev 00, and corrected in Class 2 Rev 01

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Series and Onboarding Training DD	111	25-Jun-15	Training - Onboarding	Why is the onboarding training cost higher for the second unit than for the first unit? Please provide backing information/justification for this.	Training	This is an artifact of the arbitrary reduction in schedule. Provide explanation and analysis the difference in the cost between units. JV agrees. Comparison to be done between unit specific histograms versus 4 unit resource histograms as input to training chapter. Optimum solution to be presented. JV agrees. July 23 Update: Agreed -Root cause is schedule compression from 42 ts 27 months and gap between units resulting in increased onboarding for second unit.. Onboarding quantities are determined by resource loaded schedule and will be recalculated for R1. Histograms will be added to chapter as an appendix. Resources leveling still required to optimize the execution resourses resulting in on-boarding costs being reduced accordingly.	**Carried in Entry ID 114**	$0	Verified Item	included in id 114 value not yet verified
Series and Onboarding Training DD	112	25-Jun-15	Training - Onboarding	"The quantity of personnel on-boarded is based upon the 4-unit resource loaded P6 schedule using one-month intervals as the basis for new hires that will require on-boarding" Explanation on process to determine training numbers required.	Training	Provide a clear explanation of methodology in the chapter report on how the P6 schedule is incorporated into the schedule. JV agrees. Obtain OPEX on return on multiple unit projects (nuclear and non-nuclear). JV agrees. Consider the schedule loaded histogram to optimize the number of people require training. JV agrees. Provide basis for 60% for "New to Nuclear" (i.e.. Pickering OPEX and Industry Reports) and ensure that it is referenced in the chapter report. Optimize the 60% new hires to nuclear and forward any difference for discussion on risk. JV agrees. Provide explanation on execution strategy on screening/channelling of new workers to the appropriate series (section 1.1). JV agrees. July 23 Update: Agreed New to nuclear assumption of 60% basis to be provided in an appendix. Agreed on unit over unit optimization of 60%/55%/50%/50% for each subsequent unit. 55% is based on no overlap, but reasonably short gap between units. 50% based on unit overlap. 5090407-0000-00000-33RA-0158 Class 2 -Training - Onboarding Chapter report will require a revision to reflect this change.	JV to provide OPG with revised Support Services iSEP spreadsheets. TCD is pending. **Carried in Entry ID 114**	$0	Verified Item	included in id 114 value not yet verified
Series and Onboarding Training DD	113	25-Jun-15	Training - Onboarding	Please specify the number of trainers, classrooms and computers required. This information was specified in Rev PB but has been removed for Rev 0. Training schedule required to determined.	Training	JV to provide interim numbers in change log for review by OPG. July 23 Update: Agreed -To complete this item the DFL and schedule is required to be finalized. The number of revised personnel and schedule will subsequently determine the number of trainers, classrooms, computers stations for CBT's for the On-boarding. 50904-0000-00000-60IM-0001 Infrastructure and Space Allocation plan will be required to be updated to reflect changes. 50904-0000-00000-73IM-0001 Mock-up Training plan to be confirmed if changes are required. 50904-0000-00000-73IM-0002 Onboarding Training Plan	**Carried in Entry ID 114**	$0	Verified Item	included in id 114 value not yet verified
Series and Onboarding Training DD	114	25-Jun-15	Training - Onboarding	"• The On-Boarding Training Estimate includes general nuclear in-processing requirements such as proximity/TLD badge processing, 1.5 hour allowance applied to all PMT and DFL. • Nuclear Security Clearance (NSC) is a trade specific prerequisite for employment, therefore no allowance allocated to DFL for security clearance initial processing. One hour allowance is included for NSC renewal every 5 years; • PMT are required to apply for NSC upon hire, 1 hour allowed for each PMT resource to complete the application process as part of the on-boarding process and 1 hour allowance is included for NSC renewal every 5 years; • The Estimate Basis includes percentage allowances for task-specific qualification requirements (i.e. working at Heights 75% of all DFL). Refer to Appendix A of this Chapter;" Remove all.	Training	1st bullet will stay in - task based estimate. 2nd bullet is DFL Renewal; Check OPG precedence. JV agrees. July 30: Agreed that renewal security clearance for DFL will be carried 1 time over the course of the project. Total is 2,950 man hours. ˚ 3rd bullet: PMT Security Clearance - Item to be removed. JV agrees but double check with HR. JV agrees. July 27-Agreed to remove the 1 hour per PMT renewal cost. 4 the bullet: 75% of work at height: JV to provide basis for task specific qualifications. For example, 75% of DFL being training for working at heights justified by tallying looking into CWP Estimates. JV agrees. July 27- Agreed - The 75% of working at heights carried in the estimate was based on the 60% of the "New to Nuclear" DFL only. This should actually be 100% of the 60% " New to Nuclear" workers in order to allow for dose management, complete mobility for trades across tasks /crews and elimination of possible human performance issue whereby a personnel is found working at heights but is not qualified.	iSEP spreadsheet tasks start/stop and durations to be linked to schedule. **Includes all monetary changes within this CWP. Onboarding Training Chapter 5090407-0000-00000-33RA-0158 Rev 0 Cost ($74,821,394) does not align with Executive Summary cost ($69,783,366) Rev o. Executive Summary Estimate value for Onboarding is correct. Chapter Report will be corrected for Sept 18 submittal in the cost summary table. Monetization captured here is correct.**	($21,968,885)	Verified Item	cost adjustments have been included, and is matching the JV summary record R00 VS R01. see summary item 2.1
Series and Onboarding Training DD	115	25-Jun-15	Training - Onboarding	"300 workers will need to be replaced with new workers due to reaching the annual radiological exposure dose limit" Cost associated with replacement workers should be removed from this chapter and included in risk. Will 300 brand new workers be on boarded for each unit? What is the strategy for relocating workers for dose management to reduce the number of replacement workers required (support services, tool management, clean room, DEC, feeder prep, clean storage facility, etc.)? Chapter assumes 60% of incoming workers are new to nuclear (i.e. no dose). This is inconsistent with the Dose Chapter (509407-0000-00000-33RA-0167 Revision 00). Replacement worker numbers could be revised further and moved to risk.	Training	Provide the unit specific number of new onboard required as driven by dose limits. JV agrees. The number to be provided prior to CL2 Rev 1 for agreement with OPG. JV agrees. July 27- Required the Alara chapter to be resolved concerning the final number of replacement workers that will be required. Kwok/Jag Current reduction is based on JV number only not concurred by OPG yet: Unit 2 - 281, Unit 3 - 276, Unit 1 - 203, Unit 4 - 219 replacement workers have been used. July 30: Agreed to revised numbers above as per email.	**Carried in Entry ID 114.**	$0	Verified Item	included in id 114 value not yet verified
Series and Onboarding Training DD	116	26-Jun-15	Training - Onboarding	Please explain rationale for initial on boarding hours carried.	Training	JV to clarify the basis of section 7. JV agrees. Perform the calculation for off boarding (similar to on boarding). The retention to be obtained. Calculate the requalification for the remaining group. JV agrees. Review actions captured on item 1 from training deep dive and apply to off boarding where appropriate. JV agrees. July 28-Agreed - Same response as comment 111.	Provide a column for which activities are schedule dependant. **Carried in Entry ID 114.**	$0	Verified Item	included in id 114 value not yet verified
Series and Onboarding Training DD	117	26-Jun-15	Training - Onboarding	"The basis of this confidence in AACEi Class 2 Estimate is as follows: • Total number of craft labour has been well defined; • Timing of training sessions have been scheduled project requirements during Execution Phase; • Estimate includes train-the-trainers and training materials." Please demonstrate how these requirements have been met.	Training	Provide on boarding resource profile on monthly basis in P6. JV agrees. July 29-Agreed The onboarding requirements will be determined by the updating training schedule and resourse requirements from updated P6.	**Carried in Entry ID 114.**	$0	Verified Item	included in id 114 value not yet verified
Series and Onboarding Training DD	118	26-Jun-15	Training - Onboarding	40 hour training NUASC Supervisor Training Course should not be reimbursable. It is OPG's expectations that qualified supervisors be hired and therefore do not require the training.	Training	Remove from CL2 Rev 1. JV agrees. July 23 Update: Agreed to remove from R1. Monetization provided by JV and agreed to by OPG. OPG evaluation was $5.6M based on estimated labour rate and 100% staff training. JV monetization based on actual labour rates and 60% training.	**(Carried in Entry ID 114)**	$0	Verified Item	included in id 114 value not yet verified
Series and Onboarding Training DD	119	26-Jun-15	Training - Onboarding	Nuclear construction supervisor academy. 16 hour course for all foreman. This course should not be reimbursable.	Training	OPG to confirm with Roy Brown on Scope Control Change (item #16) and obtain alignment with N-PROC and Sylviu. July 28- Agreed - Course is required at this time.	**(Carried in Entry ID 114)**	$0	Verified Item	included in id 114 value not yet verified
Series and Onboarding Training DD	120	26-Jun-15	Training - Series	All training repeated for each unit. No allowance for refresher courses in lieu of full training for each unit	Training	OPG and JV to document contractual position. OPG to review contract language and training plan (Mock-up Training Plan, Project Training Plan). Language in the SOW to verified by July 29 OPG.3.2.2 Rehearsal Training–Mock^Up- Wording from SOW The type and the amount of specific training will vary significantly between job functions and even between individuals within a job function. The contractor is accountable to organize the work in an efficient and cost effective manner and the training plan and program should reflect this. Personnel need to be trained on work as an integrated team and will be required to participate in at least five rehearsal exercises prior to achieving qualification for their respective work. July 29. -Agreed-The Mockup training plan and CL2 Series chapter will be revised to meet the intent of the SOW above and specific personnel qualifications requirements called up by the Candu tech specs are being identified to define the actual requirement of the 5 rehearsal exercises . July 30: Through optimization of the training process for subsequent units (proficiency, OPEX, lessons learned) a reduction in the training program of 10% for the second unit and 20% for the third and fourth unit relative to the first unit.	**(Carried in Entry ID 121)**	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Series and Onboarding Training DD	121	26-Jun-15	Training - Series	The training staff requirements for Technical Instructors shows the numbers varying between 1 & 10. Given that these staff need to be: -Trained to be effective trainers (Presentation / Training skills) -Trained on the specific series activities. -Incorporating current event Opex into training. It doesn't seem feasible that they would be available on a "rotating door" basis. Their roles should be considered more "base loaded". What are 1-10 trainers doing when they aren't needed for training activity? PMT Chapter Section 2.7.1 - Series instructors are part of construction crew and will go into vault with the crew. Please provide estimate basis for series instructors and how they interact with supervisors on face.	Training	Incorporate the cost of the trainer. JV to provide the interim information for review by OPG prior the CL2 Rev 1 submission. JV agrees. July 27-Agreed--Instructor will not accompany crews into the vault in order to effectively manage the training program.	**Includes all monetary changes within this CWP**	($46,289,127)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Series and Onboarding Training DD	122	26-Jun-15	Training - Series	Who is responsible for controlling, monitoring, and determining the configuring the mockup to support the training objectives & schedule? Where is the estimate for this scope captured?	Training	Verify and ensure that the responsibility for re-configuration of the mock-up is captured in the estimate (roles and responsibilities in PMT). JV agrees. July 27 Training Supervisors role already incorporates the responsibility of the training readiness thought the use of the checklist.. July 29- Still need to confirm who has responsibility for DEC /mockup reconfig/ consumables etc. May require a new position. Senior Management to decide on PMT position. July 30: DEC facilities coordinator (DEC trade supervisor) position and role to be added reporting to the operations manager and training manager in GF type role. Responsibilities include controlling, monitoring, and determining, configuring the mockup and consumables to support training objectives and schedule. Interface with DEC facilities personnel.	**(Carried in Entry ID 121)**	$0	Verified Item	Included in ID 121 but this needs validation.
Series and Onboarding Training DD	123	26-Jun-15	Training - Series	States 17% cost was added for attrition. Please provide OPEX to support this number. Move to risk.	Training	Remove 17% attrition but an offset to be considered for the short term series. For longer series, provide separate cost and strategy. JV agrees. July 23, Update; It was agreed to remove the 17% Attrition from the estimate do to the following rationale. This attrition rate was dedicated to personnel quitting or leaving the project during training or during the execution of the series but this will not be practical to train new personnel as typically this will be crew based training not individuals, certain series will be complete prior to any possible training of new personnel and the progressive mock-up configurations need for each series training will not allow new personnel to be trained. It is recognised that there will be a level of attrition for the longer series but as a mitigation plan a strategic series by series approach for additional personnel to be cross trained will be adopted and addressed in the plan. The training plan is to be updated to describe the process for choosing personnel to be crossed trained i.e. A Level of effort personnel for each required trade can be chosen so that new personnel can replace these positions with little or no special training and then the new personnel can be placed in the training rotation for a subsequent series and the LOE could return to their former position.	**(Carried in Entry ID 121)**	$0	Verified Item	Included in ID 121 but this needs validation.

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Series and Onboarding Training DD	124	26-Jun-15	Training - Series	States 300 additional personnel to be trained due to reaching annual dose limits. Cost associated with replacement workers should be removed from this chapter and included in risk. Same comment as for Onboarding.	Training	Provide the unit specific number for series training required due to dose limits. The number to be provided prior to CL2 Rev 1 for agreement with OPG. July 27- require JV and OPG to finalize Alara chapter to finalize additional workers. -Kwok /Jag July 30: Cost will be revised based on training strategy for number of trainees in comment 125.	(Carried in Entry ID 121)	$0	JV agreed but cost adjustment not implemented.	Included in Sept 18, 2015 submission, Working Group (War Team) documentation
Series and Onboarding Training DD	125	26-Jun-15	Training - Series	A full resource loaded training schedule is required to provide a reliable series training estimate. Series durations are known, therefore the training schedule can be determined.	Training	Provide submittal detailing the offsite infrastructure requirements from OPG. Once agreed by OPG, additional cost can be discussed for addition to the CL2 estimate. July 27- agreed -JV is preparing a complete detailed resource loaded plan for Rev 1 Estimate submission which includes or considers all items listed below. Estimated reductions to be included in this comment. Preliminary review shows no additional offsite infrastructure will be required. General strategies are being employed as an example 100% of the supervisors and 10% - 20% of required trades per series although each training package is being assessed for logical number of trainees and any requirement for cross training. Provide a resource loaded training schedule taking into consideration: - Course level granularity in P6 - Class Size - Mock up availability - Contingency and non CWP related courses - Number of class rooms - Training tool quantities - RPPE requirements - Shift Patterns - Overtime requirements - Interface with vault series activates - All resource requirements (example PMT, SS&E) - Cross training -# of trainers	(Carried in Entry ID 121)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Series and Onboarding Training DD	126	26-Jun-15	Training - Series	17% attrition applied twice, once in spreadsheet and once in Section 5.	Training	Will be removed. JV agrees. July 23 update: JV states there was an error in the table placed in the Series training Chapter report as it was from the class 3 estimate and that the 17% attrition was not applied twice. To be confirmed by OPG. See comment 123 for explanation on removal of attrition for all series training.	(Carried in Entry ID 121)	$0	Verified Item	Included in ID # 121, To be verified.
Series and Onboarding Training DD	127	26-Jun-15	Training - Series	Variance cost - Error in CL2 # of hours in Table 5. 1485692 hours should be 1879665 hours from Table 4.	Training	Will be removed. JV agrees. July 23 Update: Agreed that the 509407-0000-00000-33RA-0157 Training Series Chapter report will be revised in R01 Submission including any other adjustments arising form the review process.	(Carried in Entry ID 121)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Series and Onboarding Training DD	128	26-Jun-15	Training - Series	Please provide basis for 25% cross training?	Training	Define cross training strategy in the chapter report. JV agrees. Incorporate cross training into the P6 schedule and estimate. JV agrees. Remove 25% cross training and replace with customized strategy. July 29- Agreed - Cross training strategy is included in revised approach as per comment 125.	(Carried in Entry ID 121)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Series and Onboarding Training DD	129	26-Jun-15	Training - Series	Quantities of staff for training courses are listed in fractional quantities. Please demonstrate how quantities are calculated.	Training	Fractions will be removed and rounding to closest whole number will be performed. JV agrees. July 23-Update:-Staffing adjustments in 509407-0000-00000-33RA-0157 Training Series Chapter report Appendix A will be revised in R01 and will be formatted such that the quantities of personnel as rounded off whole numbers.	(Carried in Entry ID 121)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Series and Onboarding Training DD	130	26-Jun-15	Training - Series	Support & Execution Series Training PMT: - Are these numbers based on a per crew basis? - Is the RCC GF the same as the RCC Supervisor? If not what training will the RCC Supervisor receive? - How is relief coverage provided given the limited number of staff? Are relief staff numbers included in training matrix? - Where is training for Technical Support staff identified? (Tooling Technicians and Engineers). - Where is training specified for TRT supervisory staff using the Tool Management System? Should other GF's also receive Tool Management System training? - Where is the training requirements / qualifications of the Series Leads specified? - Have these staff numbers been validated against the latest class 2 estimate numbers?	Training	July 29 - Agreed 1. Currently Crews have not been assigned still based on task based estimate and schedule. 2. The RCC GF will take an overview of the RCC operation while the supervisor will take the specific RCC Supervisor course. 3. DFL staff have been accounted for in the training to cover any relief situations. 4. Technical support is to be trained during Pre Execution rehearsal phase. 5. TRT supervisory staff receive overview training for TMS during the onboarding , Additional personnel requiring TMS training will be done as required. 6. Series leads qualifications are based on previous experience and will participate in the training and interface with Series Training supervisors for readiness reviews. 7. The training estimate numbers are being revises as per comment 125.	(Carried in Entry ID 121)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Series and Onboarding Training DD	131	26-Jun-15	Training - Series	Contingency Annulus Spacer capture training is not included.	Training	July 23 - Agreed that the Contingency annulus spacer course is being added to the training Course. No cost to be added as this is a contingency course only.	(Carried in Entry ID 121)	$0	Verified Item	Contingency cost - No cost impact to base cost.
Series and Onboarding Training DD	132	26-Jun-15	Training - Series	High hazard radiological conditions. OPG Green men are currently required to participate in the training for high hazard radiological conditions. Has this been accounted for in the estimate?	Training	July 28- Agreed - OPG RP plan includes RP personnel to take part in the training program, Bob to confirm RP numbers from OPG to confirm classroom space requirements and be included in numbers P6 Schedule No cost differential to JV estimate at this time. Bob confirmed no classroom space required as RP personnel will attend rehearsals only.	(Carried in Entry ID 121)	$0	Verified Item	Comment related to Greenman hours. No cost impact
Series and Onboarding Training DD	133	26-Jun-15	Training - Series	What volume of laundry is expected (suits, rad. PPE)? This needs to be determined.	Training	JV to calculate RPPE requirements (including training) and send to OPG as submittal. JV agrees. July 27- RPPE including suits for training only will be quantified in the training series Chapter and be based on the Alara chapter per series or task requirements. The base principle will be to issue a suit per trainee for the duration of the training series, (cleaned as required with Alcohol wipes) and once the series is over send out for full laundering. Enough suits to be ordered to have a full set at the DEC in use the same quantity being cleaned and some spares on hand. There is still the issue of the use of a training suit to be resolved concerning the laundering of the as this was discussed. July 30: Bob to estimate number of suits and requirements for number of suits for training will be incorporated in the OSM and Goods Chapter. Cost of laundering suits will go under subcontractor.	(Carried in Entry ID 121)	$0	Verified Item	No Cost Impact.
Series and Onboarding Training DD	134	26-Jun-15	ALARA and Dose Analysis	For waste tooling there does not appear to be any consideration for Hot Tool Training in the ALARA and Dose Analysis Chapter Report (i.e. for the Waste Tooling System). Given that no mock-ups are available for some of the tooling, this should be included.	Training	July 28- Agreed -Waste tooling training will be based on the tools being clean for the first unit , the training will be adapted to use RPPE for subsequent units as REP (to be issued) HP.	There is a no justification to conduct "Training" on the "Hot" tools. There will be adequate OPEX on operation and radiological hazards for the WTS. It is planned that post unit 2 the training and ALARA planning will be re-evaluated to optimize worker interface with the radiological hazards. Most of the high risk operations are automated. It is expected that there will be contamination on the tooling and ambient dose rates are expected to be low. No personnel training will be permitted without removing major radiation source terms have been removed or shielded ie., VRS presses replaced, EF station decontaminated, all filters and contaminated hoses replaced, etc. **No Cost Impact**	$0	Verified Item	No Cost Impact
Series and Onboarding Training DD	135	26-Jun-15	Execution Phase Class 3 Summary Report	Is 3% rework applied to Training hours?	Training	Raise this opportunity to Senior management for ruling. 25AUG: Consensus based on Senior Management Review is to leave 3% Rework in the Training Estimate. No change required.	3% Rework is applied to all hours. (Carried in Entry ID 121)	$0	Verified Item	No change required.
ALARA and Dose	136	25-Jun-15	ALARA and Dose Analysis	Add wordings in the paragraph to state clearly that the RPC dose is not included in the Estimated Collective Dose. Add a column in Table 1 to show RPC dose for each unit and add a column to show the sum total of the Estimated Collective Dose and the RPC dose.	ALARA	N/A- OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	Has been incorporated. Appendix A has also been updated to include the RPC contribution **No Cost Impact. All changes to be capture in R01 ALARA and Dose Estimate Chapter Report.**	$0	Verified Item	OPG-JV notes: No cost impact. Alara and Dose Chapter reportwill captures changes.
ALARA and Dose	137	25-Jun-15	ALARA and Dose Analysis	Section 3.5 of 509407-0000-00000-33RA-0158 "Class 2 - Training - Onboarding" indicated that only 60% of DFL and PMT will require on-boarding training. It is unclear whether these workers have any dose uptake (i.e new to nuclear) or workers with expired training. Basis to be clarified.	ALARA	N/A- OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	This information is from the training plan and is expected to have no impact on the collective dose estimates. As per training plan all trades hired will require the planned on-boarding training. As far as on-borading dose it is taken as 200 mrem. **No Cost Impact. All changes to be capture in R01 ALARA and Dose Estimate Chapter Report.**	$0	Verified Item	OPG-JV notes: No cost impact. Alara and Dose Chapter reportwill captures changes.
ALARA and Dose	138	25-Jun-15	ALARA and Dose Analysis	Number of replacement workers in Appendix D1 of 509407-0000-00000-33RA-0158 shows 332 (boilermaker) + 25 (electrician) for a total of 357. The ALARA chapter backing sheets show 300 replacement work. Consistency is required between Training and ALARA chapters to confirm the onboard dose for workers. Detailed information to be provided on number of workers onboarding at various dose levels (example 300 workers at 200 mrem). This basis is to be documented in the ALARA chapter.	ALARA	August 4: JV indicated that a cover letter (509407-30CC-I-1044) and memo (509407-30MA-I-0210) with respect to RPPE Estimate will be issued by 2015 July 31. JV to provide documents for OPG review prior to finalization of the Rev 1 Dose Estimate. 25AUG: Unit 2 Collective Dose and other supporting data accepted by Arif Rai of OPG on 24AUG. Most up to date P6 Schedule has been used to determine replacement workers required and JV Training has used this to develop the Training and Resourcing Estimates which have been sent to OPG and are aligned with the U2 Collective Dose Estimates. Additionally the RPPE Letter referenced above has been provided to OPG.	The alignment between the ALARA dose estimate and the training estimate has been checked, corrected and explained. **No Cost Impact. All changes to be capture in R01 ALARA and Dose Estimate Chapter Report.**	$0	Verified Item	OPG-JV notes: No cost impact. Alara and Dose Chapter reportwill captures changes.
ALARA and Dose	139	25-Jun-15	ALARA and Dose Analysis	RPPE estimate graphs needs to be included in the R1 submission.	ALARA	RPPE Estimate/Graphs Provided- 509407-30MM-1-0210.	Covered in letter (509407-30CC-I-1044) and memo (509407-30MA-I-0210) will be sent to OPG separately but will be referenced in the dose chapter. Letter is in-progress. TCD: July 31,15. **No Cost Impact. All changes to be capture in R01 ALARA and Dose Estimate Chapter Report.**	$0	Verified Item	OPG-JV notes: No cost impact. Alara and Dose Chapter reportwill captures changes.
ALARA and Dose	140	25-Jun-15	ALARA and Dose Analysis	Existing radiation field as calculated in the CEI Report appears to be too conservative. JV to review this basis. All figures and tables and Estimated collective dose in the ALARA Chapter to be updated as required.	ALARA	N/A- OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	The JV has reviewed the basis for the dose rates calculated in the CEI report and believes them to be representative of Darlington RFR dose rates for the various reactor configures. These dose rates were calculated based on models created using the OPG supplied outage measurements, modeling, and OPEX. At this point it is concluded that no change is required. **No Cost Impact. All changes to be capture in R01 ALARA and Dose Estimate Chapter Report.**	$0	Verified Item	No cost impact at this point
ALARA and Dose	141	25-Jun-15	ALARA and Dose Analysis	Contingency dose needs to be shown with the integrated baseline dose for Unit 2. The contingency dose should be derived from the risk registers for items that could lead to dose increase. These items need to be highlighted in the revised Chapter.	ALARA	N/A- OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	Has been incorporated. Items from the risk register that have an impact on project collective dose have been incorporated. A graph showing the baseline collective dose along with the contingency collective dose are included in the chapter **No Cost Impact. All changes to be capture in R01 ALARA and Dose Estimate Chapter Report.**	$0	Verified Item	OPG-JV notes: No cost impact. Alara and Dose Chapter reportwill captures changes.
CWP Top 40	142	26-Jun-15	CWP 2121	CWP 2121 – Operate and maintain Moderator drying equipment. Step-1 – Total cost $ 1,902,092 The Scope of Wok between CWP 2121 (Operate and Maintain Moderator Drying Equipment) and shutdown & system layup to be reassessed, to eliminate the conflict. If required; one journeyman report to vault coordinator, Operation activities; half an hour every 2 hr's Maintenance activities; 6 hours every 4 days No bump or walk factor to be added. Expected saving per unit - $ 1,308 K	DFL - TMODS (Pre&Post)	Provide the technical basis and estimate for continuous and non-continuous monitoring requirements. JV agrees. This basis should be based on OPEX, past performance and vendor technical requirements of this equipment. JV agrees. Compare the risk between equipment failure during continuous monitoring versus non-continuous monitoring. JV agrees. Baseline and risk to be adjusted based on outcome of assessment. JV agrees. July 23 Update: JV to consider utilizing 2 rovers per shift for monitoring of mod and pht vac dry equipment, munters, ACU condensate collection. Jurisdiction must be agreed upon. Review chapter reports and revise accordingly. July 28 Update: An operator is required to monitor system at the monitoring station. Bump shift will be removed. Shift logic will be 12 hour shifts, days and nights. As previously discussed, JV will develop maintenance crew that will be responsible for several CWPs. This DEC is not complete. Estimate may be revised upon design completion. 25AUG: JV has developed maintenance crew that will be responsible for monitoring activities associated with multiple CWPs. Associated reductions have been incorporated into R01 Estimate.	Maintenance Manual TCD required from Tooling. 20 JULY Update: OPEX - SCR No: D-2015-11517 munter reference, Munters require continuous monitoring. No change to estimate. **Carries all cost for this CWP.**	($4,259,035)	Verified Item	Bump factor removed at rev 1
CWP Top 40	143	26-Jun-15	CWP 2202	CWP 2202 -Monitor and Control PHT Vacuum Drying System from remote operating station. -Journeyman should report to vault coordinator, foreman is not required. Expected saving per unit - $ 225 K - Journeyman hours should not be factored (bumped). - Optimize the monitoring activities by sharing the duty between other monitoring items. Expected saving per unit - $ 103 K	DFL - TMODS (Pre&Post)	JV will revise CWP 2202 for CL2 Rev 1 to include a listing of which items will be require routine checks. JV agrees. July 23 Update: JV to consider utilizing 2 rovers per shift for monitoring of mod and pht vac dry equipment, munters, ACU condensate collection. Jurisdiction must be agreed upon. Review chapter reports and revise accordingly. July 28 Update: An operator is required to monitor system at the monitoring station. Bump shift will be removed. Shift logic will be 12 hour shifts, days and nights. As previously discussed, JV will develop maintenance crew that will be responsible for several CWPs. 25AUG: JV has developed maintenance crew that will be responsible for monitoring activities associated with multiple CWPs. Associated reductions have been incorporated into R01 Estimate.	Maintenance Manual TCD required from Tooling. 20 JULY Update: same as Entry ID 142. OPEX - SCR No: D-2015-11517 munter reference, Munters require continuous monitoring. No change to estimate. **Carries all cost for this CWP.**	($1,208,125)	Verified Item	OPG-JV war room monetization is not available. The change is implemented and the Sub-foreman has been removed. The reduced amount is entered in the CWPs change to Rev-01

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
CWP Top 40	144	26-Jun-15	CWP 2249	CWP 2249 The estimate rejected based on quality. P6 description (CWP 2249 PHT Vacuum Dry System Pressure Test) is not aligned with estimate description (Perform walk-down visual inspection of all welds, closure plugs, feeder connections, and tubing welds to monitor for leaks during pressure hold of hydrostatic test). PHT hydro test seems to be excessively high. (Test duration and number of workers) Expected saving per unit- $403 K	DFL - TMODS (Pre&Post)	Describe shift pattern and breakdown of hydrostatic test hours in Commissioning Chapter. JV to verify OPEX during past campaigns. OPG/JV to collaborate to produce firm basis. Correct title of the CWP 2249. July 23 Update: JV Action - Ensure revised estimate is complete and acceptable. Review chapter reports and revise accordingly. July 28 Update: OPEX from fuel handling FLM on June 26 for support requirements for PHT fill and test revised estimate for CWP 2249 as per OPEX to be issued for Rev01. Chapter report to be revised to include carpenter support.	Confirmed with OPG FLM Jun-26-15 support requirements for PHT Fill and Test. Revised estimate for CWP 2249 to be issued for R1. 20 JULY Update: email received from OPG SPOC Gerard Edison Jun-26-15 8:04am regarding PHT Fill manpower requirements. Revised estimate completed by Mike Boyce. **Carries all cost for this CWP.**	$3,840,570	Verified Item	The cost record is matching. Further validation is required.
CWP Top 40	145	26-Jun-15	CWP 0010	CWP 0010 Waste Processing The supervision is high. The foreman hours close to 15% of journeyman hours. Expected saving per unit- $ 281 K (Based on 10% foreman hours)	Waste/Volume Reduction	Agreed per previous discussion. 2015-8-7: JV and OPG agree and further reductions in manpower we made based upon ATS Waste Processing timings provided which show under and overutilization. Over= EF process where 1 additional body was added, Under = CTI and CT processing at RWP8 where a 30% reduction in manpower has been realized.	**Same as entry ID 27**: Provide an outline of the supervision model i.e. the rules for when a Forman is needed and why. Look at the stickout (high %) packages and provide rationale for supervisor hours in relation to Crew assemblies. Explore ways of optimizing these hours e.g. having one supervisor oversee multiple small crews, use of sub-foreman, etc,. Separate meeting to be set up to discuss once completed. **(Carried in Entry ID 52)**	$0	Verified Item	Included with ID: 52
CWP Top 40	146	26-Jun-15	CWP 0010	CWP 0010 Waste Processing Based on waste logistics plan – S09407-0000-00000-40IM-0005; CTI processing non productive time is 50%-75%. Calculated based on removal rate (process input) and the waste processing rate (process output). Action CTI crew can be reduced to 50%, or share the crew with other activities. Expected saving per unit- $ 660 K	Waste/Volume Reduction	Preliminary analysis of transfer route to be documented in a memo as an input to the Waste Logistics Plan. The waste Logistics Plan is to be revised. JV agrees. Waste Logistics will be updated post CL 2 Rev 1. Preliminary Analysis (memo) to be included as Appendix to Chapter Report. JV agrees. Describe crewing strategy in the Waste Chapter and work allocation during downtime. JV agrees. 2015-8-10: JV and OPG agree that further reductions in manpower are not feasible as men required for works in WTS need to be in place for actual task works. However, JV agrees that they will compile a list of potential off-peak or between duration work for these crews.	1. No reduction to crew basis for CTI release. 2. Estimate matches new critical path. **(Carried in Entry ID 52)**	$0	Verified Item	See ID 52 Reduction in cost from R0 to R1
CWP Top 40	147	26-Jun-15	CWP 2124	CWP 2124 Why we need operator sub-foremen for (crane Operator). Expected saving per unit- $ 184 K	DFL - TMODS (Pre&Post)	Change resource from sub-foreman to journey men. JV agrees. July 23 Update: JV Action - Confirm	Agree **(Carried in Entry ID 261)**	$0	Verified Item	Changes included in ID 261
CWP Top 40	148	26-Jun-15	CWP 2125	CWP 2125 Supervision- Why journeymen and operator counted as supervision (step Description). Expected saving per unit- $ 347 K	DFL - TMODS (Pre&Post)	Remove journeymen from supervision and ensure the supervision hours are as per supervision model. JV agrees. July 23 Update: JV Action - Confirm with Estimating team that changes have been implemented	Agree **(Carried in Entry ID 151)**	$0	Verified Item	Included in ID # 151
CWP Top 40	149	26-Jun-15	CWP 2125	CWP 2125 Why we need operator sub-foremen for (crane Operator). . Expected saving per unit- $ 118 K	DFL - TMODS (Pre&Post)	Change resource from sub-foreman to journey men. JV agrees. July 23 Update: JV Action - Confirm with Estimating team that changes have been implemented	Agree **(Carried in Entry ID 151)**	$0	Verified Item	Included in ID # 151
CWP Top 40	150	26-Jun-15	CWP 2124	CWP 2124 and CWP2125 -Supervision is excessively high. Expected saving per unit- $ 650 K (based on 25% time of journeyman)	DFL - TMODS (Pre&Post)	Supervision ratio previously discussed and being reviewed. JV agrees. July 23 Update: JV Action - Confirm with Estimating team that proposed changes are warranted. Reduce as required. 25AUG: Bump Shift for supervision removed for CWP2125. For CWP2124, no changes have been made to date. Item to be added to Opportunity List to remove Bump Shift from CWP2124 post Class 2 Rev 1.	Agree **(Carried in Entry ID 261)**	$0	Verified Item	Changes included in ID 261
CWP Top 40	151	26-Jun-15	CWP 2125	CWP 2124 and CWP2125 - CWP 2124- installation – Journeyman hours is 27500 hr's (filter journeyman on CWP) -CWP 2125- removal - Journeyman hours is 24500 hr's (filter journeyman on CWP) The ratio between removal and installation are excessive high. Expected saving per unit- $ 651 K	DFL - TMODS (Pre&Post)	JV to provide the details of that bottom up commodity estimate (Weld length/hour). JV agrees. Attach reference letter (83/50%) to the relevant chapter report and provide explanation of the percentages. JV agrees. Correct estimate productivity factor. JV agrees. July 23 Update: JV Action - Construction to review installation vs removal hours and consider a reduction. July 29 2015: JV reviewed hours, current hours align with the current basis of estimate. If "Special Initiatives" are approved, the shielding hours will be removed. 25AUG: CWP2124, 2125: Item has been added to the Opportunity List for Shielding Design to be reduced/optimized which has the potential to reduce the Estimate post Class 2 Rev 1. No changes for Class 2 Rev 1. CWP2124: Bulkhead Install: Item has been added to the Opportunity List for use automated welding system to reduce labour requirements. This has the potential to reduce the Estimate post Class 2 Rev 2. No changes for Class 2 Rev 1.	Agree **Includes all monetary changes within this CWP**	$1,134,160	Verified Item	OPG-JV war room monetization is not available. Estimate cost Increased in Rev-01, the amount is entered in the CWPs Changes to Rev-01 sheet. Per OPG/JV working session comment, were expected cost adjustment of approx. $306k per unit
CWP Top 40	152	26-Jun-15	CWP 2189	CWP 2189 Operation # 207- step# 8 "If required, repeat BLOW DOWN or RAG PULL and bore scope inspection until there is no visible particulate in the feeder." Should be removed- activity covered by rework. Expected saving per unit- $ 14K	DFL - Feeders	Rag pull through is a technical requirement for Feeder ID cleaning - must be performed as per Candu Tech Spec 38RF-33160-TS-006. This is not considered rework	Revision to CWP does not impact rev 0 prime submission. 20 JULY Update: Complete move action to CWP R0 COS (Sebastian Wojewoda). No Cost or Schedule Impact. **This line item carries all monetary changes associated with this CWP.**	($1,346,313)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Top 40	153	26-Jun-15	CWP 2172	CWP 2172 Material handling task- Crew not required- support services will deliver the material to Airlock-1, installation crew to move the material to working area. Expected saving per unit- $ 1,732K	DFL - Install	(July 27) See JV Disposition comments	No cost impact, tasks are different than the support services as discussed with James M during the deep dive on Jun-25-15 meeting at the DEC in 3B. Identify in support services chapter "handshake" and "Work Location" for crews between series transitions in/out to support service tasks. Applies to all support service tasks. JV agrees. **(Carried in Entry ID 243)**	$0	Verified Item	JV Disposition comments; No cost impact.
CWP Top 40	154	26-Jun-15	CWP 2172	CWP 2172 The task description – indicate "east side", we assume these tasks are for combined assembly.	DFL - Install	(July 27) See JV Disposition comments	No cost impact as discussed with James M during the deep dive on Jun-25-15 meeting at the DEC in 3B. **(Carried in Entry ID 243)**	$0	Verified Item	JV Disposition comments; No cost impact.
CWP Top 40	155	26-Jun-15	CWP 2172	CWP 2172 Two cranes are available. Crane operator should be 2 not 3. Expected saving per unit- $ 284 K	DFL - Install	(July 27) See JV Disposition comments	No cost impact, 3rd operator is for RAB gantry crane as discussed with James M during the deep dive on Jun-25-15 meeting at the DEC in 3B. **(Carried in Entry ID 243)**	$0	Verified Item	JV Disposition comments; No cost impact.
CWP Top 40	156	26-Jun-15	CWP 2033	CWP 2033 The electrical estimate required independent review. Set up the job; Pre job, post job, authorization, other = 353 hr's Doing the job = 121 hr's The cleanup should be excluded; the area will be part of the other CWP. Expected saving per unit- $ 21K	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator July 27: Temporary lighting removal. Each OPN likely have pre, post job applied to them in the CWP estimate. Electricians will review estimate to determine if a pre, post per shift can be applied. Guy!! Are these numbers accurate? Dave Worton counts 24 hours. July 28 Update: Review schedule and ensure there is only one pre/post job, work authorization etc. per shift, per task. 25AUG: This change has not been captured for Class II Rev 1. Due to the amount of effort involved, pre/post job, work authorization etc tasks to be investigated post Class II Rev 1.	Not discussed between OPG/JV prior to Jul-8-15. **This line item carries all monetary changes associated with this CWP.**	(569,611)	Verified Item	Change Implemented, reduced task manhours. The reduced amount is entered in the CWPs changes to Rev-01
CWP Top 40	157	26-Jun-15	CWP 2144	CWP 2144 Header Nozzle ID Build up & Weld Prep- step 58-59-60-61 is rework cost. Expected saving per unit- $ 71K	DFL - Feeders	Removed to rework and contingency.	**Includes all monetary changes within this CWP**	($2,482,995)	Verified Item	Saving is almost equal to the savings for one unit only. Please confirm is applying to one unit.
CWP Top 40	158	26-Jun-15	CWP 2182	CWP2182 - Material transportation by support service team. Expected saving per unit - $ 37K	DFL - Install	Aug 20- OPG-JV agrees that Transportation Operations (600-601) from the Estimate sheet to be removed and Support Services to perform this work. 31AUG: OPG-JV agree that previous note in this column is incorrect, and Transportation Operations (600-601) do require Trades Support. No change required to the Estimate.	Not discussed between OPG/JV prior to Jul-8-15 **No Cost Impact.**	$0	Verified Item	no cost impact required
CWP Top 40	159	26-Jun-15	CWP 2182	Foreman to journeyman percentage is 25%, is high. Expected saving per unit - $ 100 K Explain why the walking factor is included. Assign calandria tube step-001-019; the paperwork is excessively high. Paperwork should be assigned to PMT. Expected saving per unit - $ 328 K	DFL - Install	Aug 20- OPG-JV agrees that Assign Calandria Tube to Lattice Site Operations step 500 (001-019) from the Estimate sheet to be removed as this is already performed by warehouse personnel. Walk time to be removed as this is in the clean room area only. The supervision level has been accounted for in onboarding and series training levelling- no change. 31AUG: OPG-JV agree that previous note in this column is incorrect, and Assign Calandria Tube Operations Step 500 (001-019) do require Trades Support. No change required to the Estimate.	**Same as entry ID 27**: Provide an outline of the supervision model i.e. the rules for when a Forman is needed and why. Look at the stickout (high %) packages and provide rationale for supervisor hours in relation to Crew assemblies. Explore ways of optimizing these hours e.g. having one supervisor oversee multiple small crews, use of sub-foreman, etc,. Separate meeting to be set up to discuss once completed. **No Cost Impact.**	$0	Verified Item	no cost impact required, however further meetings expected to identify changes in this item
CWP Top 40	160	26-Jun-15	CWP 2146	CWP 2146 Construction logistics communication; 168 feeders per face (total 336 feeders) are required site fabrication. Please re-exam the multiplier. Step -39 "Wrap upper field weld location with protective shim "should be excluded. Protective shim should not be used. Sleeve should be used and provided as part of tools, to ensure the welding quality. Expected saving per unit- $ 103 K	DFL - Feeders	Agreed. Will correct multiplier to reflect 124 x2 = 248 East/West ….Step #39 Estimate will be reviewed in light of alumuminum tracks being used for majority of feeder welds. Estimated savings of $92K in manhours (work performed in parallel to feeder welding) See item 213 for response to in-vault fabrication of lower feeders. (B.G/B.C/R.P)	Not discussed between OPG/JV prior to Jul-8-15 **(Carried in Entry ID 213)**	$0	Verified Item	included in id 213
CWP Top 40	161	26-Jun-15	CWP 2142	CWP 2142 Multiplier 528- explains the item duplication and multiplier number. Expected saving per unit- $ 132 K	DFL - Feeders	JV & OPG Agree. Estimating error, Multiplier will be corrected to 508 (delta is 20 feeders). 8hrs/feeder removal x 20 feeders = 160hrs . 160hrs * 4 BMs * $88/hr = $56,000 in man-hour savings (B.G/B.C/R.P)	Not discussed between OPG/JV prior to Jul-8-15 **Includes all monetary changes within this CWP**	($1,443,044)	Verified Item	cost adjustments provided as per comments
CWP Top 40	162	26-Jun-15	CWP 2017	CWP 2017 Operation #200- step 3,4,5,6. Please explain the multiplier column. Expected saving per unit - $ 428K	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator. July 28 Update: Multiplier was incorrect due to clerical error. Multipliers will be revised to 'x2' to account for east and west side.	Corrected estimate error, pricing resolved. **This line item includes all monetary changes for this CWP.**	($1,398,733)	Verified Item	Change implemented (multiplier corrected to 2x for items from line 14 to 25). OPG-JV war room monetization is not available. The reduced amount is entered in CWPs changes to Rev-01 sheet.
Basis Sheets	163	7-Jul-15	CWP 2183	QC/QA hold and witness points -- (using bump shift) - Comment # 96	DFL - Install	(Jul 22) Duplicate comment; eliminate from change log	**(Carried in Entry ID 242)**	$0	Verified Item	Duplicate comment; eliminate from change log
Basis Sheets	164	7-Jul-15	CWP 2142	Cutting instrumentation lines on and around upper feeders (includes feeder scanner removal) -- (need proper basis / time-study to document need for 4 shifts x 10 hours = 2 days) - Comment # 29	DFL - Feeders	J.V & OPG agree. Critical tube harvesting for weld development (new to old tube) will be done in parallel with soffit panel removal. Remove 2d from basis (B.G/B.C/R.P)	**(Carried in Entry ID 161)**	$0	Verified Item	included in id 161, comments have been incorporated and cost adjustments provided
Basis Sheets	165	7-Jul-15	CWP 2166	Installation and commission on both sides of the reactor Note: Total Time at DEC = 9 days on one 10+2 hour shift, first time evolution -- (included in 1.5 day commission activity above) - Comment # 33	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to remove this 0.75 day adjustment item	**(Carried in Entry ID 249)**	$0	Verified Item	Refer to ID # 249
Basis Sheets	166	7-Jul-15	CWP 2166	RTP movements -- (reject portion of basis, 30 min basis for each move on 24 rows) - Comment # 36	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to remove 0.3 days off this adjustment item	**(Carried in Entry ID 249)**	$0	Verified Item	Refer to ID # 249
Basis Sheets	167	7-Jul-15	CWP 2166	Cutting Head Changes -- (60 min per head change, every 40 channels-need basis) - Comment # 38	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to keep this adjustment item in the base duration	**(Carried in Entry ID 249)**	$0	Verified Item	No change to basis sheet
Basis Sheets	168	7-Jul-15	CWP 2166	Remove PT Cut Tool -- (need basis of duration from flowsheet) - Comment # 39	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to keep this adjustment item in the base duration	**(Carried in Entry ID 249)**	$0	Verified Item	No change to basis sheet
Basis Sheets	169	7-Jul-15	CWP 2166	Remove EF-SPIRT -- (need basis of duration from flowsheet) - Comment # 40	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to keep this adjustment item in the base duration	**(Carried in Entry ID 249)**	$0	Verified Item	No change to basis sheet
Basis Sheets	170	7-Jul-15	CWP 2166	Remove VAS -- (need basis of duration from flowsheet) - Comment # 41	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to keep this adjustment item in the base duration	**(Carried in Entry ID 249)**	$0	Verified Item	No change to basis sheet

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Basis Sheets	171	7-Jul-15	CWP 2168	Commissioning tool takes an additional 60 hours (exclusive of troubleshooting), -- (First time occurrence at DEC, need basis for included hours) - Comment # 42	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce commissioning by 36 hrs (1.5 days)	(Carried in Entry ID 232)	$0	Verified Item	included in id 232
Basis Sheets	172	7-Jul-15	CWP 2168	OPEX from DEC shows tools (pallet + S-SPIRT) will take approx 20 hours to place on platform and bolt down once it is slung from the vault crane. -- (First time occurrence at DEC, need basis for included hours) - Comment # 43	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce commissioning by 12 hrs (0.5 days)	(Carried in Entry ID 232)	$0	Verified Item	included in id 232
Basis Sheets	173	7-Jul-15	CWP 2168	and final SCADA integration an additional 20 hours -- (First time occurrence at DEC, need basis for included hours) - Comment # 44	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to remove system commissioning time by 20 hours (0.83 days)	(Carried in Entry ID 232)	$0	Verified Item	included in id 232
Basis Sheets	174	7-Jul-15	CWP 2168	Electrical connections (VAS, OICT, Pallet, SSPIRT) will take 10 hours -- (First time occurrence at DEC, need basis for included hours) - Comment # 47	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed basis has been accepted	(Carried in Entry ID 232)	$0	Verified Item	included in id 232
Basis Sheets	175	7-Jul-15	CWP 2168	Coordination of material transfer between east and west -- (congestion factor in vault - mitigate with training and sequencing work) - Comment # 48	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce this adjustment factor by 12 hrs (0.5 days)	(Carried in Entry ID 232)	$0	Verified Item	included in id 232
Basis Sheets	176	7-Jul-15	CWP 2168	Flask Transfer from Platform to AGV and from buffer nest to platform -- (base duration at mockup tool 16 min/60/24*480 = 5.33 days time study - need basis) - Comment # 49	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce this adjustment factor by 2.7 days	(Carried in Entry ID 232)	$0	Verified Item	included in id 232
Basis Sheets	177	7-Jul-15	CWP 2168	Operator response times to SCADA operator prompts will take additional time -- (risk, stated as assumption) - Comment # 51	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce this adjustment factor by 1.7 days	(Carried in Entry ID 232)	$0	Verified Item	included in id 232
Basis Sheets	178	7-Jul-15	CWP 2168	Platform and indexing time missing from TPG test -- (TPG chosen as average, need basis to understand delta to TPG average) - Comment # 52	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to keep this item with no change	(Carried in Entry ID 232)	$0	Verified Item	No change. N/A
Basis Sheets	179	7-Jul-15	CWP 2168	Thumb Tack Stud install and locking -- (basis provided, OPG to agree on time study basis provided) - Comment # 53	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to keep this item with no change	(Carried in Entry ID 232)	$0	Verified Item	No change. N/A
Basis Sheets	180	7-Jul-15	CWP 2168	Additional platform move not performed in TPG (return up to the next site) -- (need basis, 1 platform movement missing for 5th channel of TPG test) - Comment # 54	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to keep this item with no change	(Carried in Entry ID 232)	$0	Verified Item	No change. N/A
Basis Sheets	181	7-Jul-15	CWP 2168	Coordination between flask movements between east and west side -- (included in TPG times) - Comment # 55	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to increase duration by 1.4 days	(Carried in Entry ID 232)	$0	Verified Item	included in id 232
Basis Sheets	182	7-Jul-15	CWP 2168	Transition out includes: - removal of EF specific tooling on the Pallet System, removal of the EF Flasks -- (no basis for TPG time) - Comment # 58	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to keep this item with no change	(Carried in Entry ID 232)	$0	Verified Item	No change. N/A
Basis Sheets	183	7-Jul-15	CWP 2169	Vault Learning Curve -- (already included in actuals, mock up training etc...). (contradicts bump shift philosophy) - Comment # 60	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has allowed this adjustment item to allocate time for the following activities: Garter spring OICT inspections: 1 day . Manual intervention coordination (Flasking and bung): 1 day	(Carried in Entry ID 217)	$0	Verified Item	Included with ID 217
Basis Sheets	184	7-Jul-15	CWP 2175	Install and route Control Cables, High Frequency Cables and Hoses through the Cable Management System 76 HRS Note: Time directly from Basis Sheets (4.9 DEC time + 0.5+0.5+0.25) = 6.15 -- (need basis of 3.2 days, time-study or standards referenced, perform in parallel?) - Comment # 63	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to keep this activity in the base duration	(Carried in Entry ID 228)	$0	Verified Item	As agreed the activity is kept in the base duration.
Basis Sheets	185	7-Jul-15	CWP 2175	Additional time compared to TPG for transfer of material to both faces Note: Time directly from Basis Sheets (4.9 DEC time + 0.5+0.5+0.25) = 6.15 -- (duplicated with above durations) - Comment # 64	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to remove this 0.25 day from this adjustment factor.	(Carried in Entry ID 228)	$0	Verified Item	included in id 228
Basis Sheets	186	7-Jul-15	CWP 2175	Additional time compared to TPG for commissioning of both faces of tooling Note: Time directly from Basis Sheets (4.9 DEC time + 0.5+0.5+0.25) = 6.15 -- (risk based on OPEX) - Comment # 65	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to keep this activity in the base duration	(Carried in Entry ID 228)	$0	Verified Item	As agreed the activity is kept in the base duration.
Basis Sheets	187	7-Jul-15	CWP 2175	Sequential high-power commissioning test Note: Time directly from Basis Sheets (4.9 DEC time + 0.5+0.5+0.25) = 6.15 -- (duplicate of commission task above) - Comment # 66	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to remove this 0.25 day adjustment factor	(Carried in Entry ID 228)	$0	Verified Item	included in id 228
Basis Sheets	188	7-Jul-15	CWP 2175	Tool Preventative Maintenance -- (tooling design, risk, rework, spares, 1 hour per shift + 2 hours per row on avg + maintenance and repairs on face = 2 days) - Comment # 68	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to remove 1.8 days from this adjustment factor. It is now 1 day in duration (24 instances of preventative maintenance)	(Carried in Entry ID 228)	$0	Verified Item	included in id 228
Basis Sheets	189	7-Jul-15	CWP 2175	Operator response times to SCADA operator prompts will take additional time -- (risk, mitigated with training on mockup, supervision) - Comment # 69	DFL - Remove/Inspect	(July 28) Already removed in Rev 0 Basis Sheets; JV-OPG collaborative team agrees to keep it out of basis	(Carried in Entry ID 228)	$0	Verified Item	As agreed the activity is kept in the base duration.
Basis Sheets	190	7-Jul-15	CWP 2175	Vault Learning Curve -- (mitigated with training on mockup, supervision) - Comment # 70	DFL - Remove/Inspect	(July 28) Already removed in Rev 0 Basis Sheets; JV-OPG collaborative team agrees to keep it out of basis	(Carried in Entry ID 228)	$0	Verified Item	As agreed the activity is kept in the base duration.
Basis Sheets	191	7-Jul-15	CWP 2175	End Shield monitoring with the FARO system -- (Duplication with another series - check to see if included in that series, is required in both?) - Comment # 71	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to keep this activity in the base duration	(Carried in Entry ID 228)	$0	Verified Item	As agreed the activity is kept in the base duration.
Basis Sheets	192	7-Jul-15	CWP 2175	RTP check-list prerequisites prior to move -- (24*10 min / 60 min/hr / 24 hours = 0.166), validate basis - Comment # 75	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to keep this activity in the base duration	(Carried in Entry ID 228)	$0	Verified Item	As agreed the activity is kept in the base duration.
Basis Sheets	193	7-Jul-15	CWP 2175	Additional HWT move not performed in TPG move from 5th site -- (1.5 min every 5 channels = 1.5*480/5/60/24 = 0.10), validate basis - Comment # 76	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to keep this activity in the base duration	(Carried in Entry ID 228)	$0	Verified Item	As agreed the activity is kept in the base duration.
Basis Sheets	194	7-Jul-15	CWP 2176	Vault Learning Curve -- (built into actuals) - Comment # 80	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed to remove this adjustment factor as there is minimal variance in TPG cycles. This resulted in a net reduction of 3 days	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	195	7-Jul-15	CWP 2176	Inspections if any? -- Need basis - Comment # 83	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to keep this activity in the base duration	(Carried in Entry ID 218)	$0	Verified Item	JV Disposition comments; No cost impact.
Basis Sheets	196	7-Jul-15	CWP 2179	Crew swap over on each jump -- (covered by bump shift philosophy) - Comment # 84	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed upon 2 min per hot handoff. This results in a reduction of 1.4 days from the critical path duration.	(Carried in Entry ID 525)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	197	7-Jul-15	CWP 2179	Narrow rows work efficiency -- (need to understand basis of 0.94 hours added per 28 locations?) - Comment # 87	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed upon 16 sites where narrow row work efficiency is applicable. This results in a reduction of 0.5 days from the critical path duration.	(Carried in Entry ID 525)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	198	7-Jul-15	CWP 2178	CVI -- (no basis provided for this series) - Comment # 93	DFL - Remove/Inspect	(July 29) Basis sheet has been prepared. No change in duration, M1 = 7 days. OPG and JV agree	Includes all monetary changes within this CWP	($103,658)	Verified Item	OPG-JV war room monetization is not available. Critical path duration and the multiplier have been revised, total cost has reduced and entered in the CWPs changes to Rev-01
Basis Sheets	199	7-Jul-15	CWP 2183	Crew swap over on each jump -- (bump shift & hot hand offs) - Comment # 97	DFL - Install	(Jul 22) (Quality-related issue) JV-OPG collaborative team has agreed upon a crew swap over time of 2 minutes for CT Install series. This constitutes a total adjustment of approximately 1 day and a reduction of 3.9 days from the original adjustment item	(Carried in Entry ID 242)	$0	JV agreed but cost adjustment not implemented.	included in Sept 18, 2015 submission, schedule Basis Sheet #2183
Basis Sheets	200	7-Jul-15	CWP 2183	Transition In - Parallel Work -- no credit for Transition in for working in parallel - Comment # 99	DFL - Install	(Aug 27) No change to basis sheet	(Carried in Entry ID 242)	$0	Verified Item	No change to basis sheet
Basis Sheets	201	7-Jul-15	CWP 2183	Vault ramp-up to full production speed -- (already included in actuals) - Comment # 100	DFL - Install	(Jul 22) JV-OPG collaborative team has agreed to eliminate this adjustment factor in favour of increasing base duration to 63 days. Reduction of 1 day.	(Carried in Entry ID 242)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	202	7-Jul-15	CWP 2183	Vault ramp-up to full production speed -- (already in actuals & training) - Comment # 101	DFL - Install	(Jul 22) Duplicate comment; eliminate from change log	(Carried in Entry ID 242)	$0	Verified Item	Duplicate comment; eliminate from change log
Basis Sheets	203	7-Jul-15	CWP 2183	QC/QA hold and witness points -- (should be part of actuals) - Comment # 102	DFL - Install	(Jul 22) Already removed in JV R0 Basis sheets; agreed to keep out of base duration	(Carried in Entry ID 242)	$0	Verified Item	No change to basis sheet
Basis Sheets	204	7-Jul-15	CWP 2180	Additional time compared to TPG for transfer of material to both faces -- (measured time was 8 hours or .3 days, not 1 day) - Comment # 105	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed to reduce this adjustment factor by 0.25 days	(Carried in Entry ID 206)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	205	7-Jul-15	CWP 2180	Additional time compared to TPG for commissioning -- (above line staggers work, do not need staggering twice) - Comment # 106	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed to leave this adjustment factor in the base duration	(Carried in Entry ID 206)	$0	Verified Item	JV Disposition comments; No cost impact.
Basis Sheets	206	7-Jul-15	CWP 2180	Crew swap over on each jump -- (bump shift applied) - Comment # 107	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed to reduce time for hot handoffs to 2 min each. This results in a reduction of 1.4 days	Includes all monetary changes within this CWP	($811,160)	Verified Item	Cost matching the record..$135K saved in each unit due to the comments related to CWP 2180 and the duration adjustment. ($90K x 3) saved in unit 1, 3, &4. additional cost adjustment. due to pre-req comment #453.
Basis Sheets	207	7-Jul-15	CWP 2180	Vault ramp-up to full production speed -- (already included in actuals) - Comment # 108	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed to remove this 1 day adjustment item	(Carried in Entry ID 206)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	208	7-Jul-15	CWP 2180	QC/QA hold and witness points -- (should not be scheduled on critical path) - Comment # 109	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed to remove this 0.8 day adjustment item	(Carried in Entry ID 206)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	209	7-Jul-15	CWP 2172	Crew swap over on each jump -- (contradicts bump shift philosophy) - Comment # 111	DFL - Install	(July 22) JV-OPG collaborative team has agreed to a crew swap over time of 2 min (Install series). This constitutes an adjustment addition of 1.11 days to the base FC Install series duration. Reduction of 4.5 days from original R0 basis sheet	(Carried in Entry ID 243)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	210	7-Jul-15	CWP 2172	Series Tooling not correctly staged on RTP's during TPG -- (risk) - Comment # 114	DFL - Install	(July 22) JV-OPG collaborative team has agreed to remove 1 day adjustment factor, but moved into the uncertainty band.	(Carried in Entry ID 243)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	211	7-Jul-15	CWP 2172	Craning the Inspection Cart out of the way for HWT access -- (duplicated with another CWP for inspection work) - Comment # 115	DFL - Install	(July 22) JV-OPG collaborative team has agreed to reduce row movement time to 15 min per row, resulting in a reduction of 0.1 days. Adjustment factor is now 0.2 days.	(Carried in Entry ID 243)	$0	Verified Item	Not included
Basis Sheets	212	7-Jul-15	CWP 2172	CWP Estimate File: CWP_2172_S3.A_R1(GHR4)(MB) -- Is a bump shift appropriate for this crew? This is covered in Support Services-Reactor Auxiliary Bay (RAB) & Vault Support? - Comment # 118	DFL - Install	(July 22) Manpower related comment. Remove from change log. Will be eliminated by crewing collaboration.	(Carried in Entry ID 243)	$0	Verified Item	Not included
Basis Sheets	213	7-Jul-15	CWP 2146	Feeder fabrication in vault -- (excessive and does not account for working teams in parallel (e.g. just in time) - Comment # 119	DFL - Feeders	It has been agreed to remove 23.8 days from basis sheet for lower feeder install. This duration was created by the previous requirement to fabricate 248 lower horizontal feeders in the vault that would not fit whole through the airlock. By installing the vertical sections (dubbed the "Middle Feeder" these 248 lower feeders sections are installed in parallel with PT installation(below P-Row) , the additional critical path time required during Lower Feeder Installation is removed. This option may require a 12 hour window on critical path during PT install to remove the feeder template. It is imperative that the feeder template is designed in four sections which allows it to be removed without impacting fuel channel installation . I.E. Fuel Channel installing batch of 8 south side . Remove 1/4 section feeder template north side. A detailed lower feeder installation sequence will be generated and validated by CAD modeling. It will be highly beneficial to practice the critical installation sequence during Standby Work. (B.G/B.C/R.P)	Includes all monetary changes within this CWP	($10,597,134)	Verified Item	comments have been incorporated, cost adjustments shown
Basis Sheets	214	7-Jul-15	CWP 2146	Interference and Congestion -- (duration is excessive. Endeavour to plan and execute program without interference & congestion) - Comment # 120	DFL - Feeders	JV & OPG Agree. We can weld 16 feeders per face prior to branching into 4 quadrants, not 24. reducing 4.4 days from basis. Will incorporate changes to CWP.(B.G/B.C/R.P)	(Carried in Entry ID 213)	$0	Verified Item	comments incorporated cost adjustments shown included in id 213
Basis Sheets	215	7-Jul-15	CWP 2146	PAUT/LPI -- (non-invasive NDE doe not require work to stop) - Comment # 122	DFL - Feeders	Welded feeders must pass phased array testing, prior to tacking adjacent target feeder. Can only fit-up/torque feeder. No change to basis sheet. (B.G/B.C/R.P)	(Carried in Entry ID 213)	$0	Verified Item	comments incorporated cost adjustments shown included in id 213
Basis Sheets	216	7-Jul-15	CWP 2146	Hanger adjustments -- (rework under Agreement 3% Allowance) - Comment # 125	DFL - Feeders	JV & Lower & Upper spacers adjustments are considered initial field work, this will be adjusted to accommodate clearances for feeder technical specification requirements. No change to basis sheet. (B.G/B.C/R.P)	(Carried in Entry ID 213)	$0	Verified Item	comments incorporated cost adjustments shown included in id 213
Basis Sheets	217	7-Jul-15	CWP 2169	Expected recovery time from machine and non-machine occurrences during the series -- (risk/rework handled through Agreement). (rework 3% contract allowance) - Comment # 59	DFL - Remove/Inspect	(Jul 23) JV-OPG collaborative team agreed to move this adjustment factor duration to global risk and remove from base duration. Reduction of 5 days.	Includes all monetary changes within this CWP	($1,114,919)	Verified Item	Change in estimate Implemented and entered in the CWPs changes to Rev-01 but not per the OPG-JV war room monetization. Duration and final multiplier reduced.
Basis Sheets	218	7-Jul-15	CWP 2176	Reshock and Retrieve -- (rework 3% under Agreement) - Comment # 78	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed that this is rework. Reduction of 6.9 days	Includes all monetary changes within this CWP	($2,173,455)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	219	7-Jul-15	CWP 2176	Expected recovery time from machine and non-machine occurrences during the series -- (rework 3% under Agreement) - Comment # 79	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed that this is global risk. Reduction of 3 days	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	220	7-Jul-15	CWP 2176	Unique sites -- (rework 3% under Agreement) - Comment # 81	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed that this is contingency. Reduction of 1 day. Risk re-named 'CTI falls out of tubesheet into lattice tube'.	(Carried in Entry ID 218)	$0	Verified Item	Change in estimate Implemented. Duration and final multiplier reduced.

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Basis Sheets	221	7-Jul-15	CWP 2179	Expected recovery time from machine and non-machine occurrences during the series -- (Contractor to manage Tooling) # 86	DFL - Remove/Inspect	(July 23) Already been removed in R0 Basis Sheets; JV-OPG collaborative team has agreed to keep out of base duration and add as a risk	(Carried in Entry ID 525)	$0	Verified Item	JV Disposition comments; No cost impact.
Basis Sheets	222	7-Jul-15	CWP 2183	Expected recovery time from machine and non-machine occurrences during the series -- (rework 3% under Agreement) - Comment # 94	DFL - Install	(Jul 22) Duplicate comment; remove from change log	(Carried in Entry ID 242)	$0	Verified Item	Duplicate comment; eliminate from change log
Basis Sheets	223	7-Jul-15	CWP 2183	Expected recovery time from machine and non-machine occurrences during the series -- (3 % rework) - Comment # 98	DFL - Install	(Jul 22) Already removed in JV R0 Basis sheets; agreed to keep out of base duration	(Carried in Entry ID 242)	$0	Verified Item	No change to basis sheet
Basis Sheets	224	7-Jul-15	CWP 2183	Rerolls -- (rework 3% allowance under Agreement) - Comment # 103	DFL - Install	(Jul 22) JV-OPG collaborative team has agreed to eliminate this adjustment factor. Reduction of 0.2 days.	(Carried in Entry ID 242)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	225	7-Jul-15	CWP 2183	Re-rolls -- (3% rework) - Comment # 104	DFL - Install	(Jul 22) Duplicate comment; remove from change log	(Carried in Entry ID 242)	$0	Verified Item	Duplicate comment; eliminate from change log
Basis Sheets	226	7-Jul-15	CWP 2172	Contingent Operations (as per the sheet agreed to with OPG and construction) -- (rework 3% contract allowance) - Comment # 113	DFL - Install	(July 22) JV-OPG collaborative team has agreed to eliminate this adjustment factor. Reduction of 4.4 days in base, moved to the uncertainty range.	(Carried in Entry ID 243)	$0	Verified Item	Agreed not to implement the comments.
Basis Sheets	227	7-Jul-15	CWP 2146	Cold bending -- (rework under Agreement 3% Allowance) - Comment # 124	DFL - Feeders	JV & OPG agree. Cold bending will be a result of a concealed condition, due to incorrect isometric drawings, undocumented Fit-up/clearance modifications. No change to basis sheet. (B.G/B.C/R.P)	(Carried in Entry ID 213)	$0	Verified Item	comments incorporated cost adjustments shown included in id 213
Basis Sheets	228	7-Jul-15	CWP 2175	Expected recovery time from machine and non-machine occurrences during the series -- (risk/rework handled through Agreement) - Comment # 67	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to remove this 3 day adjustment factor. Moved to global risk.	Includes all monetary changes within this CWP	($164,330)	Verified Item	Included as per JV OPG Mtg Notes, cost adjustments shown.
Basis Sheets	229	7-Jul-15	CWP 2166	Contaminated Cut Head Changes -- (include as risk and plan for RP involvement in minimum cut head changes. Additional cut head changes, RTP moves, RP involvement etc. - projected) - Comment # 35	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to keep this adjustment item in the base duration	(Carried in Entry ID 249)	$0	Verified Item	No change to basis sheet
Basis Sheets	230	7-Jul-15	CWP 2166	Contingency cuts -- (risk) - Comment # 37	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to remove this 0.5 day adjustment item. Moved to rework risk.	(Carried in Entry ID 249)	$0	Verified Item	Refer to ID # 249
Basis Sheets	231	7-Jul-15	CWP 2168	Installation and commission on both sides of the reactor -- (risk to be managed, OPEX) - Comment # 45	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to keep this item with no change	(Carried in Entry ID 232)	$0	Verified Item	No change. N/A
Basis Sheets	232	7-Jul-15	CWP 2168	Expected recovery time from machine and non-machine occurrences during the series -- (risk, mitigated with training and readiness activities) - Comment # 50	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce this adjustment factor by 3 days	Includes all monetary changes within this CWP	($1,058,936)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	233	7-Jul-15	CWP 2168	OICT inspections may take longer if indications found -- (risk) - Comment # 56	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to keep this item with no change	(Carried in Entry ID 232)	$0	Verified Item	No change. N/A
Basis Sheets	234	7-Jul-15	CWP 2169	Platform and indexing time missing from TPG test -- (between 2 items above, more than ample time added for platform moves etc..). (mitigated with training and readiness activities) - Comment # 61	DFL - Remove/Inspect	(Jul 23) As P row was not the true central row of the reactor, the RTP movement times performed during TPG are not reflective of the true average. The movement would have to be performed from M row for this to be true. As a result, JV-OPG collaborative team has agreed to leave this adjustment factor in the base duration	(Carried in Entry ID 217)	$0	Verified Item	Included with ID 217
Basis Sheets	235	7-Jul-15	CWP 2169	Additional platform move not performed in TPG (return up to the next site) -- (between 2 items above, more than ample time added for platform moves etc..). (mitigated with training and readiness activities) - Comment # 62	DFL - Remove/Inspect	(Jul 23) JV-OPG collaborative team has agreed to leave this adjustment item in base duration	(Carried in Entry ID 217)	$0	Verified Item	Included with ID 217
Basis Sheets	236	7-Jul-15	CWP 2175	Inability to shock heat both faces simultaneously -- (risk handled through Agreement) - Comment # 72	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to remove this 0.4 day adjustment factor. Capability does exist to simultaneously shock faces	(Carried in Entry ID 228)	$0	Verified Item	Included in id 228, cost adjustments shown
Basis Sheets	237	7-Jul-15	CWP 2175	Recovery from emergency stop -- (risk handled through Agreement) - Comment # 73	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team has agreed to remove this 0.3 day adjustment factor. This was moved to global risk.	(Carried in Entry ID 228)	$0	Verified Item	Included in id 228, cost adjustments shown
Basis Sheets	238	7-Jul-15	CWP 2179	Work not performed in TPG -- (risk) - Comment # 85	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team to leave this adjustment item in the base duration	(Carried in Entry ID 525)	$0	Verified Item	JV Disposition comments; No cost impact.
Basis Sheets	239	7-Jul-15	CWP 2179	Vault ramp-up to full production speed -- (mitigated with training and readiness activities) - Comment # 88	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has adjusted TPG base duration by accounting for learning curve during the execution of the series. It is assumed that 8 crews require 4 channels to achieve TPG optimal time of 50 min per channel. For the 32 "learning" channels, 66 minutes per channel (TPG "worst" time) was applied. For the remaining 448 channels, the 50 min/channel was used. This changed the base duration (Before adjustment items) from 19 days to 17 days. In addition, the vault learning curve adjustment item of 1 day was removed. Overall, this exercise resulted in a CP duration reduction of 3 days	(Carried in Entry ID 525)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	240	7-Jul-15	CWP 2179	QC/QA hold and witness points -- (risk) - Comment # 90	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed upon 15% of 960 sites for QA/QC hold-ups. This resulted in a reduction of 0.5 days from CP	(Carried in Entry ID 525)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	241	7-Jul-15	CWP 2179	Work not performed in TPG -- (to be actively managed and coordinated within Contractor) - Comment # 91	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team to leave this adjustment item in the base duration	(Carried in Entry ID 525)	$0	Verified Item	JV Disposition comments; No cost impact.
Basis Sheets	242	7-Jul-15	CWP 2183	Narrow rows work efficiency -- (risk & coordination) - Comment # 95	DFL - Install	(Jul 22) JV-OPG collaborative team has agreed to eliminate this adjustment factor in favour of increasing base duration to 63 days. This results in a net duration change of 3 days (6 day reduction for adjustment item - 3 days added from base duration increase)	Includes all monetary changes within this CWP	($2,080,440)	JV agreed but cost adjustment not implemented.	Included in Sept 18, 2015 submission, schedule Basis Sheet #2183
Basis Sheets	243	7-Jul-15	CWP 2172	No batches completed in parallel with other batches during TPG-complexity and interference between batches -- (mitigated with training and readiness activities) - Comment # 112	DFL - Install	(July 27) JV-OPG collaborative team has agreed to remove from base duration and include as uncertainty. Reduction of 5 days	Includes all monetary changes within this CWP	($1,741,454)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	244	7-Jul-15	CWP 2172	Crane modifications affecting production on Column 1 & 24 -- (mitigated with training and readiness activities) - Comment # 116	DFL - Install	(July 22) JV-OPG collaborative team has agreed to leave this adjustment factor in the base duration	(Carried in Entry ID 243)	$0	Verified Item	JV Disposition comments; No cost impact.
Basis Sheets	245	7-Jul-15	CWP 2172	Crane modifications affecting production on Alpha row SA & EF installation -- (mitigated with training and readiness activities) - Comment # 117	DFL - Install	(July 22) JV-OPG collaborative team has agreed to leave this adjustment factor in the base duration	(Carried in Entry ID 243)	$0	Verified Item	JV Disposition comments; No cost impact.
Basis Sheets	246	7-Jul-15	CWP 2146	Unique Sites -- (rework under Agreement 3% Allowance) - Comment # 123	DFL - Feeders	JV & OPG Agree.Cold spring was not correctly simulated during TPG, cold spring was never incorporated into mock-up design. Shorter vertical feeders will be more difficult to fit-up , leave duration in basis. No change to basis sheet. (B.G/B.C/R.P)	(Carried in Entry ID 213)	$0	Verified Item	included in id 213, cost adjustments shown
Basis Sheets	247	7-Jul-15	CWP 2146	Feeder hub and EF side port repair -- (rework under Agreement 3% Allowance) - Comment # 126	DFL - Feeders	JV & OPG agree that this falls under the re-work criteria. 0.8d removed from basis (B.G/B.C/R.P)	(Carried in Entry ID 213)	$0	Verified Item	included in id 213, cost adjustments shown
Basis Sheets	248	7-Jul-15	CWP 2146	Weld Repairs -- (rework under Agreement 3% Allowance) - Comment # 121	DFL - Feeders	J.V & OPG agree that this falls under the rework criteria. 6.4d removed from basis. (B.G/B.C/R.P)	(Carried in Entry ID 213)	$0	Verified Item	included in id 213, cost adjustments shown
Basis Sheets	249	7-Jul-15	CWP 2166	Expected recovery time from machine and non-machine occurrences during the series -- (Risk, mitigated with training and readiness activities) - Comment # 34	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to remove this 1.6 day adjustment item. Add to global risk	Includes all monetary changes within this CWP	($980,159)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	250	7-Jul-15	CWP 2168	Crane Maintenance Activities -- (risk, crane refurb to be performed during pre-requisites) - Comment # 46	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to keep this item with no change	(Carried in Entry ID 232)	$0	Verified Item	No change. N/A
Basis Sheets	251	7-Jul-15	CWP 2167	RP Intervention in the work -- (Basis) - Comment # 7	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed to remove this adjustment factor in favour of adding an additional 0.1 days to the "Cutting Head Change" adjustment item. The removal of the RP involvement adjustment factor results in a reduction of 0.25 days.	(Carried in Entry ID 300)	$0	Verified Item	Included with ID: 300
Basis Sheets	252	7-Jul-15	CWP 2142	RP Intervention in the work -- (OPG to manage) - Comment # 30	DFL - Feeders	RP Risk assumed by OPG. 1.6d removed from basis. (B.G/B.C/R.P)	(Carried in Entry ID 161)	$0	Verified Item	Comments have been incorporated where 1.6 days have been reduced, included in id 161
Basis Sheets	253	7-Jul-15	CWP 2142	Rubber area decommissioning -- (duplicate/parallel of "Cleaning of work area after all feeders removed") - Comment # 31	DFL - Feeders	OPG and JV have agreed to no basis change. Item will remain on basis. (B.G/B.C/R.P)	(Carried in Entry ID 161)	$0	Verified Item	Cost updated to provide cost adjustments for this item.
Basis Sheets	254	7-Jul-15	CWP 2142	RP surveys of the area after clean up and additional cleaning as required -- (duplicate/parallel of "Cleaning of work area after all feeders removed") - Comment # 32	DFL - Feeders	OPG and JV have agreed to no basis change. Item will remain on basis. (B.G/B.C/R.P)	(Carried in Entry ID 161)	$0	Verified Item	Cost updated to provide cost adjustments for this item.
Basis Sheets	255	7-Jul-15	CWP 2175	RPA checks prior to performing maintenance and tool recovery activities -- (OPG risk to manage) - Comment # 74	DFL - Remove/Inspect	(July 28) Reduced as per agreement to 24 instances of preventative maintenance in Line Item 188. Reduced by 0.1 days	(Carried in Entry ID 228)	$0	Verified Item	included in id 228, cost adjustments shown
Basis Sheets	256	7-Jul-15	CWP 2176	RP Intervention in the work -- (OPG risk to manage) - Comment # 82	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed reduction of 0.5 days in basis	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	257	7-Jul-15	CWP 2179	Housekeeping/Contam control -- (mitigated with training and readiness activities) - Comment # 89	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed to remove 0.5 days from base duration (30 min cleaning allowance per day) based on reduced contamination concerns as bellows are not activated	(Carried in Entry ID 525)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	258	7-Jul-15	CWP 2180	Housekeeping/Contam control -- (opg will control RP and this item in particular) - Comment # 110	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed to increase this adjustment item by 1 day in order to account for platform and tool wipedowns	(Carried in Entry ID 206)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	259	7-Jul-15	CWP 2146	RP Intervention in the work -- (OPG risk) - Comment # 127	DFL - Feeders	RP Risk assumed by OPG. .25d removed from basis. (B.G/B.C/R.P)	(Carried in Entry ID 213)	$0	Verified Item	included in id 213, cost adjustments shown
General	260	7-Jul-15	General	JV to produce Estimate Quality chapter to demonstrate what systematic quality checks will be performed on CL2 Rev 1. This chapter will demonstrate how any quality issues related to R0 are addressed.systematically.	Contracts/Commercial	As per Management Discussion on 25AUG, JV to submit Estimate Quality Chapter Report to demonstrate compliance. OPG and JV in agreement. JV to provide Estimate Quality Chapter Report as part of revised R01 Submission.	No Cost Impact	$0	Verified Item	No cost impact
General	261	7-Jul-15	CWP 2124	~~When the BH panels are in place, assume there will be no vault work, on or above the BH panels, is interrupted due to FH activities. 83%,50% per the previous memo applies to work below 100m el when the panels are not in place.~~ MINOR WORDING CHANGES TO IMPROVE CLARITY: When the BH panels are in place, assume there will be no interruptions due to FH activities for any vault work, on or above the BH panels. When the BH panels are not in place, the 83% and 50% efficiencies per the previous memo still apply to any work below 100m el	DFL - TMODS (Pre&Post)	July 23 Update: OPG Action - Provide letter outlining revised productivity factors July 29 Update: Letter has been distributed by OPG. JV to review impact on durations and provide monetization. This change has been included in the Class 2 Rev 1 Estimate.	20 July Update: JV agrees to revise estimate pending receipt of letter from OPG. Includes all monetary changes within this CWP.	$5,450,364	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
General	262	7-Jul-15	General	Further efficiencies in execution of work should be accounted for due to approved work protection practice #7 THIS COMMENT IS TO BE CONSIDERED CLOSED.	N/A	N/A	COMMENT TO BE CONSIDERED CLOSED. No Cost Impact.	$0	Verified Item	General comment no cost impact.
General	263	7-Jul-15	General	Hydrostatic test can be performed in parallel to other work prior to unit mechanical completion	Special Initiatives	August 21st: OPG and JV agree that this change will be made for R01.	Incorporated into R1 VIA Overall Project Duration Change.	$0	No Change yet, JV agreed to change in final Rev 01.	Working Group (War Team) Special Initiative adopted and critical path reduction achieved in Class 2 Rev 01
General	264	7-Jul-15	General	A reduction in number of channels for DB and Frob Series from 150 to 30 to be incorporated	Special Initiatives	August 20: Confirmation / agreement from stake holders was not obtained. This change will not be included in R1 estimate.	20 July Update: JV agrees to change to 30 as per Roy Brown. Revise duration basis sheet to reduce from 150-to 30 DBs. No Cost Impact.	$0	Verified Item	This change will not be included in R1 estimate.
General	265	7-Jul-15	General	A 10 day reduction in OPG defueling duration should be incorporated	Special Initiatives	August 20: Confirmation / agreement from stake holders was not obtained. This change will not be included in R1 estimate.	No Cost Impact.	$0	Verified Item	This change will not be included in R1 estimate.
Logistics DD	266	9-Jul-15	Logistics DD	Discussion during OPG -JV Meeting	Support Services & Infra	JV to provide the EF material movement/processing time study. (July 30) JV-OPG collaborative team has found this comments non-monetizable. Has no effect on total estimate schedule, cost, or manpower impacts. Deals with proof of principle and planning	No Cost Impact.	$0	Verified Item	Comments non-monetizable. No cost impact.
Logistics DD	267	9-Jul-15	Logistics DD	Discussion during OPG -JV Meeting	Support Services & Infra	JV to provide overall Logistics Plan (JV Management Level) taking into account unit overlap (site access control, material, waste, tooling, people movement, transportation management plan). Aaron to confirm. (July 30) JV-OPG collaborative team has found this comments non-monetizable. Has no effect on total estimate schedule, cost, or manpower impacts. Deals with proof of principle and planning	No Cost Impact.	$0	Verified Item	Comments non-monetizable. No cost impact.
Logistics DD	268	9-Jul-15	Logistics DD	Discussion during OPG -JV Meeting	Support Services & Infra	Evaluate unit overlap for AGV usage and contingency for AGV unavailability and charging requirements. Adjust execution phase started as necessary. JV agrees (July 30) JV-OPG collaborative team has found this comments non-monetizable. Has no effect on total estimate schedule, cost, or manpower impacts. Deals with proof of principle and planning	No Cost Impact.	$0	Verified Item	Comments non-monetizable. No cost impact.
Logistics DD	269	9-Jul-15	Logistics DD	Discussion during OPG -JV Meeting	Support Services & Infra	Provide extent of condition analysis for common tooling and construction equipment. JV agrees. (July 30) JV-OPG collaborative team has found this comments non-monetizable. Has no effect on total estimate schedule, cost, or manpower impacts. Deals with proof of principle and planning	No Cost Impact.	$0	Verified Item	Comments non-monetizable. No cost impact.
Logistics DD	270	9-Jul-15	Logistics DD	Discussion during OPG -JV Meeting	Support Services & Infra	JV to provide RWPB extension crane and gantry crane utilisation study and process flow. JV agrees. (July 30) JV-OPG collaborative team has found this comments non-monetizable. Has no effect on total estimate schedule, cost, or manpower impacts. Deals with proof of principle and planning	No Cost Impact.	$0	Verified Item	Comments non-monetizable. No cost impact.

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Logistics DD	271	9-Jul-15	Logistics DD	Discussion during OPG -JV Meeting	Support Services & Infra	Prior to submission of R1 of P6, provide detail logistics planning for key windows (see below). Provide six shift look-ahead for key windows. JV agrees. - Unit 1 EF Removal - Unit 3 RTP Removal - Unit 1 RTP Removal -Unit 4 RTP Install - Unit 4 EF Removal (July 30) JV-OPG collaborative team has found this comments non-monetizable. Has no effect on total estimate schedule, cost, or manpower impacts. Deals with proof of principle and planning	**No Cost Impact.**	$0	Verified Item	No cost impact
Logistics DD	272	9-Jul-15	Logistics DD	Discussion during OPG -JV Meeting	Support Services & Infra	Develop the crew size and structure will be able to achieve this work. This is to provided to OPG for review. Sample for unit 2 start from bulk head shielding install start to RTP install finish. JV agrees. (July 30) JV-OPG collaborative team has found this comments non-monetizable. Has no effect on total estimate schedule, cost, or manpower impacts. Deals with proof of principle and planning	**No Cost Impact.**	$0	Verified Item	No cost impact
Basis Sheets	273	10-Jul-15	CWP 2167	Expected recovery time from machine and non-machine occurrences during the series -- (rework 3% allowance) - Comment # 11	DFL - Remove/Inspect	(July 23) Already removed in R0 Basis Sheets; collaborative team has agreed to keep this factor out of the base duration. This is not considered rework, it has been moved to global risk	**(Carried in Entry ID 300)**	$0	Verified Item	Included with ID: 300
Basis Sheets	274	10-Jul-15	CWP 2141	Expected recovery time from machine and non-machine occurrences during the series -- (risk/rework handled through Agreement) - Comment # 25	DFL - Feeders	OPG and JV have agreed to no basis change. Item will remain on basis (item was already 0d) (B.G/B.C/R.P)	**(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	275	10-Jul-15	CWP 2141	Disconnect OPEX on Dust -- (risk) - Comment # 26	DFL - Feeders	OPG and JV have agreed to no basis change. Item will remain on basis (item was already 0d) (B.G/B.C/R.P)	**(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	276	10-Jul-15	CWP 2141	Stall during shear -- (risk) - Comment # 27	DFL - Feeders	JV & OPG Agree to move to risk registry. .3d removed from basis. (B.G/B.C/R.P)	**(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	277	10-Jul-15	CWP 2141	FME checks -- (part of TPG) - Comment # 28	DFL - Feeders	JV & OPG agree to remove, No FME checks required, cap screws and seal rings will be accounted for with RCC coordinator NOTE: Check and revise CWP as required to reflect. No Cost change - was already 0d on basis. (B.G/B.C/R.P)	**(Carried in Entry ID 43)**	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Basis Sheets	278	10-Jul-15	CWP 2168	Tool Preventative Maintenance -- (PM activities once per month for 1 hour on critical path?) - Comment # 57	DFL - Remove/Inspect	(Aug 27) JV-OPG agree this item is not listed in the basis sheet, no change.	**(Carried in Entry ID 232)**	$0	Verified Item	No change. N/A
Basis Sheets	279	10-Jul-15	CWP 2175	Contingency second shock heat if required -- (risk) - Comment # 77	DFL - Remove/Inspect	(July 28) Already removed in Rev 0 Basis Sheets; JV-OPG collaborative team agrees to keep it out of basis	**(Carried in Entry ID 228)**	$0	Verified Item	As agreed the activity is kept in the base duration.
Basis Sheets	280	10-Jul-15	CWP 2179	FME checks -- (included in TPG) - # 92	DFL - Remove/Inspect	(July 23) Already zeroed in R0 Basis Sheets; JV-OPG collaborative team agrees to keep out of base duration	**(Carried in Entry ID 525)**	$0	Verified Item	The comment implemented in the previous revision.
CWP Top 40	281	10-Jul-15	CWP 2187	CWP 2187 – Commissioning Containment Pressure and leak tests For step description: -Scaffolding Erection. -Complete record sheet. -Verification test. -Scaffolding removal. Not in critical path-The bump factor is not required. Expected saving per unit - $ 145K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Determine what percentage of scaffold could be constructed in advance without interfering with other activities. July 28 Update: Agreed. Scaffold build, record sheet, verification test and scaffold removal are not on critical path. Bump shift will be removed. Task duration to be revised based on removal of bump shift, inclusion of walk times, breaks etc.	**(Carried in Entry ID 330)**	$0	Verified Item	Includes with ID: 330
CWP Top 40	282	10-Jul-15	CWP 2188	CWP 2188 (Same as CWP 2187) For step description: -Scaffolding Erection. -Complete record sheet. -Verification test. -Scaffolding removal. Not in critical path-The bump factor is not required. Expected saving per unit - $ 144K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Determine what percentage of scaffold could be constructed in advance without interfering with other activities. July 28 Update: Agreed. Scaffold build, record sheet, verification test and scaffold removal are not on critical path. Bump shift will be removed. Task duration to be revised based on removal of bump shift, inclusion of walk times, breaks etc.AJ330	**This line item includes all monetary changes associated with this CWP.**	($1,230,516)	Verified Item	OPG-JV war room monetization is not available. The change is implemented and the bump factor has been removed for scaffolding. The reduced amount is entered in the CWPs change to Rev-01
CWP Top 40	283	10-Jul-15	CWP 2143	Offside warehouse- Remove the factor related to Darlington site, such as walk factor Expected saving per unit - $ 224K	DFL - Feeders	JV & OPG agree that walk factor should be removed. (B.G/B.C/R.P)	**(Carried in Entry ID 286)**	$0	Verified Item	Includes with enter ID: 286
CWP Top 40	284	10-Jul-15	CWP 2143	Operation #202- Step 3 & 4. Revise the multiplier column; The multiplier based on the feeders numbers, but the step description should be base on Crate number (12 Number). Expected saving per unit - $ 198K	DFL - Feeders	JV & OPG agree that estimate Multiplier will be changed to 20 crates. Estimate is to be revised. (B.G/B.C/R.P)	**(Carried in Entry ID 286)**	$0	Verified Item	Includes with enter ID: 286
CWP Top 40	285	10-Jul-15	CWP 2143	Step # 8, 46, 50, & 51. Revise the multiplier column; there are 960 flanges instead of 1200. Expected saving per unit - $ 13K	DFL - Feeders	JV & OPG agree that estimate Multiplier will be changed from 1200 to 960 (B.G/B.C/R.P)	**(Carried in Entry ID 286)**	$0	Verified Item	Includes with enter ID: 286
CWP Top 40	286	10-Jul-15	CWP 2143	Step # 32-39 for damaged feeders; part of risk. In current estimate the assumption is to have 1200 damaged feeders. Remove the steps. Expected saving per unit - $ 774K	DFL - Feeders	JV& OPG Agree. Remove surface indication repair from estimate, as this is re-work. (B.G/B.C/R.P) No montatary change as this was captured pre-war room (rev 0 prime) CWP 2143 Work instructions will be revised to reflect that re-work tasks are contingency (weld repair, surface repair, etc...)	**Includes all monetary changes within this CWP**	($4,533,135)	Verified Item	Removed rework tasks, removed walking time, revised multiplier. Estimate reduced and the amount entered in the CWPs changes to Rev-01
CWP Top 40	287	10-Jul-15	CWP 2150	Paper work – no need for bump. Please review the hours required for this step, the hours used to prepare the record sheet are excessively high. Expected saving per unit - $ 57K	DFL - Feeders	JV & OPG agree that estimated hours can be reduced for paper work (B.G/B.C/R.P)	**(Carried in Entry ID 419)**	$0	Verified Item	Refer to ID # 419
CWP Top 40	288	10-Jul-15	CWP 2148	Step 9- The hours are excessively high. Please explain the required hours. Expected saving per unit - $ 264K	DFL - TMOD5 (Pre&Post)	Corrected installation of Protective Caps (Step 9, Phase 1) to 3.5hrs per quadrant from 7 hours. Removed (Speed Caps).	**(Carried in Entry ID 427)**	$0	Verified Item	Reference Entry ID 526
CWP Top 40	289	10-Jul-15	CWP 2229	Please explain the multipliers (x 100). Considering total duration is 26 days (based on schedule). Expected saving per unit - $ 75K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Review multiplier to determine if it is realistic. Revise estimate if required. July 28 Update: If OPG provides concurrence for maintenance crew, all drumming hours will be removed from the estimate July 29 Update: Discuss with estimating to determine potential impact of maintenance crew 25AUG: JV has developed maintenance crew that will be responsible for monitoring activities associated with multiple CWPs. Associated reductions have been incorporated into R01 Estimate.	**This line item includes all monetary changes associated with this CWP.**	($88,460)	Verified Item	OPG-JV war room monetization is not available. The change is implemented and the reduced amount is entered in the CWPs change to Rev-01.
CWP Top 40	290	10-Jul-15	CWP 2053	CWP 2053-No bump factor required- Not in critical path- not in vault Expected saving per unit - $ 194K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Determine if there is any justification for bump shift. Revise estimate as required. Clean up required on all tasks. Agreed upon by both parties. July 27 Update: Electrical group agrees that no bump shift is required. Confirm with Estimating and revise accordingly	**This line item includes all monetary changes associated with this CWP.**	($751,270)	Verified Item	Change implemented, Bump factor removed. The reduced amount is entered in the CWPs changes to Rev-01
CWP Top 40	291	10-Jul-15	CWP 2203	CWP 2203 Mod Dry System (Operation & Maintenance) - Lower Moderator- Not in critical path- No bump required. Expected saving per unit - $ 114K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Bump shift may have been applied due to continuous monitoring requirements. Will review logic and revise estimate as required. July 29 Update: Discuss with estimating to determine potential impact of maintenance crew. Training group must be notified 25AUG: JV has developed maintenance crew that will be responsible for monitoring activities associated with multiple CWPs. Associated reductions have been incorporated into R01 Estimate.	**This line item includes all monetary changes associated with this CWP.**	($574,976)	Verified Item	OPG-JV war room monetization is not available. The change is implemented and the bump factor has been removed. The reduced amount is entered in the CWPs change to Rev-01.
CWP Top 40	292	10-Jul-15	CWP 2100	CWP 2100 - All tasks except those which pertain to the East bridge beam, elevators or ball screws (73113K820-K8040)- Not in critical path-No bump required. Expected saving per unit - $ 114K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Further analysis required of what effect removal of bump shift has on parallel activities. Could push activities on, or near critical path. July 29 Update: Schedule analysis indicated that removal of bump shift would push activities on, or near critical path. Bump shift is justifiable.	**No Cost Impact.**	$0	Verified Item	OPG-JV war room monetization not available, no change to the estimate except for the rate increase (Holidays). Estimated cost is increased by $33.90K for all units. The increased amount is entered in the CWPs changes to Rev-01
CWP Top 40	293	10-Jul-15	CWP 2149	CWP 2149 Feeder Instrumentation - Channel Monitor Removal- Not in critical path-No bump required. Expected saving per unit - $ 103K	DFL - Feeders	JV & OPG agree to the following: We have factored in that lunch breaks are mandatory between the 4-5 hour of the shift, which essentially means we will have 2 hours throughout 24 hours with no coverage. We can pay them through their lunch, but it's solely up them. The collective agreement allows us to stagger start times 3hrs without overtime requirements, furthermore it eliminates any issues with full coverage. R.Pettet, J.Palmateer and B.Campbell have discussed impact with Bump Shift, both parties mutually agree that all removal activities require bumps shift, and explore alternative shift patterns and crewing for execution, I.E.hit it hard straight through with 2 super crews 12 hours per day ,12 hours nights with staggered starts. Based on Bruce 21RT OPEX, running the crew straight through during a small critical path window, has benefits of reducing Supervision/support staff by 50%, furthermore reducing DFL training and onboarding costs, Plus in turn eliminating the back up to speed learning curve and shift turnovers from the crews returning from 4 days off. Note the majority of the DFL will be Local 128 permit and will receive 1 ECY (1600 mrem) R.L. Pettet. This crewing scenario will be discussed during upcoming review of labour DFL histograms I.E. crewing strategy Currently The Rev 1 REQ submission for CWP 2142 " Feeder Removal has bump-shift factor on for all trades groups , CWP 2149 is directly linked to Upper Feeder removal as R.T.D. and instrumentation tubing removal is sequential with the bank by bank removal logic.	**No Cost Impact until Post R1.**	$0	Verified Item	OPG-JV war room monetization not available, no change to the estimate at this time (until post R-01) except for the rate increase (Holidays). Estimated cost is increased by $21.59K for all units. The increased amount is entered in the CWPs changes to Rev-01
CWP Top 40	294	10-Jul-15	CWP 2073	CWP 2073 Feeder Platforms & Template Install-Only Feeder Template Install task 73113H6065-Not in critical path-No bump required. Expected saving per unit - $ 57K	DFL - Feeders	July 23 Update: JV Action - Involve CSS Tech and Estimator - Determine if there is any justification for bump shift. Revise estimate as required. July 27 Update: Cannot work beneath template install crew. Safety. Both parties agreed. Bump shift will remain	**No Change Made. No Cost Impact.**	$0	Verified Item	No Cost Impact.
CWP Top 40	295	10-Jul-15	CWP 2055	CWP 2055 Install TPDS 600V Panels, Power Carts, and Cables in RAB -Not in critical path-No bump factor required- vault and outside vault activities. Expected saving per unit - $ 54K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Determine if there is any justification for bump shift. Revise estimate as required. July 27 Update: Electrical group agrees that no bump shift is required. Ensure estimate is revised accordingly.	**This line item includes all monetary changes associated with this CWP.**	($207,700)	Verified Item	Change implemented, Bump factor removed. The reduced amount is entered in the CWPs changes to Rev-01
CWP Top 40	296	10-Jul-15	CWP 2059	CWP 2059 Remove (2) Sets of Staircase Towers, (4) Platforms, (4) Platforms --Not in critical path-No bump factor required-(807 days float) Expected saving per unit - $ 53K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Review duration in schedule July 28 Update: Bump shift to be removed from estimate. Verify task duration after removal of bump shift. Andy to verify that pre-fab tasks are not captured on P6. Verify with Mark Burrows.	**This line item includes all monetary changes associated with this CWP.**	($202,462)	Verified Item	Change implemented, Bump factor removed. The reduced amount is entered in the CWPs changes to Rev-01
CWP Top 40	297	10-Jul-15	CWP 2061	CWP 2061 Remove Miscellaneous Steel Within Tooling Envelope--Not in critical path-No bump factor required. Same as CWP - 2064, 2085, 2237, 2076, &2099. Expected saving per unit - $ 77K	DFL - TMOD5 (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Review logic/duration July 29 Update: Bump shift will be removed. Scheduling to determine impact on durations.Estimating to provide monetization	**This line item includes all monetary changes associated with this CWP.**	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	298	14-Jul-15	CWP 2146	FME Program Allowance -- Further reduction of 0.83 days is required to bring the total Basis Sheet adjustment to 0 days. Fill in papers in parallel in the RCC Was 0.83 days.	DFL - Feeders	JV&OPG agree to leave duration in basis sheet. No change.	**(Carried in Entry ID 213)**	$0	Verified Item	No change. N/A
Basis Sheets	299	14-Jul-15	CWP 2166	Error on Basis Sheet -- Further reduction of 1.1 days is required to bring the total Basis Sheet adjustment to 0 days. Arithmetic error; this was previously indicated at basis sheet review meeting	DFL - Remove/Inspect	(Jul 28) Error has been corrected through edited through basis sheet editing. Reduced by 1.1 days	**(Carried in Entry ID 249)**	$0	Verified Item	Refer to ID # 249
Basis Sheets	300	14-Jul-15	CWP 2167	Manual EF Rotation and Cut confirmation -- Further reduction of 0.5 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Should be part of contingency. What is the basis for 10% channels requiring manual EF rotation	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed to remove this adjustment item	**Includes all monetary changes within this CWP**	($121,700)	Verified Item	OPG-JV war room monetization is not available. Revised critical path duration and the final multiplier. The reduced amount is entered in the CWPs changes to Rev-01
Basis Sheets	301	14-Jul-15	CWP 2167	Tool Recalibration -- Further reduction of 0.25 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Should be moved to risk register. Unknown and unplanned; not anticipated in JV procedures	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed to remove this adjustment item	**(Carried in Entry ID 300)**	$0	Verified Item	Included with ID: 300
Basis Sheets	302	14-Jul-15	CWP 2166	Tool wipe down and release at Airlock -- Further reduction of 0.25 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Done in parallel. Not critical path work.	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to remove this 0.25 day adjustment item	**(Carried in Entry ID 249)**	$0	Verified Item	Refer to ID # 249
Basis Sheets	303	14-Jul-15	CWP 2168	RTP Check-list Prerequisites prior to move -- Further reduction of 3.3 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - RTP checks are included in TPG time. Only the fifth RTP movement was not part of the TPG time. This is already captured in "Additional platform move not performed in TPG (return up to the next site)" Double count	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce this adjustment factor by 2.3 days	**(Carried in Entry ID 232)**	$0	Verified Item	Cost reduced as per comments

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Basis Sheets	304	14-Jul-15	CWP 2168	Tool wipe down and release at Airlock -- Further reduction of 0.1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Parallel path activities	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce this adjustment factor by 0.1 days	(Carried in Entry ID 232)	$0	Verified Item	Cost reduced as per comments
Basis Sheets	305	14-Jul-15	CWP 2168	Material movement coordination -- Further reduction of 0.1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Parallel path activities	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce this adjustment factor by 0.1 days	(Carried in Entry ID 232)	$0	Verified Item	Cost reduced as per comments
Basis Sheets	306	14-Jul-15	CWP 2166	Removal of PT Cut heads or LLWC if required -- Further reduction of 0.1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Based on Wolsong PT Severing Transition OUT OPEX, these activities were performed on parallel path. What is the basis of shift rounding?	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to remove this 0.1 day adjustment item	(Carried in Entry ID 249)	$0	Verified Item	Refer to ID # 249
Basis Sheets	307	14-Jul-15	CWP 2166	Level off Transition out and transition in to whole shift increments -- Further reduction of 0.1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Based on Wolsong PT Severing Transition OUT OPEX, these activities were performed on parallel path. What is the basis of shift rounding?	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to remove this 0.1 day adjustment item	(Carried in Entry ID 249)	$0	Verified Item	Refer to ID # 249
Basis Sheets	308	14-Jul-15	CWP 2169	Flask Transfer from platform to AGV and from buffer nest to platform -- Further reduction of 1.3 days is required to bring the total Basis Sheet adjustment to 0 days. (4) RP to navigate unknown fields around flask, given JV radiation physics group assessment (4 mins) OPG COMMENT - Item 4 is part of TPG time	DFL - Remove/Inspect	(Jul 23) JV-OPG collaborative team has removed 2.7 days from this adjustment factor by mutually agreeing that moving empty flask on AGV is a parallel path item and that the RP field assessment was both captured in TPG and can be captured as a risk if higher-than-expected readings are found at the face	(Carried in Entry ID 217)	$0	Verified Item	Included with ID 217, JV-OPG war room monetization not considered
Basis Sheets	309	14-Jul-15	CWP 2169	RTP Check-list Prerequisites prior to move -- Further reduction of 3.3 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - RTP checks are included in TPG time. Only the fifth RTP movement was not part of the TPG time. This is already captured in "Additional platform move not performed in TPG (return up to the next site)" Double count	DFL - Remove/Inspect	(Jul 23) JV-OPG collaborative team agreed upon additional 6 minutes to lower and raise RTP per site due to lower amount of control in vault conditions compared to TPG conditions which will likely extend duration of RTP checklist and movement. This resulted in a reduction of 1.3 days from the base duration.	(Carried in Entry ID 217)	$0	Verified Item	Included with ID 217, JV-OPG war room monetization not considered
Basis Sheets	310	14-Jul-15	CWP 2172	Parameter verification - welding on critical path -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Basis of 53 min for Bellows Welding is required to be shown.	DFL - Install	(July 27) As JV-OPG collaborative team has agreed, the base TPG duration has been reduced to 67.8 days which accounts for this adjustment factor. This factor is now to be removed.	(Carried in Entry ID 243)	$0	Verified Item	Can not be validated.
Basis Sheets	311	14-Jul-15	CWP 2172	Parameter verification - Spacer verification -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Basis of 27 min for Eddy Current Detection needs to be provided. What is the basis of multiplying this duration by 24?	DFL - Install	(July 22) Basis for 27 min provided in TPG time. 24x multiplier accounts for number of sites in Alpha and Bravo row. No further reductions made. Adjustment factor allowed by collaborative team in base duration	(Carried in Entry ID 243)	$0	Verified Item	Based on JV disposition; No cost impact, No further reductions made.
Basis Sheets	312	14-Jul-15	CWP 2172	Tail end critical path activities not performed in parallel with the batch -- Further reduction of 0.4 days is required to bring the total Basis Sheet adjustment to 0.6 days. OPG COMMENT - 99 min per channel. 8 channels at 99 min/60 mins/24 hrs per day = 0.55 days	DFL - Install	(July 22) JV-OPG collaborative has agreed to reduce this adjustment item by 0.3 days to 0.7 days based on sequence review performed by JV on the last rows	(Carried in Entry ID 243)	$0	Verified Item	Can not be validated.
Basis Sheets	313	14-Jul-15	CWP 2172	Column 1 and 2 - Using PT Straightening Tool instead of levelling tool as baseline -- Further reduction of 0.1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - This is considered SA Install rework	DFL - Install	(July 27) JV-OPG collaborative team has agreed to leave this adjustment factor in the base duration	(Carried in Entry ID 243)	$0	Verified Item	JV Disposition comments; No cost impact.
Basis Sheets	314	14-Jul-15	CWP 2176	Additional time compared to TPG for transfer of material to both faces -- Further reduction of 0.5 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Parallel path activity	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to reduce this adjustment item by 0.25 days	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	315	14-Jul-15	CWP 2176	Additional time compared to TPG for commissioning of both faces of tooling -- Further reduction of 0.5 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Already included in commissioning. Both sides can be troubleshot simultaneously. Moreover, the install durations of each side are staggered; one side will be completely installed before the other, presenting adequate time windows for any necessary troubleshooting	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to not alter this duration	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	316	14-Jul-15	CWP 2176	Flask transfer -- Further reduction of 1.4 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Flask transfer time was validated to be 16 min at DEC mock-up. RTP movement time was validated to be 10 min at DEC mock-up (Down and up). There are 47 flask movements. Calculation is (10+16)*47/60/24 = 0.85 days	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed upon 24 min per flask transfer. This results in a reduction of 1.4 days	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	317	14-Jul-15	CWP 2176	RTP Check-list Prerequisites prior to move -- Further reduction of 0.1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - RTP checks are included in 10 min RTP movement time allotment	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed upon adding 0.3 days to this adjustment factor as flask transfer movements were not included in R0 basis sheets	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	318	14-Jul-15	CWP 2176	Operator response times to SCADA operator prompts will take additional time -- Further reduction of 1.7 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - This human performance is already accounted for in the TPG time	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team has agreed that this is contingency. Reduction of 1.7 days	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	319	14-Jul-15	CWP 2176	Tool Preventative Maintenance -- Further reduction of 0.1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Preventative maintenance is non-existent on critical path. Any preventative maintenance to be performed is done prior and after series	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to not alter this duration	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	320	14-Jul-15	CWP 2176	Pad-to-Pad measurements -- Further reduction of 0.5 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - At Wolsong/Pt Lepreau, dial indicators and cameras were used to gauge any changes in End Shield positioning. Similar tooling should be provided to perform this in parallel path	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agrees with increasing this adjustment item by 0.5 days to account for platform movements associated with FARO measurements	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	321	14-Jul-15	CWP 2176	Transfer tooling to Airlock -- Further reduction of 0.2 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Parallel path activities	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agrees with removing this 0.2 day adjustment item	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	322	14-Jul-15	CWP 2176	Tool wipe down and release at Airlock -- Further reduction of 0.2 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Parallel path activities	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agrees with removing this 0.2 day adjustment item	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	323	14-Jul-15	CWP 2180	Transfer tooling to Airlock -- Further reduction of 0.2 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Parallel path activity	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agrees with removing this 0.3 adjustment item	(Carried in Entry ID 206)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	324	14-Jul-15	CWP 2180	Tool wipe down and release at Airlock -- Further reduction of 0.3 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Parallel path activity	DFL - Remove/Inspe	(July 29) JV-OPG collaborative team agrees with removing this 0.3 adjustment item	(Carried in Entry ID 206)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	325	14-Jul-15	CWP 2183	Commissioning tool set -- Further reduction of 1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Limited commissioning of this manual toolset required. Based on TPG OPEX, this took 2 12 hour shifts including all troubleshooting. This is equivalent to 1 full day of critical path	DFL - Install	(Jul 22) Duplicate comment; remove from change log	(Carried in Entry ID 242)	$0	Verified Item	Duplicate comment; eliminate from change log
Basis Sheets	326	14-Jul-15	CWP 2183	RTP Check-list Prerequisites prior to move -- Further reduction of 0.3 days is required to bring the total Basis Sheet adjustment to 0.3 days. OPG COMMENT - There are actually 40 trips. 240 tubes are installed from each RTP. 240/6 = 40 trips. RTP moves (East and west) are independent of each other.	DFL - Install	(Jul 22) JV-OPG collaborative team has agreed upon adjustment duration of 0.6 days (20 min per movement cycle - 10 min up, 10 min down, 40 cycles - 240 tubes, 6 tubes per cycle)	(Carried in Entry ID 242)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	327	14-Jul-15	CWP 2183	OPG Hold point -- Further reduction of 1 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Currently, there are no defined OPG hold points.	DFL - Install	(Jul 22) Already removed in JV R0 Basis sheets; agreed to keep out of base duration	(Carried in Entry ID 242)	$0	Verified Item	No change to basis sheet
Basis Sheets	328	14-Jul-15	CWP 2245	Shielding plate install (960 total, with two workers) -- Further reduction of 0.4 days is required to bring the total Basis Sheet adjustment to 0 days. Silkaflex is 'Dose effective' on lower half of reactor face only. Only install up to M row	DFL - TMODS (Pre&Post)	Captured in Removal and Inspection DFL (Christopher, James, Gladys)	Not captured in Rev 1. To be added to Post Rev 1 Errata List.	$0	Verified Item	OPG-JV war room monetization not available, no change to the estimate (to be added to post Rev-01) except for the rate increase (Holidays). Estimated cost is increased by $1.55K for all units. The increased amount is entered in the CWPs changes to Rev-01
Basis Sheets	329	14-Jul-15	CWP 2245	Removal of the shield plates (From RTP - 5 work locations) -- Further reduction of 0.25 days is required to bring the total Basis Sheet adjustment to 0 days. Lower half only Will be performed during CP and PA removal, but on critical path, as there are already 4 parallel work streams in CP and PA removal, and the plates	DFL - TMODS (Pre&Post)	Captured in Removal and Inspection DFL (Christopher, James, Gladys)	Not captured in Rev 1. To be added to Post Rev 1 Errata List.	$0	Verified Item	Included with ID: 328
Basis Sheets	330	14-Jul-15	CWP 2187	Temporary Containment Boundary Commissioning Pressure Test -- Further reduction of 2 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - JV has provided a revised TS for the pressure test with an updated test duration of 3 days. The basis sheet should be updated to reflect this	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Ensure basis sheet has been updated to reflect changes in estimate. July 28 Update: Basis Sheet to be updated by Ron Craig to reflect new durations	Includes all monetary changes within this CWP	($1,585,487)	Verified Item	OPG-JV war room monetization is not available. Bump factor is partially removed and added walking factor. The reduced amount is entered in the CWPs changes to Rev-01 however does not match the changes in the detailed CWPs. However the delta is minor.
Basis Sheets	331	14-Jul-15	CWP 2100	Remove Reactor Area Bridge, Carriage & Suspension Including (2) Beams, (8) Ball Screws & (2) Carriages (SCI 35220) -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. 10 day duration -OPG COMMENT - No basis provided to this base duration	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Provide basis for 10 day duration July 28 Update: Technical Specs, mockup validation and OPEX provided by Estimator. Agreed to by both parties.	No Cost Impact.	$0	Verified Item	Included with ID: 292
Basis Sheets	332	14-Jul-15	CWP 2017	Install RTP Columns / Decking c/w anchors / Structural Bracing & Stiffeners -- Further reduction of 13 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - According to RTP DR Rev 3 (RT38-11610-DR-001) 4.1.7 and 4.1.8, the RTP deck/front extension shall be designed to be installed and commissioned within 17 days and the RTP columns shall be designed to be installed and commissioned within 8 days (Assuming a day is 24 hrs of work). As per RTP QTR (RT38-11630-001-EP-002 Rev 0) (See screenshot), there is an outstanding action to validate the RTP installation and commissioning duration. First time set-up for east RTP took approximately 12 days on 12 hr day shift (~6 days of CP). A second AGV and Column Handler has been procured for additional validation testing prior to breaker open (Standby plan).	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Estimate using 2 AGVs was Validated on West side with single AGV. Second AGV not available, and validation is planned in Standby Plan which is yet to be approved.	(Carried in Entry ID 162)	$0	Verified Item	Included with ID: 162
Basis Sheets	333	14-Jul-15	CWP 2147	Feeder Cabinet Removal (includes support frames and misc. steel and Shield Tank insulation re-install) -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Is this 18 day duration entirely critical path?	DFL - Feeders	July 23 Update: JV Action - Involve CSS Tech and Estimator - Verify if 18 day duration all falls on critical path. Revise estimate accordingly July 27 Update: Feeder group to review basis sheet and schedule to determine what percentage of duration could be done off critical path. July 31 2015: Basis of estimate provided. Feeder group has confirmed that all tasks are on critical path.	(Carried in Entry ID 501)	$0	Verified Item	Includes with ID: 501
Basis Sheets	334	14-Jul-15	CWP 2073	Install Feeder Platform -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Basis and breakdown of this duration needs to be provided	DFL - Feeders	July 23 Update: JV Action - Involve CSS Tech and Estimator - Provide basis and breakdown July 27 Update: Feeder group to provide supporting information (basis sheet, DWI, documentation from Winsafe)	No change was made to CWP 2073	$0	Verified Item	No Cost Impact.
Basis Sheets	335	14-Jul-15	CWP 2142	Upper and Lower Feeder Removal Measured TPG Duration (DEC): 1.9364 hrs/per channel -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. Average TPG time was used. Opportunity for improvement in process, tools, time, and dose should be accounted for in critical path	DFL - Feeders	JV & OPG agree to remove the learning curve, we feel it should balance out throughout the series. (B.G/B.C/R.P)	(Carried in Entry ID 161)	$0	Verified Item	This item is to be validated as this is global for "Learning Curve"
Basis Sheets	336	14-Jul-15	CWP 2227	Dummy Bundle Removal -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. Removal sequence step breakdown do not have descriptions nor basis for the time durations. Additionally, the steps have not been validated at DEC mock-up or other testing - OPG RFR to integrate with Defueling project on the requirement for nine or less dummy bundles per channel versus planned eleven per channel (It appears that the Defueling project has made a conservative assumption that has created a 7.5 day impact on critical path for RFR project per unit) - The presence of dummy bundles in the PT creates technical challenges and radiological hazards during PT volume reduction (i.e., opening the backdoor of the press during each PT crushing sequence is a substantial radiological hazard). This has yet to be proven through testing.	DFL - Remove/Inspe	(July 29) Addressed in Line Item 337	(Carried in Entry ID 337)	$0	Verified Item	Comments addressed in the comment # 337
Basis Sheets	337	14-Jul-15	CWP 2227	Dummy Bundle Removal -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. From GE-Hitachi estimate, the minimum number of channels where DB removal is required is 40. JV to estimate the minimum quantity of dummy bundles required in removal. All other dummy bundle removal should be included as OPG contingency - What is the destination of ILW not bound to be inserted into RWCs? (i.e., contaminated vacuum hoses, vacuum filters, vacuum) (Reference Lepreau VRS primary filters OPEX)	DFL - Remove/Inspe	(July 29) Using Roy Brown's confirmation with Fuel Handling, JV-OPG collaborative team agreed upon 124 channels requiring DB removal. Results in a reduction of 1.18 days	Includes all monetary changes within this CWP	($242,911)	Verified Item	Cost matching the record. Comments addressed , and the cost reduction result from this comment only.
Basis Sheets	338	14-Jul-15	CWP 2227	Dummy Bundle Removal -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. CTSB HWT operations are similar in complexity (Automated tools mixed with manual tools) to DB removal, From TPG, CTSB HWT duration (Visual inspection, swab, polishing) is 55 min per channel. Without any validated testing data, the DB removal durations per channel should be analogous to CTSB TPG durations per channel with an additional reduction as the DB removal has fewer tasks per channel	DFL - Remove/Inspe	(July 29) JV-OPG collaborative team agreed on not performing this exercise and keeping original DB removal per channel duration	(Carried in Entry ID 337)	$0	Verified Item	No change to basis sheet
Basis Sheets	339	14-Jul-15	CWP 2227	Dummy Bundle Removal -- Further reduction of 5.99 days is required to bring the total Basis Sheet adjustment to 0 days. RTP movements - Low flow channels are concentrated in the bottom half of the reactor face. Therefore, only 12 platform moves form the base amount of movements. All others are contingency - Since basis has been greatly reduced, OPG is satisfied with JV range analysis (Comments 336-339 cumulatively total a deduction of 5.99 days)	DFL - Remove/Inspe	(July 29) JV-OPG collaborative team agreed on 18 platform movements, resulting in a 1 hr CP duration reduction	(Carried in Entry ID 337)	$0	Verified Item	Duration has been adjusted. however; The reduction amount to be Validated.
Basis Sheets	340	14-Jul-15	CWP 2074	Feeder Platforms and Template Removal -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Basis and breakdown of this duration needs to be provided	DFL - Feeders	July 23 Update: JV Action - Involve CSS Tech and Estimator - Provide basis and breakdown July 27 Update: Feeder group to provide supporting information (basis sheet, DWI, documentation from Winsafe) July 31 2015: Basis and breakdown provided.	No change was made to CWP 2074	$0	Verified Item	No cost impact.

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Basis Sheets	341	14-Jul-15	CWP 2173	New Fuel Loading (with Transition in and Out) -- Further reduction of 1.5 days is required to bring the total Basis Sheet adjustment to 0 days. No basis provided for these durations - RTP movement - Should be 10 min per move - NFL task - Should be 45 min as per CWP Estimate - Shift rounding issue can be removed when crew-based estimate is developed - How often is RTP moving and for what purpose? (i.e., replenishing fuel bundle stocks) - Can any of these activities be performed in parallel to reduce overall critical path duration? - Additional PT full length ID FME inspections (Bruce OPEX)/ Possible Swabbing of PT (New Construction criteria) and fuel bundle delivery time are OPG risks. Basis needs to be provided on QA/logistical uncertainties	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech - Need to validate durations July 27 Update: Estimate should be adjusted to 10 mins for RTP move, was previously 30 mins. Agreed. NFL durations also include bundle inspection. 50 mins per channel, as per Bruce OPEX. Each site must be visited twice. RTP will be driven to home position for tooling swap. RTP movements will be dictated by fuel load sequence which has not been. Special initiatives: NFL potentially will be re-vamped to 3 phase approach which will double phase 2 efficiency. PT inspection is performed after completion of PT installation. QA inspections are PMT, not task-based. 26AUG: Basis Sheet corrected for 10 minute RTP Movement times. Basis Sheet reflects 50 minute duration for loading fuel into the channel, Bundle Inspection to be completed as a parallel activity. New Fuel Load process to move to 3 phase approach as per special initiative has been completed and is reflected in the Basis Sheet. In addition, a mapped risk has been generated in case this special initiative cannot be fully implemented. Level 1 FME Check is confirmed to be a part of the FC Installation process this eliminates the requirement to swab the PT prior to fuel loading. Full OPG-JV Agreement has been achieved on series durations as per signed Basis Sheet.	Cost Carried in ID524.	$0	Verified Item	Included with ID: 524
Basis Sheets	342	14-Jul-15	CWP 2148	Feeder Cabinet Install (includes support frames and misc. steel) -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. Basis sheet does not provide any justification for 9 day duration	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Validate duration and provide basis July 27 Update: Feeder group to provide supporting information (basis sheet, DWI, documentation from Winsafe)	(Carried in Entry ID 427)	$0	Verified Item	Reference Entry ID 526
Basis Sheets	343	14-Jul-15	CWP 2020	Remove RTP Rear Columns / Decking c/w anchors / Structural Bracing & Stiffeners -- Further reduction of 8.8 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - According to RTP DR Rev 3 (RT38-11610-DR-001) 4.1.9, 4.1.10, and 4.1.11, the RTP deck shall be dismantled and removed within 8 days, the RTP front extension shall be dismantled and removed within 2 days, and the RTP columns shall be designed to be dismantled and removed within 7 days (Assuming a day is 24 hrs of work). As per RTP QTR (RT38-11630-001-EP-002 Rev 0) (See screenshot), there is an outstanding action to validate the RTP removal duration. A second AGV and Column Handler has been procured for additional validation testing prior to breaker open (Standby plan).	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Estimate using 2 AGVs was Validated on West side with single AGV,. Second AGV not available, and validation is planned in Standby Plan which is yet to be approved.	No change to cost at this time.	$0	Verified Item	OPG-JV war room monetization not available, no change to the estimate at this time except for the rate increase (Holidays). Estimated cost is increased by $48.77K for all units. The increased amount is entered in the CWPs changes to Rev-01
Basis Sheets	344	14-Jul-15	CWP 2102	Replace Reactor Area Bridge, Carriage & Suspension Including (2) Beams, (8) Ball Screws & (2) Carriages (SCI 35220) -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - No basis provided to this base duration	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Provide basis for 10 day duration July 28 Update: Technical Specs, mockup validation and OPEX provided by Estimator. Agreed to by both parties.	No Cost Impact.	$0	Verified Item	OPG-JV war room monetization not available, no change to the estimate except for the rate increase (Holidays). Estimated cost is increased by $56.54K for all units. The increased amount is entered in the CWPs changes to Rev-01
Basis Sheets	345	14-Jul-15	CWP 2060	Install Staircase Towers and Platforms -- Further reduction of 5.5 days is required to bring the total Basis Sheet adjustment to 0 days. Fabrication to be performed outside vault, assembly only inside vault, east and west will be performed in parallel 3 days +1.5 days for interferences What is the basis for the critical path activities included in the CWP estimate?	DFL - TMODS (Pre&Post)	July 23 Update: JV Action - Involve CSS Tech and Estimator - Task duration and schedule was reviewed. Reinstall is the critical Path.	No change in cost	$0	Verified Item	No change in cost.
Basis Sheets	346	14-Jul-15	Multiple CWPs	Bulk Interferences -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 0 days. On the Rev 5 LFD, there is a critical path activity titled "Bulk Interferences" (Box ID 064) of 22 day duration comprised of: CWP 2041 CWP 2061 CWP 2063 (Partial) CWP 2077 (Partial) CWP 2079 CWP 2099 CWP 2096 CWP 2107 CWP 2219 (Partial) CWP 2063 (Partial) Upon further examination of the DFL hour breakdown of these CWPs, it is understood that they are task-based estimated. It is OPG's opinion that the next step in the estimating process is to rationalize the resources required on a crew basis to execute these CWPs. In addition, Support Services crew-based resourcing needs to be considered in tandem with the DFL crewing.	DFL - TMODS (Pre&Post)	July 29 Update: JV Action - Bulk Interferences is a Critical Path activity 24/7 on bump. Little to no difference will be seen in a task based to crew based estimate.	No Cost Impact.	$0	Verified Item	No Cost Impact.
Basis Sheets	347	14-Jul-15	CWP 2177	Flask Transfer from platform to AGV and from buffer nest to platform -- Further reduction of 3.3 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Flask change and AGV movement are the only critical path items. Items 2-4 are parallel path activities	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has removed 2.7 days from this adjustment factor by mutually agreeing that moving empty flask on AGV is a parallel path item	Includes all monetary changes within this CWP	($162,739)	Verified Item	Change in estimate Implemented and entered in the CWPs changes to Rev-01 but not per the OPG-JV war room monetization. Duration and final multiplier reduced
Basis Sheets	348	14-Jul-15	CWP 2177	RTP Check-list Prerequisites prior to move -- Further reduction of 3.3 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - RTP checks are included in TPG time. Only the fifth RTP movement was not part of the TPG time. This is already captured in "Additional platform move not performed in TPG (return up to the next site)" Double count	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team agreed upon additional 6 minutes to lower and raise RTP per site due to lower amount of control in vault conditions compared to TPG conditions which will likely extend duration of RTP checklist and movement. This resulted in a reduction of 1.3 days from the base duration.	(Carried in Entry ID 347)	$0	Verified Item	Included with ID 347, JV-OPG war room monetization not considered
Basis Sheets	349	14-Jul-15	CWP 2177	Platform and indexing time missing from TPG test -- Further reduction of 1.7 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - Detailed basis of this item should be provided for OPG to accept this adjustment. It is assumed that P row was chosen as RTP movements from this row represents an average movement rate	DFL - Remove/Inspect	(July 23) As P row was not the true central row of the reactor, the RTP movement times performed during TPG are not reflective of the true average. The movement would have to be performed from M row for this to be true. As a result, JV-OPG collaborative team has agreed to leave this adjustment factor in the base duration	(Carried in Entry ID 347)	$0	Verified Item	Included with ID 347
Basis Sheets	350	14-Jul-15	CWP 2178	Tool Preventative Maintenance -- Further reduction of 0.7 days is required to bring the total Basis Sheet adjustment to 0 days. OPG COMMENT - This is considered parallel path for PT Removal. The same practice should be followed with CT Removal	DFL - Remove/Inspect	(July 29) No change. JV/OPG agree, this comment does not apply to CVI (CWP 2178) or PTR (2168)	(Carried in Entry ID 198)	$0	Verified Item	Included with ID: 198
Basis Sheets	351	14-Jul-15	CWP 2179	End Shield monitoring with the FARO system. OPG COMMENT - At Wolsong/Pt Lepreau, dial indicators and cameras were used to gauge any changes in End Shield positioning. Similar tooling should be provided to perform this in parallel path	DFL - Remove/Inspect	(July 29) Already non-present on Basis Sheet. JV-OPG collaborative review has agreed to keep it out of the base duration	(Carried in Entry ID 525)	$0	Verified Item	The comment implemented at previous revision. non-present on Basis Sheet.
Basis Sheets	352	14-Jul-15	CWP 2145	Upper Feeder Installation -- Further reduction of 0 days is required to bring the total Basis Sheet adjustment to 53.5 days. This is a parallel path activity for a ~248 day critical path window. It is extremely unlikely that this will become a critical path activity	DFL - Feeders	JV & OPG agree to remove repairs and move to contingency additionally modify contract for OPG to absorb global risks associated with RP. Base estimate doesn't have captured template surveys, FME header inspections, instrumentation install, and congestion during installation of last banks, needs to stay in basis .However we have catwalk steps implemented into the base, and we can revise congestion/interference to 12.3 days, since catwalk is in the base reducing 5 days. A further 8.8 manhour days removed for re-work(B.G/B.C/R.P)	(Carried in Entry ID 415)	$0	Verified Item	Confirm
Basis Sheets	353	14-Jul-15	CWP 2176	CTI Removal Commissioning -- Further reduction of 0.25 days is required to bring the total Basis Sheet adjustment to 0.25 days. Commissioning on face shall be completed in half of a shift/tool max.	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team agreed to not alter this duration	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	354	14-Jul-15	CWP 2169	PT Removal Commissioning -- Further reduction of 1 days is required to bring the total Basis Sheet adjustment to 1 days. Based on a phased approach to commissioning, trained personnel, and proper documentation available. (Pallet/SPIRIT/VAS East and West side)	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team agrees with reducing commissioning duration from 48 hrs to 24 hrs (1 day reduction). 24 hrs is allocated in the uncertainty range.	(Carried in Entry ID 217)	$0	Verified Item	Included with ID 217, JV-OPG war room monetization not considered
Basis Sheets	355	14-Jul-15	CWP 2167	BCT Electrical Connection -- Further reduction of 0.42 days is required to bring the total Basis Sheet adjustment to 0.08 days. Electrical connections are simpler as compared to C6 tooling (as GTCS runs are already in place). Competent individuals with proper W.I.s should complete in less than 2 hours. According to IRP, there are 10 cables to connect.	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed to remove 6 hrs (0.25 days) from this particular item	(Carried in Entry ID 300)	$0	Verified Item	Included with ID: 300
Basis Sheets	356	14-Jul-15	CWP 2167	BCT Commissioning -- Further reduction of 0.75 days is required to bring the total Basis Sheet adjustment to 0.25 days. Commissioning on face shall be completed in half of a shift/tool max.	DFL - Remove/Inspect	(July 23) JV-OPG collaborative team has agreed that BCT Commissioning encompasses both Vacuum Commissioning and SCADA Integration. As a result, the total duration of BCT Commissioning is now 27 hrs (1.1 days) and the 0.5 day durations for both Vacuum Commissioning and SCADA Integration were removed. This results in a total net deduction of 9 hrs (0.38 days)	(Carried in Entry ID 300)	$0	Verified Item	Included with ID: 300
Basis Sheets	357	14-Jul-15	CWP 2166	Commission HWT/ PT CUT/EF-SPIRT -- Further reduction of 0.75 days is required to bring the total Basis Sheet adjustment to 0.75 days. Commissioning Docs are indicative of on face level commissioning. Is there a document for more detailed commissioning in the RWBP. If so, then not all of the steps need to be repeated on face (just perform high level checks). This would shorten the duration and reduce dose estimates to the workers.	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to remove 8 hrs (0.33 days) off this activity	(Carried in Entry ID 249)	$0	Verified Item	Refer to ID # 249
Basis Sheets	357	14-Jul-15	CWP 2166	PT Cut System Integration -- Further reduction of 0.17 days is required to bring the total Basis Sheet adjustment to 0.33 days. Commissioning RCC Internals and SCADA/Interlocks/tool offsets	DFL - Remove/Inspect	(Jul 28) JV-OPG collaborative team has agreed to keep this adjustment item in the base duration	(Carried in Entry ID 249)	$0	Verified Item	No change to basis sheet
Basis Sheets	358	14-Jul-15	CWP 2141	QC/QA hold and witness points - Further reduction of 0 days required to bring Basis Sheet adjustment duration to 0 days -- Go-no-go operation after the Feeder coupling is broken was performed in TPG, but a record keeping of this was not done, so there was no 3 way communication with the QC who will record this. This will add approx 2 mins per site. OPG Comments - Parallel activity with feeder disconnecting activities. OPG recommendation is : this should be moved to feeder removal series when feeder jacking is not required.	DFL - Feeders	JV& OPG agree to move bolt grinding to feeder removal , will incorporate time into feeder removal estimate. Remove .3d from basis sheet. (B.G/B.C/R.P) Bolt grinding DFL was removed from 2141 and added to 2142. Moved to Feeder Removal.	(Carried in Entry ID 43)	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
Chapter Report	359	16-Jul-15	PMT	The proposed organization is (by OPG estimate based upon past Refurbishment OPEX) 30% "fat" to achieve the desired outputs from the organization for dual unit overlapped refurbishments where progressive organizational efficiency would be captured during follow on unit execution. The initial Unit 2 refurbishment will benefit from a leaner organization with a more focused command and control accountability structure. Appropriate risk registry entries can be made to expand the organization incrementally as required to deal with multi unit overlapped refurbishment issues based upon OPEX learned from Unit 2. Specific comments regarding required reductions to address this issue, and others have been provided below.	PMT	General comment. JV/OPG Meeting July 28 - Summary percentage reduced to be entered here when PMT actions are resolved. This will be an editorial change to the comment only. 06AUG: This comment is a summary of all changes made by specific Change Log Comments below. Based on this, this comment can be closed. It does not drive any specific changes. CHANGE SIGNED AND AGREED.	Includes all monetary changes within this CWP	($33,636,624)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Chapter Report	360	16-Jul-15	PMT	Sharing of Project resources between the TGR and RFR groups do not appear to have been implemented into RFR Class 2 estimate. Common areas for amalgamation would be Administration, Human Resources, Payroll admin, Health & Safety, Nurse(s). Please revise the PMT Estimate to account for sharing of project resources between TGR, ESMSA and RFR Groups.	PMT	General comment. JV/OPG Meeting July 28 - July 17 Brian, Aaron took action to assess this opportunity and provide options. 29JUL MGMT Meeting: Aaron: Collective Estimate Nailed down for both TGR and RFR first, then determine potential optimizations as part of finalizing target price.OPG Management Team agrees. Action on WAR Room to define list of personnel that can be shared, and then comment to be moved to Opportunities List. WAR Room Action: Investigation regarding sharing of personnel between TGR and RFR to include: Administration, Human Resources, Payroll Administration, Health & Safety, Nurse(s), Environmental Specialists, Project Controls, Human Performance, FARO Technicians and Labour Relations. This comment is now ready to be added to the Opportunities List. 06AUG: Based on WAR Room and JV Discussion with their Management, this will be feasible. Implementation will have to wait for TGR Contract Acceptance. NOT INCLUDED IN DRAFT MONETIZATION. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	361	16-Jul-15	PMT	Vault Coordinators and work co-ordinators will be redundant positions with the number of Project Controls Analysts-Planners & Schedulers envisioned for the project. The following positions do not appear to be justified in the Organization Chart based on above: - IT Tech (covered under Corporate Overhead)- 1 position - U2 Planner (remove 1 position removed until overlapped units) - Tooling Planner (redundant position with Tool Org Eng/Tech)- 1 position - Report Analyst and Field Scheduler Positions should be combined to remove 1 position - Cost Analyst (less manpower required)- 1 position - Timesheet/Payroll Clerk (less manpower required until unit overlap)- 1 position - Document Control Clerk (less manpower required until start of unit overlap)- 1 position.	PMT	General Comment: Division of responsibility between SNC and AECON to be clearly defined for many areas. Ultimately, investigation to be completed (meeting to be set-up and proposal put forth) to determine whether SNC and AECON can be covered under one QA program. JV/OPG - July 28 - moved to opportunity bucket for further discussion due to level of complexity this will not e resolved prior to R01 submission, therefore no monetization to be realized at this time. 30JUL: This item to be moved to Opportunities List.06AUG: WAR Room and Management Agreement has been obtained on this, but this will not be completed prior to R01 issuance due to the magnitude of work involved in making this happen. To be added to Opportunities List. NOT INCLUDED IN DRAFT MONETIZATION. CHANGE SIGNED AND AGREED. OPG and JV to investigate revision of allowed costs to allow back office staff to assume fractional duties. Currently, this is not allowed as per cost allocation table and would allow some reductions in the PMT Organization. JV/OPG July 28 - Senior management to provide direction on this item. 29JUL MGMT: OPG position is that all PMT Positions should be estimated based on required effort, and then number of positions or "FTEs" required should be determined based on the required effort afterwards. 07AUG: JV agrees to re-estimate based on the ability to use back office staff to assume fractional duties where possible with the exception of IT Staff. NOT INCLUDED IN DRAFT MONETIZATION AT THIS TIME DUE TO COMPLEXITY. CHANGE SIGNED AND AGREED. Tool management IT support (as a result of other OPG comments related to Rev 0 review) to be captured into two IT personnel. JV/OPG July 28 - agreed 1 IT position to be assigned to Aecon and one to be assigned to SLN. Editorial change only. CHANGE SIGNED AND AGREED. Two IT Tech Personnel (position 804C and 804D) to be shown as working for two different companies. JV/OPG July 28 - Agreed. Editorial change only. CHANGE SIGNED AND AGREED. U2 Planner (DEC Day, position 8862): 2nd planner to be phased off after the beginning of the fourth unit. JV/OPG July 17 - Agreed. Monetization Required.- Planner PMT2 Position phased out half way through 2023 (2022 unchanged, 1080Hrs in 2023 remaining hours estimated in 2024-2026 removed). CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Chapter Report		16-Jul-15	PMT	See above.	PMT	Bruce, Wolsong and Point Lepreau Organization Charts to be provided by JV. JV/OPG July 17 - Justin to provide org charts to be completed.(Justin). 06AUG: OPG Position is that these Org. Charts from past projects are no longer required. Partial review of Point Lepreau and Wolsong Org. Charts was completed and these Organizations are not applicable to the Darlington RFR Project. CHANGE SIGNED AND AGREED. Field scheduler (position 7415, 7429) to be placed on day shift. OPG is okay with the total quantities of Field Schedulers. JV/OPG July 17 - agreed. Editorial change. CHANGE SIGNED AND AGREED. Timesheet/Payroll Clerk (position 8302/8303) to be shown as working for two different companies. JV/OPG July 17 - agreed. Editorial change. CHANGE SIGNED AND AGREED. JV to rationalize location of the Document Control Clerks (position 7161 to 7164) and stagger the start of Document Control Clerks. JV to investigate whether an in increase in the number of Document Control Clerks can justify reduction in hours in other areas. JV/OPG - July 17 discussions JV was to increase doc control (warehouse, RFRISA, DEC). 11AUG: Document Control Clerks to be shared between the RFRISA, DEC, Warehouse Clean Room and Feeder Warehouse as required. Additionally, 2 Document Control Clerks to be added to the PMT from the start of Bulkhead Install until mechanical completion. INCLUDED IN MONETIZATION (2080 HRS/YEAR FULL TIME X (886 DAYS/365 DAYS/YR (FROM BULKHEAD INSTALL TO MECHANICAL COMPLETION)= 5049HRS X 2 CLERKS X 4 UNITS = 40392HRS X $50/HR= $2.02M. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	362	16-Jul-15	PMT	The following positions do not appear to be justified in the Organization Chart: - Nurse (all positions should be eliminated and agreement for coverage with Station ERT should be established)- 3 positions - Senior Site Safety Advisor, and Site Safety Advisor Positions (redundant positions appear to be included)- 3 positions - Environmental Specialist (do not require full time coverage, should be contract on an as required basis only)- 1 position.	PMT	Nurses (position 7715, 7720, 7721) could be removed from JV CL2 Estimate if OPG is willing cover responsibilities of a nurse in their program (i.e. through OPG ERT Support).JV must initiate this process. 29JUL: To be discussed with Mitch. 30JUL: No changes agreed to WAR Room Level, Mitch Holt to justify no change to Aaron Johnson and Perrik LeDreff. OPG ERT should be able to deal with any incidents. May need to maintain one position for JV Case Management. 06AUG: Based on OPG Management discussion with JV Management, Nurse only required 5x8 on day shift. August 7 update: Taking 2 nurses out and leaving 2 nurses on overlapping 5x8 coverage on days. Monetization updated to 2.5 nurses from 3.5 nurses. CHANGE SIGNED AND AGREED. JV to provide to OPG, for each Organization Chart, Total FTEs in the Organization Chart and Number of Hours Estimated. This comment applies to all Organization Charts in the Chapter Report. JV/OPG July 17 - Justin to provide org charts to be completed.(Justin), 31JUL: Received- OPG Review underway. DEFERRED TO COMMENT DIRECTLY BELOW. NOT DISCUSSED DURING MEETING: JV to provide 4 sets of PMT Organization Charts showing the PMT Organization during each of the following ISEP Window pairings: 1/2, 3/4, 5/6 and 7/8. JV to provide feedback on feasibility and TCD for this action. 29JUL: Justin to provide. 06AUG: Still waiting on this. Revised request sent by Steve Allen in 05AUG Email requesting PMT Organization Charts showing the PMT Organization on a yearly basis from 2017-2025. At the WAR Room Level, the TCD for providing these Organization Charts to OPG is 31AUG. JV to investigate man-hours and metrics regarding hours of field labour vs. hours of safety support for other OPG projects (i.e. definition projects/ other projects & modification projects/OPEX etc.) and compare with Class II Estimate. This information to be provided to OPG for further discussion. 29JUL: Justin to provide. 06AUG: OPG position is that this is no longer required based on the changes and resource sharing between the Vault, RWPB and offsite locations as per below, agreed to at the WAR Room Level to be finalized by Management. SEE COMMENT BELOW. JV to investigate potential sharing of PMT resources with other projects (i.e. TGR) (repeated comment). SEE #360.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report		16-Jul-15	PMT	See above.	PMT	JV to investigate removal of dedicated RWPB safety resources. Currently there is one to two resources on day shift and another resource on night shift completely dedicated to the RWPB. It is OPG's position that responsibilities could be combined, and the resources assigned to the vault could cover everything. 29JUL: To be discussed with Mitch. Mitch to investigate opportunity for sharing resources. 30JUL: No changes agreed to WAR Room Level, Mitch Holt to justify no change to Aaron Johnson and Perrik LeDreff. WAR Room suggestion is to eliminate the RWPB Senior Site Safety Advisor and two nights Site Safety Advisor Positions leaving a total of one Senior Safety Advisor and six Site Safety Advisors shared between the RWPB, Vault, and offsite locations. One of the removed Site Safety Advisors from the RWPB should be moved to the DEC to support a second shift of training. This is a net removal of 2 positions. (Can be monetized, but agreement at management level should be attained first). 07AUG: CHANGE AGREED TO BY MANAGEMENT AND TO BE IMPLEMENTED AS PER ABOVE. CHANGE SIGNED AND AGREED. Aug 12, OPG and JV agree to change the Safety Advisor comment above to a have a total of 1 Senior Safety Advisor and 1 Safety Advisor. The extra Safety Advisor is to be included in the Unit 2 estimate and be re-evaluated for subsequent units based on work load. The Role of this advisor is to support Offsite locations, support worker orientations, Supervisor Redbook training and provide coverage for vacation/illness etc. for the safety team. This position would be days based but support the different shifts as required. CHANGE SIGNED AND AGREED. Environmental Specialist (position 7270) will not be required on a full-time basis. JV to investigate potential sharing of resources with other projects (TGR, ESMSA). JV/OPG July 28 - Agreed environmental is not a full time position. Meeting to be set up with Mitch and Justin to discuss and get agreement on cuts. 30JUL: Agreed that Environmental Specialist is not a full time position, this position is to be shared between TGR and RFR as part of investigation. NOT INCLUDED IN DRAFT MONETIZATION. SEE #360.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	363	16-Jul-15	PMT	The quoted OPEX does not specifically address areas which were "over staffed" in previous refurbishment projects. It has not accounted for accountability and execution issues from previous refurbs that have been corrected with a more streamlined focussed organizational structure (especially in the areas of QA/QC, Engineering, Construction Support and Tooling). The following positions do not appear to be justified in the Organization Chart based on above: - Zone 3 Tooling Engineer (redundant with another position)- 1 position - Zone 3 Tooling Technician (redundant with another position)- 1 position - Clean Storage Shipping and Receiving (redundant with another position)- 1 position - Administration (only 50% duty required, merge with Procurement Administrator) - Active Series Tooling Technicians (redundant with Series Lead and CSS Technician positions)- 4 positions. - Active Series and Incoming Series Programmer (should not be OPG's cost)- 5 positions - Tooling Readiness Supervisor (duplication within existing PMT Organization)- 1 position. - Incoming Series and Outgoing Series Tooling Engineers (should cover both series)- 1 position - Incoming Series and Outgoing Series Tooling Technician (should cover both series)- 1 position	PMT	JV to provide percentage and justification of the PMT and DFL hours related to Preventative Maintenance vs. Corrective Maintenance work. Task force to be established to review the bottoms up build up of the Tool Management Estimate with management oversight to be involved. JV/OPG - July 28 - Confirm that this has been dealt within tooling meetings. If not set up meeting with Tool Management group to finalize an agreement. 29JUL: to be discussed with Cam/Saumil.. 31JUL: MGMT to ensure taskforce is established. 06AUG: This comment has been addressed during the Tool Management Meeting. The following changes are required to the TMO PMT: For the Out-going series, the Tooling Engineer will change to a Tooling Mechanical Tech, the already existing Tech will become a Tooling Electrical Tech - For the Active series, the 4 Tooling Engineers on shift become 4 Tooling Mechanical Techs, and the 4 existing Techs become 4 Tooling Electrical Techs - For the incoming series, one Tooling Electrical Tech to be added and one Tooling Mechanical Tech to be added (these two will be working on the afternoon/night shift to support Training). - The Tooling Engineering Lead, will become a Tooling Mechanical Engineering Lead and next to him we will add a Tooling Electrical Engineering Lead. Net: Remove 5 Tooling Engineers and Replace with Technicians x 16024 hours= 80120 x35$/hr reduction (difference between Engineer rate and Technician rate= $2804200 reduction, add 2 Technicians at 16024 hrs x 2 =32048 hours x 65$/hr= $2083120 addition 1 Engineer 16024 hours x 100$/hr= $1602400. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	364	16-Jul-15	PMT	The following positions do not appear to be justified in the Organization Chart: - Labour Relations (position not required)- 1 position.	PMT	Labour Relations (position 7645) to be changed to AECON. Editorial change only. CHANGE SIGNED AND AGREED. JV to investigate whether all HR positions can be consolidated with TGR, ESMSA, etc. JV/OPG - July 17 - agreed. Brian and Aaron to confirm as per July 17 deep dive. (Covered above- See #360). CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	365	16-Jul-15	PMT	The quoted OPEX does not specifically address areas which were "over staffed" in previous refurbishment projects. It has not accounted for accountability and execution issues from previous refurbs that have been corrected with a more streamlined focussed organizational structure (especially in the areas of QA/QC, Engineering, Construction Support and Tooling). The following positions do not appear to be justified in the Organization Chart based on above: - Project Coordinator (only 1 position required, do not need separate position for both SNC and AECON - Incoming Series MODS Mechanical Technician, Electrical Technician, Civil Technician and Containment Technician (required for pre-requisites and post-requisites only)- 4 positions - Execution and Closeout MODS CSS Technicians (redundant positions)- 2 positions	PMT	Project Coordinator (position 786C) to removed. JV/OPG July 17 deep dive Sebastian agreed to remove project coordinator from org chart.29JUL: Justin to make change to Org. Chart/Estimate. Monetization is based on Monetization for Construction Support Project Coordinator Position below. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	366	16-Jul-15	PMT	The following positions do not appear to be justified in the Organization Chart: - Warehouse Supervisor and Warehouse Coordinator (off-site/feeder) (redundant positions)- 1 position - Warehouse Coordinator (DEC) and Site Material Supervisor T/Mods-P/Mods (should be combined into 1 position)- 1 position - Site Material Supervisor (position not required)- 1 position	PMT	No change is required at this time. Adjustment pending submission of FTE numbers in each Organization Chart. JV/OPG July 28 - Justin to provide FTE numbers as described above (Justin). 31JUL: Received- OPG Review underway. DEFERRED TO #362.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	367	16-Jul-15	PMT	The following positions do not appear to be justified in the Organization Chart: - Bulks and Consumables Procurement Lead and Expeditor (duties should be combined)- 1 position	PMT	Administrator responsibilities for Procurement (position 7810) to be shared with Tooling Management. This position to be removed from Procurement and responsibilities to be assumed by position 700B from Tool Management. JV/OPG July 17 - agreed. Change will be made on org chart. 29JUL: Justin to make change to Org. Chart/Estimate. Monetization is based on Revision 0 P6 Schedule. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	368	16-Jul-15	PMT	Please quantify what the training numbers were at Wolsong and Lepreau and complete a comparison to what is in this chapter. Please rationalize how the increased numbers are going lead to more effective training being executed over a normal 40 hour week i.e.: No overtime. Additionally, training material should be in place before execution ever starts as per Phase 2 deliverables of the Standby Plan. Why should extra staff be included here for additional training material development? The following positions do not appear to be justified in the Organization Chart: - Technical Writer (redundant position, function will be completed by Training Supervisor/Instructor and Training Assistant, revisions will be relatively minor)- 1 position - Training Assistant and Training Coordinator Positions (combine duties, potentially retain both once overlapped units start)- 1 position - Removal Training Supervisor and Inspect and Install Training Supervisor (combine duties)- 1 position.	PMT	Technical Writer (Position 8285) to be removed. JV/OPG - July 17 - agreed.29JUL: Justin to make change to Org. Chart/Estimate. Monetization is based on Revision 0 P6 Schedule. CHANGE SIGNED AND AGREED. JV to align Training Organization Chart to reflect revised Onboarding/Training Execution Strategy (once it has been finalized). JV/OPG - July 17 - IP. Moved item to Training as per Jeff Palmateer. 29JUL- See #125.This item is not included in the monetization to date. To be addressed through Training Chapter. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	369	16-Jul-15	PMT	The quoted OPEX does not specifically address areas which were "over staffed" in previous refurbishment projects. It has not accounted for accountability and execution issues from previous refurbs that have been corrected with a more streamlined focussed organizational structure (especially in the areas of QA/QC, Engineering, Construction Support and Tooling). The following positions do not appear to be justified in the Organization Chart based on above: - ECC Coordinator (duties would be covered by the Engineering Manager/Administrative Support Activities)- 1 position - Electrical I&C Resident Engineer, Mechanical Resident Engineer, Civil Resident Engineer and Mechanical Engineer (duties required for Pre-Requisites and Post Requisite Activities only)- 4 positions - Welding Engineer (redundant position included in Phase 1 and 3, and in Phase 2 Series Support, only require 1 of 2)- 1 position	PMT	No changes required at this time. Adjustments pending submission of FTE numbers in each Organization Chart. JV/OPG July 28 - Justin to provide FTE numbers as described above (Justin). 31JUL: Received- OPG Review underway. DEFERRED TO #362. ECC Coordinator Role to be revisited following N-PROC-MP-0090 optimizations detailed below. Welding Engineer/Welding Specialist to be reviewed to ensure 24 hour coverage between the two resources when required by project schedule. JV/OPG July 17 during deep dive agreed to add welding specialist to SITE D2 (Included in Monetization, NEEDS TO BE ADDED TO ORG CHART) CHANGE SIGNED AND AGREED. July 28 - Samad to address.Confirmation to be provided following meeting with DA by EOB 29JUL.Additional detail to be added to the Roles and Responsibilities Form to link responsibilities of the ECC Coordinator to the Execution Phase work. Additionally Role Title to be updated to "Engineering Coordinator" (Justin). CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Chapter Report	370	16-Jul-15	PMT	Vault Coordinators and work co-ordinators will be redundant positions with the number of Supers/GFs envisioned for the project. The following positions do not appear to be justified in the Organization Chart based on above: - Project Coordinator (only 1 position required, do not need separate position for both SNC and AECON). - T/P Mods, Site Infrastructure Superintendant Containment Isolation (pre-requisite and Post-requisite Support covered by PMT Engineering)- 3 positions. - Fuel Channel Superintendant (redundant positions)- 1 position - Work Protection Coordinator (only need 1 day/1 night position with call ins as required)- 2 positions - Waste and Interface Coordinator (redundant position between Manager and Waste GFs)- 4 positions - Electrical GF (just need 1 per shift, 2nd may be required only after unit overlap begins)- 4 positions- please clarify and explain the strategy for staffing of all GF Positions. Some of the GF Positions appear to be heavily staffed given the amount of work anticipated. - Onboarding Instructor, Onboarding Training Coordinator (reduce by 1 each, training will be CBT based)- 2 positions.	PMT	Electrical GF (Electrical-GF-PMT-#) start/finish dates to be revised and GF coverage to be removed when support is not required. JV/OPG July 17 agreed that 2 Electrical GF's per shift is only required for Windows 1,2,7 and 8. Reduce to 1 electrical GF per shift for Windows 3,4,5 and 6. 29JUL: Justin to make change to Org. Chart/Estimate. Included in Monetization. CHANGE SIGNED AND AGREED. Onboarding Coordinator/Instructor-PMT start/stop dates to be linked to DFL activities (once Onboarding Training plan is finalized). Cannot be completed at this time until DFL/required training resources finalized. 31JUL: NO CHANGE REQUIRED AT THIS TIME, WHEN REVISED DFL IS AVAILABLE, START/STOP DATES FOR THESE RESOURCES TO BE ADJUSTED AS REQUIRED TO MATCH NEED. CHANGE SIGNED AND AGREED. Project Coordinator (position 7860) to be removed. JV/OPG July 17 - agreed.29JUL: Justin to make change to Org. Chart/Estimate. Monetization is based on Revision 0 P6 Schedule. CHANGE SIGNED AND AGREED. Work Protection Coordinator (8615, 8620, 8626, 8630) to be shown as "Work Protection Coordinator/Holder of Record"- editorial change. JV/OPG July 17 - agreed.29JUL: Justin to make change to Org. Chart/Estimate. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	371	16-Jul-15	PMT	The quoted OPEX does not specifically address areas which were "over staffed" in previous refurbishment projects. It has not accounted for accountability and execution issues from previous refurbs that have been corrected with a more streamlined focussed organizational structure (especially in the areas of QA/QC, Engineering, Construction Support and Tooling). Additionally, AECON and JV QA program differences have added "layering" affect and additional QA personnel, can this not be covered procedurally with existing QA/QC personnel? Added personnel for better planning/monitoring and reporting - is this not the job duties of the identified supervisory QA/QC personnel? Added personnel for QC positions on shift - OPEX has dictated that QC personnel have previously been extensively used for strict field verification purposes whereas trades staff should be utilized for this function. The following positions do not appear to be justified in the Organization Chart based on above: - QA Specialist (do not need separate representation from both SNC and CANDU)- 2 positions - Construction Quality Supervisor (only need 2 positions on 5X10 coverage with call in as required)- 2 positions - Quality Control Inspector (only need 1 position except for overlapped refurbishments)- 1 position - Quality Control Inspector (excessive numbers of staff estimated, only require 6 positions per shift)- 16 positions	PMT	JV to prepare a presentation (draft proposal including potential quantification of savings to CL2 Estimate including PMT), and set up a meeting to combine the SNC and AECON QA programs (TCD: July 24th) JV/OPG - July 28 - moved to opportunity bucket for further discussion due to level of complexity this will not e resolved prior to R01 submission, therefore no monetization to be realized at this time. This is a repeat comment. See #361. JV to provide Subcontractor Estimate staff build up on a "per CWP" basis for OPG review. JV/OPG - July 28 - NDE/QC subcontractor estimate to be reviewed in the subcontractor chapter/section. Move comment to subcontractor section as required following review. 29JUL:WAR Room to review NDE Subcontract 30JUL, and then decision will be made regarding adequacy of QA/QC PMT. This portion of the comment is closed for the purposes of this Chapter. 06AUG: Comment closed. NDE Subcontract has been reviewed and the QA/QC PMT does not require changes for the purposes of this comment. CHANGE SIGNED AND AGREED. August 7 Update: OPG/JV Working Session Comment: ...Additionally, AECON and JV QA program differences have added "layering" affect and additional QS personnel, can this not be covered procedurally with existing QA/QC personnel? - OPG/JV Meeting Notes Comment: ...A proposal to implement this Org change will be included in the "Special Initiatives" submission. The Org change and subsequent reduction of the 5 positions will be implemented for the R1 submission of the Class II estimate. - If we eliminate the 5 Quality Specialist positions it will result in a reduction of 77,248 hrs x $80/hr = $6,179,840 over the life of the entire project. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	372	16-Jul-15	PMT	There appears to be duplication of duties and/or opportunities for resource sharing between this PMT section and the Corresponding section in the Class 2 Estimate for "Preparation for Subsequent Units" (50940T-0000-00000-33RA-0159) which comprises 9 additional staff (based at the site) over and above what is currently required in the PMT Class 2 estimate. It is OPG's Position that the Preparation for Subsequent Units Organization can be eliminated, and the Estimated PMT Organization can handle their duties.	PMT	No changes required at this time. Adjustments pending submission of FTE numbers in each Organization Chart. JV/OPG - July 28 - Justin to provide FTE numbers (Justin). 30JUL: To be addressed in the Preparations for Subsequent Units Chapter. Comment closed for the purposes of this Chapter.SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	373	16-Jul-15	PMT	There appears to be duplication of duties and/or opportunities for resource sharing between this PMT section and the Corresponding section in the Class 2 Estimate for "Preparation for Subsequent Units" (50940T-0000-00000-33RA-0159) which comprises 39 additional staff (all based in Oakville) over and above what is currently required in the PMT Class 2 estimate. It is OPG's Position that the Preparation for Subsequent Units Organization can be eliminated, and the Estimated PMT Organization can handle their duties.	PMT	JV to provide potential savings for opportunities presented in the Prep for Subsequent Units chapter including for optimization of N-PROCs. JV/OPG July 28 - Samad to address.Confirmation to be provided following meeting with DA by EOB 29JUL. (Samad) Further comments pending submission of FTE numbers in each Organization Chart. JV/OPG - July 28 - Justin to provide FTE numbers. (Justin). 30JUL: To be addressed in the Preparations for Subsequent Units Chapter. Comment closed for the purposes of this Chapter. SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	374	16-Jul-15	PMT	There appears to be duplication of duties and/or opportunities for resource sharing between this PMT section and the Corresponding section in the Class 2 Estimate for "Preparation for Subsequent Units" (50940T-0000-00000-33RA-0159) which comprises 18 additional staff (all based in Oakville) over and above what is currently required in the PMT Class 2 estimate. OPEX for this area of the PMT appears to have been based upon preliminary information on the amount of effort required to establish new vendors for OSM material for Unit 2 - OPG envisions that these vendors will all be established for the subsequent three units and that OSM material will be secured in the he most efficient manner possible with the usual vendor oversight required. It is OPG's Position that the Preparation for Subsequent Units Organization can be eliminated, and the Estimated PMT Organization can handle their duties.	PMT	**No changes required at this time. Adjustments pending submission of FTE numbers in each Organization Chart. JV/OPG - July 28 - Justin to provide FTE numbers. (Justin). 30JUL: To be addressed in the Preparations for Subsequent Units Chapter. Comment closed for the purposes of this Chapter. SIGNED AND AGREED.**	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	375	16-Jul-15	PMT	There appears to be duplication of duties and/or opportunities for resource sharing between this PMT section and the Corresponding section in the Class 2 Estimate for "Preparation for Subsequent Units" (50940T-0000-00000-33RA-0159) which comprises 9 additional staff (all based out of Oakville) over and above what is currently required in the PMT Class 2 estimate. It is OPG's Position that the Preparation for Subsequent Units Organization can be eliminated, and the Estimated PMT Organization can handle their duties.	PMT	**No changes required at this time. Adjustments pending submission of FTE numbers in each Organization Chart. JV/OPG - July 28 - Justin to provide FTE numbers. (Justin). 30JUL: To be addressed in the Preparations for Subsequent Units Chapter. Comment closed for the purposes of this Chapter. SIGNED AND AGREED.**	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	376	16-Jul-15	PMT	Please clarify whether the second Feeder Series Lead for Pre (Incoming Series) should say D2 instead of D1. It is assumed that this is supposed to be the case. Please correct this error.	PMT	JV/OPG July 17 - Justin and Sebastian agreed to correct (Justin). CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	377	16-Jul-15	PMT	Please clarify staffing strategy for Pre (Upcoming) Series Leads. It currently appears that there will be 2 Series Lead per day shift for Fuel Channel Series Leads, but D1/D2 are not shown. Please correct this error.	PMT	JV/OPG July 17 - Justin and Sebastian agreed to correct (Justin). CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	378	23-Jul-15	Preparations for Subsequent Units	Why is it not possible to reduce the number of reviews of engineering packages by others. This process for the second unit needs to be streamlined to acknowledg	Subsequent Units	July 27: Backing Sheet MP-0090 Section 1.3.1 - Formal Preliminary COMS review to be eliminated because JV not doing MEC revision. JV has given a 12.5% reduction (0.875) as per Appendix C. JV to provide basis for the 12.5% reduction. Appendix C Page 3 of 5 - JV to optimize Step 12 in comparison with CWP preparation effort. August 4th: Significant optimization of the process have been identified. OPG and JV have reached alignment on final reduction factor and the cost build up in Appendix C of the chapter. The 12.5% reduction has been eliminated and detailed build up/explanation of the new reduction factor has been provided.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	379	23-Jul-15	Preparations for Subsequent Units	CWP should be relatively easy to produce using Unit 2 as baseline and revising. Cost saving should be continue to increase for each subsequent unit. JV action to quantify cost savings associated with CWPs for subsequent units.	Subsequent Units	August 5: CWPs (2)R4.xlsx defines basis for quantification of cost savings for CWP Preparation for subsequent Units. Scope items 1, 4, 6, 13, 14, 17, 18, 22, 23 and 29 (highlighted in green) for sub units show a savings of 31.5h (unit 1, 3 and 4) vs. 128h (unit 2) or 75% savings for subsequent unit CWP prep. During the estimate review process, it was determined that 7 additional hours were required per CWP per unit to perform reviews of Engineering Packages between units to ensure changes have been incorporated.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	380	23-Jul-15	Preparations for Subsequent Units	N-STD-MP-0009/CDIR says the vendor does not write MECs. Remove ghost writing MECs from estimate buildup.	Subsequent Units	July 27: Effort for MEC preparation to be removed. Monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Basis Sheets	381	28-Jul-15	Preparations for Subsequent Units	"Table 3 provides a non-exhaustive list..... ...The table outlines scope that is currently excluded which requires discussion with OPG and potentially an increase to the Class 2 estimate or PCD." If not included, how will they be funded? Contingency? Known scope should be in the base. If these items have not been included, the estimate is not complete. Expand the details provided in this table. Costs associated with Unique scope should be shown on a unit-by-unit basis. Ie. Under Unit 1, all "unique scope" items and cost for should be shown, Under Unit, we should have similar list.	Subsequent Units	July 27: JV did not include because this portion would not be a Class II estimate. Inclusion of this unique scope would have impacts on procurement, goods, and CWP estimates. July 28: Escalated to management for final decision. At a minimum this should be included in the scope control chapter. July 30: JV to estimate engineering, procurement and construction costs. Wording in the chapter report to be revised to remove "non exhaustive list" (section 2.5.2, prior to unique scope table) and "PCD to adjust price" to be removed (section 2.7, see scope control section). Monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Included with ID: 390
Chapter Report	382	23-Jul-15	Preparations for Subsequent Units	Could eng for all subsequent units be done at the same time and not continue throughout the life of the project? This may result in significant cost savings. For example, DECs can be completed for all units at the same time and reviewed at the same time.	Subsequent Units	August 5: All 3 Units are being done at once for R1. Monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	383	23-Jul-15	Preparations for Subsequent Units	Subsequent unit cost based on 66% of Unit 2 cost is too high. Items no longer required for subsequent units (bulkhead package, for example): - conceptual design report - EQA/EQ testing -BH assessment - modelling (limited) - design is mostly copy/paste - MEC - PDR - WD Reports In general, reduction factors seem too high and need to be revisited.	Subsequent Units	July 27: Action on Steve Rate to obtain disposition from relevant JV group. August 4: The scope listed in the "comments" sections had already been removed in the R0 submission (this removal accounted for 4848 hours). Reduction factors revised to provide further reduction as per revised Appendix C. Monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	384	23-Jul-15	Preparations for Subsequent Units	Why was 44% reduction factor shown in basis sheets rounded up to 66%? 44% still seems high.	Subsequent Units	July 28: OPG and JV have not agreed on the percentage. JV to provide revised build up to justify a percentage. July 30th: JV has provided a list. OPG is in agreement in principal with monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	385	23-Jul-15	Preparations for Subsequent Units	Paragraph suggests that Experience during the Definition phase led to productivity improvements. However, improvements are not addressed for Engineering, Procurement and QA/QC (See P. 19). In fact the estimate has increased for these functions.	Subsequent Units	July 27: The tables on P. 19 relate to the Class III estimate. JV now has a better definition of the scope and requirements since Class III. See Appendix C for reductions in effort from definition phase work. Monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	386	23-Jul-15	Preparations for Subsequent Units	Why are Engineering, QA and CWP (not procurement) estimates exactly the same for each subsequent unit? OPG would have expected to see a reduction in cost for each subsequent unit.	Subsequent Units	July 27: JV to investigate and present. If there is additional efficiency in repetition of engineering for the third and fourth units. (Engineering Only) Monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Chapter Report	387	23-Jul-15	Preparations for Subsequent Units	As addressed here, the "Execution Planning" scope includes approvals, sign-off of work steps, interfacing with ANI, etc. These are functions normally performed by Construction. Why are these "execution" functions included in the "subsequent prep" chapter estimate when there are so many FE and QA/QC in the PMT Chapter? Is there double counting or excessive staffing?	Subsequent Units	All work performed at site is captured in the PMT or DFL estimates (not prep for subsequent units). This includes some of the items in section 2.4.2. Therefore, this section will be revised. August 8: Chapter write-up to be revised to show delineation of PMT to Subsequent Units.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	388	23-Jul-15	Preparations for Subsequent Units	Commissioning Specifications should be either definition phase. Furthermore, even if commissioning specs were part of execution they should be developed for all units instead of for each unit. (25,000 hour saving).	Subsequent Units	July 27: JV to review and advise by July 28. July 28: Reduced number of hours included for Unit 1 - for Unit 3 and 4 no hours are allocated. Monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	389	23-Jul-15	Preparations for Subsequent Units	Review all MECs and determine with OPG what activities are maintenance only and do not require MOD packages.	Subsequent Units	July 28: In accordance with standard EPC model all contractor activities are to be documented through an engineering change. The documentation produced is critical for OPG's configuration management of the Unit. Monetization included in comment 378 monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	390	23-Jul-15	Preparations for Subsequent Units	"Procuring materials from the same vendors as Unit 2 could significantly reduce the costs associated with preparation of procurement documentation." Consider incorporating cost saving associated with doing 3 units worth of procurement for subsequent units.	Subsequent Units	July 30th: JV to provide final monetization for OPG review. August 4th cost build up has been provided and agreed upon with OPG.	Includes all monetary changes within this CWP	($31,601,799)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Chapter Report	391	23-Jul-15	Preparations for Subsequent Units	Perform optimization in of QA/QC resourcing as current estimate shows a flat distribution matching peak resource demand for quality surveillance activities.	Subsequent Units	COMMENT HAS BEEN RETIRED	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	392	23-Jul-15	Owner Specified Materials and Goods	Please clarify why there is variation in the Estimates for Miscellaneous OSM Material between Units (i.e. $5.1M is Estimated for Unit 2, $1.4M is Estimated for Unit 3, $6.2M is Estimated for Unit 1, $1.4M is Estimated for Unit 4). Provide more details on what is included in miscellaneous. Also, please ensure that there is no duplication of payment for various Software (i.e. TMS etc.), Training, Shielding. Also, please clarify, is only material cost included, or are personnel costs also included?	OSM & Goods	Jul 27: JV position class 2 cost is zero, see column H. There are no miscellaneous costs, only class 3 data provided for information.	Includes all monetary changes within this CWP	($26,671,390)	Verified Item	Changes implemented and entered in the CWPs change to Rev-01 sheet. For details, see doc. 509407-0000-00000-33RA-0171 Rev P8[1] Commissioning Support. Variance of Rev00 - Variance of Rev01
Chapter Report	393	23-Jul-15	Owner Specified Materials and Goods	Bulkhead Shielding for the existing Bulkhead has been included in the "OSM scope changed from Class 3" list. This should be included in the "Goods variances from Class 3 to Class 2" list. Please note, all Containment Isolations Materials are considered goods. (Cost implication on markup)	OSM & Goods	Jul 27: JV position is that as per article 1.1 (iii) and (nnnnn) bulkhead shielding is classified as OSM.	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	394	23-Jul-15	Owner Specified Materials and Goods	The team has concerns that the RWPB Demolition goods costs may be duplicated in demobilization chapter. Please clarify and confirm whether this is the case, and revise this Chapter Report if required.	OSM & Goods	Jul 27: Although prices for goods are shown in several different chapters, the actual cost is only summed from the OSM and Goods chapter.	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	395	23-Jul-15	Owner Specified Materials and Goods	Please ensure that the number of spares quoted in the "7% Spare" column is verified with Procurement to ensure number of spares matches the quantities in EQR. Additionally, what consideration has been given to reducing spare quantities for subsequent units? Throughout the tables, decimal places in the total number of items should be removed by rounding.	OSM & Goods	July 27: JV to provide basis/documentation validating the use of 7% for Spares. JV has to complete the action to verify if 7% matches the quantities in the EQR. JV to update the wording to state that no spares were carried for the 4th unit. OPG and JV have agreed unit 2 spares have been awarded at (7%), unit 1 (5%), unit 3 (3%) unit 4 (0)	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	396	23-Jul-15	Owner Specified Materials and Goods	Currently, Procurement Engineering Support is shown as being covered under target price. The team believes that this cost is already covered in the Preparation for Subsequent Units Chapter Report, not included in this Chapter Report. Please remove.	OSM & Goods	July 27th: There is no duplication of cost. JV to update the annotate the title of A1 and B1 with the following additional note: "Cost are not part of this estimate as they are captured under definition phase. They are provided for reference only"	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	397	23-Jul-15	Owner Specified Materials and Goods	Some DECs are still included in the list that should not be anymore (i.e. DEC123342- Power to Channel Drain Tool). Current Design of Tool does not include power. Please review and ensure the DEC list is up to date.	OSM & Goods	July 27th: JV to update list based on latest eng input. JV to provide a sample roll-up backing spreadsheet for review since the current Goods breakdown does not show what is being purchased.	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	398	23-Jul-15	Owner Specified Materials and Goods	Cost of shielding is high when compared to current planning basis which is to use steel plate. (Previous Comments)	OSM & Goods	July 27: JV to revise based on latest engineering input. It is expected that there will be deductions in cost of approximately $ 2 million dollars. Update: Change has been incorporated into R01 Estimate.	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	399	23-Jul-15	Owner Specified Materials and Goods	Currently, the Chapter Report indicates a Miscellaneous "Training- Series" Allocation of $5.7M per unit. Please clarify how this Estimate was determined? Please provide Backing Sheets with details on what makes up this total. There is currently not adequate detail to justify the amount estimated.	OSM & Goods	July 27th: Backing sheet provided by JV for OPG review. This backing sheet to be included as part of R1 submission.	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	400	23-Jul-15	Owner Specified Materials and Goods	The RWC/DSO Package is in production/manufacturing stage currently and there is no anticipated changes to the design. Please clarify why 4.5 M$ for added shielding and configuration changes has been included in the Estimate? The team believes that this should be removed.	OSM & Goods	July 27th: JV to review change order with B&W on RWC/DSO and provide feedback on impact for subsequent units. OPG to review prior to approval for incorporation into estimate. Aug 5th. Confirmation with B&W Project Manager 4.1 million increase in tangible materials due to design change. estimated 400,000.00 dollars in rework. $4.1 million to be applied to subsequent units	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	401	23-Jul-15	Owner Specified Materials and Goods	743,186 $/unit was included in the cost item of "RWCs & DSOs" as the cost of storing empty RWC/DSO packages in a remote warehouse. This cost could be eliminated/reduced if the containers are to be stored in the RWSB, a potential maximum saving of ~ 3M$ (4x743,186). Have the JV considered the RWSB storage option and assessed the overall cost impact to send the empty RWC/DSO packages from B&W to the RWSB?	OSM & Goods	July 27th: JV agrees. OPG to confirm availability. July 30: Availability of RWSB cannot be confirmed at this time.	(Carried in Entry ID 392)	$0	Verified Item	Included in ID 392
Chapter Report	402	23-Jul-15	Owner Specified Materials and Goods	"Procuring materials from the same vendors as Unit 2 could significantly reduce the costs associated with preparation of procurement documentation." Consider incorporating cost saving associated with doing 3 units worth of procurement for subsequent units.	OSM & Goods	July 27th: JV to obtain quotes from vendors for the scenarios of multi-unit procurement strategy. There is significant saving potential for this change. Aug 4th, This action has been completed and will be incorporated into REV01 submission	(Carried in Entry ID 392)	$0	Verified Item	Included with ID: 392
Chapter Report	403	28-Jul-15	Preparations for Subsequent Units	Ensure that lessons learned from U2 is considered when crewing the CL2 estimate. Will there be savings due to staff knowledge from definition phase of OPG/JV/vendor procedures?	Subsequent Units	July 30th: JV to provide final monetization for OPG review. August 5: OPG has reviewed and agrees with the monetization.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
General	404	27-Jul-15	DFL - Summary	For all DFL, factors such as bump shift/walk time, etc. to be removed, and each series to be crewed with an appropriate number of resources to accommodate: jurisdictions, specific series work methodology, sufficient resources to accommodate breaks/lunches when on work face manual activities, 2 crews x 12 hours for series of total duration of 7 days or less, dose management and hours of work management. All of these items are to be investigated and mapped into the P6 schedule accordingly, series by series and transition by transition, also critical and parallel operations (e.g. upper feeders).	Schedule Quality	Sudhakar to close out with Justin- 28AUG.	Carried in monetary changes mentioned above for Training (ID114 for Onboarding, and ID121 for Series).	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	405	22-Jul-15	CWP 2183	The Transition Out time should be 1.1 days as opposed to 1 days as indicated on Basis Sheet	DFL - Install	(Jul 22) JV-OPG collaborative team has corrected math error on basis sheet, increasing 1 day duration on Transition Out Basis Sheet to 1.1 days	(Carried in Entry ID 242)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	406	27-Jul-15	CWP 2172	First two channels are at 5.7 hrs each (Includes CP SA Install and East/West Bellows Welding). The next 22 channels are at 5 hrs (Includes East/West Bellows Welding, SA Install in parallel). The next 456 channels are at 3.3 hrs each (Welding is now in parallel along with SA Install). This results in a cumulative TPG base duration of 67.8 days	DFL - Install	(July 28) JV-OPG collaborative team has agreed upon a new TPG base duration (See comment for justification) of 67.8 days. This is a reduction of 4.91 days	(Carried in Entry ID 243)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	407	29-Jul-15	CWP 2177	FME check took about 15 mins during TPG. FME check will require RTP move to 1-100m el and 2-back to target site (10 mins down, 10 mins up = 20 mins) Total estimated time required for FME check on west side is 35 mins. This is longer than the flask change on the east side of 22 + 6 mins = 28 mins. Difference of 7 mins per channel Change from 0 days to 2.3 days. previously this was not added because flask change time was assumed to be 30 mins instead of the new updated time of 22 mins	DFL - Remove/Inspect	(July 29) Addition of 2.3 days to this series. Mutually agreed by JV-OPG collaborative team. See OPG Comment for details	(Carried in Entry ID 347)	$0	Verified Item	Included with ID 347, JV-OPG war room monetization not considered
Basis Sheets	408	29-Jul-15	CWP 2177	new item added due to scratches witnessed caused by the CT Ram. Inspections should take place for first CTs removed to confirm CTSBs are not being damaged during the removal process. 1. HWT move to lattice site 2. S-SPIRT remove TT SP 3. Inspect CTSB with snake eye camera 4. S-SPIRT re-insert TT SP total 1.2 hours per channel - 5 channels - TOTAL: 6 hours	DFL - Remove/Inspect	(July 29) Addition of 0.25 days to this series. Mutually agreed by JV-OPG collaborative team. See OPG Comment for details	(Carried in Entry ID 347)	$0	Verified Item	Included with ID 347, JV-OPG war room monetization not considered
Basis Sheets	409	29-Jul-15	CWP 2180	CTSB conditioning will liberate considerable contamination from the tubesheet. Vault clean-up of 0.5 days (One shift) required to be added	DFL - Remove/Insp	(July 29) Addition of 0.5 days to the series for vault clean-up.Mutually agreed by JV-OPG collaborative team. See OPG Comment for details	(Carried in Entry ID 206)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance
Basis Sheets	410	29-Jul-15	CWP 2180	Bore replication and additional brushing adjustment item added to Basis Sheet. Required to satisfy reactor eng requirements	DFL - Remove/Insp	(July 29) Addition of 0.8 days to the series for these requirements to satisfy reactor engineering. Mutually agreed by JV-OPG collaborative team. See OPG Comment for details	(Carried in Entry ID 206)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	411	28-Jul-15	CWP 2175	During collaborative review, arithmetic error was found in the base TPG duration. Should be 4.1 days, not 4.9 days	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team correct mathematical error from 4.9 days to 4.1 days	(Carried in Entry ID 228)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	412	29-Jul-15	CWP 2176	Arithmetic error present in calculation of base duration - should be 25 hrs (1.04 hrs) instead of 2.5 days	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team corrected mathematical error from 2.5 days to 1.04 days. Reduction of 1.46 days	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	413	29-Jul-15	CWP 2176	Requirement for placing CTI Removal tool in shipping configuration was added as an adjustment item of 0.4 days	DFL - Remove/Inspect	(July 29) JV-OPG collaborative team added new adjustment item of 0.4 days. See OPG Comment	(Carried in Entry ID 218)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Basis Sheets	414	28-Jul-15	CWP 2164	Previous R0 duration of 2.63 days for this basis sheet did not include scope added to this series since the TPG. Such additional scope items are removing seal caps, silflex, spraying CRC etc. (See revised Basis Sheet for complete list). This resulted in an increase of 2.03 days to a new duration of 4.56 days	DFL - Remove/Inspect	(July 28) JV-OPG collaborative team increased TPG base duration by 2.03 days (See OPG Comment)	The price shown in inclusive of all changes for this CWP	($54,702)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
DFL/Parallel Path	415	30-Jul-15	CWP 2145	Remove the bump shift . No Sub foreman utilised for the boilermakers or the labours which can reduce the number of foreman required and cost.	DFL - Feeders	07AUG2015: JV and OPG agreed to remove the bumpshift. 27AUG: OPG JV Agreement to use 1 Subforeman per quadrant (4 total) and 1 Floreman for overall Upper Feeder Installation.	Includes all monetary changes within this CWP	($19,045,675)	Verified Item	Cost matching the record. Bump factor removed. Cost reduction include other items related to CWP 2145.Cost reduced as agreed (in column-AK)
DFL/Parallel Path	416	30-Jul-15	CWP 0010	EF DR: 40 per 24 hours shift (TPG: 36 per 24 hour shift) no bump shift included	Waste/Volume Reduction	07AUG2015: No changes required as part of the Parallel Path DFL Investigation.	(Carried in Entry ID 52)	$0	Verified Item	Included with ID: 52
DFL/Parallel Path	417	30-Jul-15	CWP 2201	remove bump shift	DFL - Feeders	07AUG2015: No changes required as part of the Parallel Path DFL Investigation. Agreed to keep Bump Shift.	(Carried in Entry ID 471)	$0	Verified Item	Removed bump shift Refer to ID# 471
DFL/Parallel Path	418	30-Jul-15	CWP 2143	factors 1200x being removed if statements to be moved to risk foreman to be crewed by time	DFL - Feeders	07AUG2015: No changes required as part of the Parallel Path DFL Investigation. Covered in other comments in Change Log (#418).	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
DFL/Parallel Path	419	30-Jul-15	CWP 2150	Remove bump shift Supervision - crewing - can they schedule by time	DFL - Feeders	07AUG2015: No changes required as part of the Parallel Path DFL Investigation. Agreed to keep Bump Shift.	Includes all monetary changes within this CWP	($2,291,507)	Verified Item	Removed bump shift, however the JV OPG meeting decision to keep the bump shift on some activities.
DFL/Parallel Path	420	30-Jul-15	CWP 2144	remove bump shift H dimension is rework ID buildup is as-found condition risks moved out to risk/contingency	DFL - Feeders	07AUG2015: No changes required as part of the Parallel Path DFL Investigation. Covered in other comments in Change Log (#157).	(Carried in Entry ID 157)	$0	Verified Item	Reference Entry ID 157
DFL/Parallel Path	421	30-Jul-15	CWP 2121	remove bump operation and maintenance on 7 x 24 x 2 people - common crew, remove from task-based estimates	DFL - TMODS (Pre&Post)	07AUG2015: No changes required as part of the Parallel Path DFL Investigation. Covered in other comments in Change Log (#142).	Carried in ID142.	$0	Verified Item	Bump factor removed. Reference Entry ID 142 for additional comments on CP 2121
DFL/Parallel Path	422	30-Jul-15	CWP 2189	factors 1200x being removed if statements to be moved to risk foreman to be crewed by time	DFL - Feeders	07AUG2015: No changes required as part of the Parallel Path DFL Investigation. Covered in other comments in Change Log (#422).	(Carried in Entry ID 152)	$0	Verified Item	No change required.
Chapter Report	423	22-Jul-15	Tool Management	Offsite contaminated maintenance facility footprint to be increased from 1000sqft to 2000sqft during peak times. The space that is secured to perform maintenance work is not a large area and the consensus is that 2000sqft would be more adequate during certain times of high activity.	Tooling	July 29 - JV and OPG agree on the increase of footprint from 1000sqft to 2000 sqft in certain periods of time in the offsite contaminated storage resulting in an increase of $2,497,160. 2015-08-18: Final monetizations based on latest schedule shows an increase of 1870592 and not 2497160 as was agreed upon during the Draft monetization exercise.	The JV has come to an agreement with OPG that this increase in footprint is highly recommended and will be required to perform the necessary work at the offsite maintenance facility. Cost Carried in ID9.	$0	Verified Item	Reference Entry ID 9
Chapter Report	424	22-Jul-15	Tool Management	Re-calibration of FARO Laser trackers not included in Rev 0 of the estimate.	Tooling	July 29 - JV and OPG agree on the addition of cost of recalibration of the FARO laser trackers. This cost is calculated at $8500 per calibration plus $1500 for shipment. There are a total of 7 trackers that will need to be recalibrated annually. Over a 10 year period that is a total of $700,000 2015-08-18: Monetization included in Entry ID 25	The JV will include the cost of recalibration of the FARO laser trackers on an annual basis during execution. This includes the cost to ship the Laser trackers to FARO in the US , recalibration and receipt back at site. Cost Carried in ID9.	$0	Verified Item	Cost increased , refer to ID#9. need validation.

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Chapter Report	425	31-Jul-15	PMT	**3PEP Comment:** Overall the PMT appears to be robust in size. All critical areas appear covered and the position descriptions provide good detail. There are a number of positions in the PMT where the value added is not apparent. For example: (1) From the position description, it does not appear the Risk Manager will demand a FTE, especially if the project risk register is mature before the project starts. It is not clear why the responsibilities of this position could not be combined with another senior manager, perhaps Project Controls Manager. Why is a dedicated Risk Manager required? (3) Under the Construction Support organization, two CSS techs per shift are shown for both feeders and fuel channels. On past projects, often we would have only one tech (acting as alternate series lead) on each shift. Why two CSS techs per shift?	PMT	30JUL: (1) OPG and JV to investigate revision of allowed costs to allow back office staff to assume fractional duties. Currently, this is not allowed as per cost allocation table and would allow some reductions in the PMT Organization. JV/OPG July 28 - Senior management to provide direction on this item. 29JUL MGMT: OPG position is that all PMT Positions should be estimated based on required effort, and then number of positions or "FTEs" required should be determined based on the required effort afterwards. 07AUG: JV agrees to re-estimate based on the ability to use back office staff to assume fractional duties where possible with the exception of IT Staff. NOT INCLUDED IN DRAFT MONETIZATION AT THIS TIME DUE TO COMPLEXITY. CHANGE SIGNED AND AGREED. (3): JV clarified that 1 CSS Tech is required for current series, second for upcoming series.CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
Chapter Report	426	31-Jul-15	PMT	**3PEP Comment:** (1) Why two reactor component engineers on shift when all that is going on is feeder/tubing install? (2) Why is there a "CSS Tech MODS on night shift during feeder installation? (3) Why is there a "CSS Tech Fuel Channel" during feeder install? (4) Is there really a need for a tooling engineer during feeder install? Feeder install tools are mostly manual/conventional with the exception of the welding machines (some are custom) in which case a tooling engineer may not be more helpful than a tool tech.	PMT	(1) 29JUL- according to Steve Rate ~2 month lag is included after the series ends to allow closeout of the work packages, Steve will go back and validate length of the lag (in OPG's opinion this should be in the order of 2 weeks, as opposed to 2 months) (Steve) 31JUL: Steve: The engineers indicated on Figure 2 are Fuel Channel & Feeder Engineers and as defined in the roles and responsibilities section these engineers are responsible for feeder install series- NO CHANGE REQUIRED. CHANGE SIGNED AND AGREED, (2)- JV to confirm schedule and remove if resource is actually involved during Feeder Installation on night shift (Sebastian), 31JUL: REQUIRED FOR DOCUMENTATION CLEAN UP. No changes required. CHANGE SIGNED AND AGREED. (3)- Required because PT Removal, and Upper Feeder Removal is being completed in parallel. NO CHANGE REQUIRED. CHANGE SIGNED AND AGREED (4)- Likely supposed to be "Welding Engineer" editorial mistake (Sebastian/Steve Rate). 31JUL: THIS POSITION IS NOT RELATED TO THE FEEDER INSTALL CAMPAIGN. PART OF TOOL MANAGEMENT. No change required. CHANGE SIGNED AND AGREED.	(Carried in Entry ID 359)	$0	Verified Item	Included in ID: 359
CWP Estimate	427	31-Jul-15	CWP 2148	Duplication exists between the CWP2148 Estimated Labour and the Subcontract for this work It appears that Insulator Trades tasks need to be removed from CWP Estimate as they are currently double counted.	DFL - TMODS (Pre&Post)	31JUL: Agreed. Insulator Trades Tasks to be removed from the CWP2148 Estimate. Subcontracts Estimate will be unchanged.	Includes all monetary changes within this CWP	$0	Verified Item	Reference Entry ID 526
CWP Estimate	428	31-Jul-15	CWP 2105	Duplication exists between the CWP2105 Estimated Labour and Subcontract for this work. It appears that Sheetmetal Trades tasks need to be removed from CWP Estimate as they are currently double counted.	Subcontracts	31JUL: Agreed. Sheetmetal Trades Tasks to be removed from CWP2105 Estimate. Subcontracts Estimate will be unchanged.	Includes all monetary changes within this CWP	($182,385)	Verified Item	Changes implemented.
CWP Estimate	429	31-Jul-15	CWP 2108	Duplication exists between the CWP2108 Estimated Labour and Subcontract for this work. It appears that Sheetmetal Trades tasks need to be removed from CWP Estimate as they are currently double counted.	Subcontracts	31JUL: Agreed. Sheetmetal Trades Tasks to be removed from CWP2108 Estimate. Subcontracts Estimate will be unchanged.	Includes all monetary changes within this CWP	($107,379)	Verified Item	Changes implemented.
Subcontracts	430	31-Jul-15	N/A	The Subcontract for "WTS Ductwork to Exhaust Header (Quote Lancaster (S/M)" covers scope that is part of the Tooling Fixed Price Contract and should be removed from the Subcontracts Estimate.	Subcontracts	31JUL: Agreed. Cost to be removed from the Subcontract Estimate. 05AUG Management Review: Disagree, Subcontracts Estimate to be left as is with no changes from R00 for this portion.	(Carried in Entry ID 446)	$0	Verified Item	Reference Entry ID 446
Subcontracts	431	31-Jul-15	CWP 2066	The Subcontract to Superheat FGH for CWP2066 should be reduced to a total of $172,000 (the actual quoted figure) to remove amounts for Training and Miscellaneous costs that are currently incorporated with no basis.	Subcontracts	31JUL: Agreed. Change will be made as described.	Includes all monetary changes within this CWP	($203,396)	Verified Item	Changes implemented.
Subcontracts	432	31-Jul-15	CWP 2237	The Subcontract to Superheat FGH for CWP2237 should be reduced to a total of $43,000 to remove amounts for Training and Miscellaneous costs that are currently incorporated with no basis.	Subcontracts	31JUL: Agreed. Change will be made as described.	Includes all monetary changes within this CWP	($146,719)	Verified Item	Changes implemented.
Subcontracts	433	31-Jul-15	N/A	The Subcontract Estimates for NDE/Phased Array are Time and Materials based. Durations assumed in the Subcontract Estimates will have to be revised to match any changes made in the Basis Sheets following completion of those reviews.	Subcontracts	31JUL: Agreed, upon finalization of the Basis Sheet durations, changes will be made as required.	(Carried in Entry ID 446)	$0	Verified Item	Reference Entry ID 446
Subcontracts	434	31-Jul-15	N/A	Senior Management to review through the Special Initiatives List the feasibility of RWPB Demolition.	Subcontracts	31JUL: Management to review and add to the Special Initiatives list if they see fit. 21AUG: MGMT Input is that for now, RWPB Demolition is to remain part of the Estimate. This may be re-visited down the road, but for now we must plan on taking the building down at the end of the project.	(Carried in Entry ID 446)	$0	Verified Item	Reference Entry ID 446
Subcontracts	435	31-Jul-15	N/A	In addition to changes documented above, Subcontracts Rev 00 Submission totaled $85,328,759 and Rev 00' A Submission totaled $72,896,752. Specific changes are documented in attached documentation. All changes from Rev 00 to Rev 00' A must be made as well.	Subcontracts	31JUL: Agreed. Change will be made as described. 06AUG: The main changes made contributing to the differences between R00, and R00"A are documented in the attached document and are predominately related to receipt of quotations/updated quotations.	(Carried in Entry ID 446)	$0	Verified Item	Reference Entry ID 446
Chapter Report	436	31-Jul-15	Owner Specified Materials and Goods	"Scopes of Work defined by OPG Letters NK38-CORR-09701-0452061 and NK38-CORR-09701-0480385 are not included in the Estimate for Units 1, 3 and 4." Please clarify, should this scope not be included in the Preparations for Subsequent Units Chapter Report?	OSM & Goods	This wording is to be revised/removed from OSM & Goods chapter as the scope is covered under Engineering in Preparation for Subsequent Units.	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	437	31-Jul-15	Preparations for Subsequent Units	Appendix C: CWPs: Potential duplication of item for lift plans (#22 and #6). Should be included in item 6.	Subsequent Units	August 8: will remove JSA, HHA and Lift Plans from item #6 from Appendix C. No changes to hours.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	438	31-Jul-15	Preparations for Subsequent Units	Appendix C: CWPs: OPG review will be performed on CWPs prior to issue for next unit.	Subsequent Units	This is a JV estimate. It does not capture OPG effort. However, effort to incorporate OPG comments is captured in this estimate.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	439	31-Jul-15	Preparations for Subsequent Units	In the "Subsequent Units Engineering" Organization Chart it is shown that all resources are in Oakville. Please clarify why this is the case. Why is this team not located at site.	Subsequent Units	There is efficiency for initial setup as computer in Oakville are already setup with modelling software, offices areas and reference documentation already in place. Furthermore, staff working in Oakville office are not entitled to expenses allowing for further savings.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	440	31-Jul-15	Owner Specified Materials and Goods	Kone Cranes spare parts should be in the "Goods" section. These are spare parts to be supplied by Kone for two vault cranes to complete repairs in the event of a breakdown. Please consider moving. Additionally, please verify if this cost is incurred regardless of whether or not service is used.	OSM & Goods	AUG 5 JV agrees to move this into Goods section..	(Carried in Entry ID 392)	$0	Verified Item	Reference Entry ID 392
Chapter Report	441	31-Jul-15	Owner Specified Materials and Goods	Details regarding the change from Nu-Tech to GEH-C as the supplier for Fuel Channel Pressure Tubes is required. Clarification is required regarding justification for this change. A risk exists with using GEH-C as the supplier as they have never manufactured a PT before.	OSM & Goods	Recommendation to award presented to OPG stated GE pressure tube, with risk mitigation awarding to both suppliers. OPG approved recommendation. If OPG would like to switch to Nu-Tech as preferred supplier, OPG to provide direction in official letter.	(Carried in Entry ID 392)	$0	Verified Item	Includes with ID: 392
Chapter Report	442	31-Jul-15	Owner Specified Materials and Goods	Please clarify how materials being procured for contingency are separated from the baseline materials required to complete the work. Separation is important to ensure that you are not left with excess material at the end of the outage. What forms the basis for the order quantities for contingency materials included in this chapter? OPG needs to see the basis and strategy before accepting this Chapter Report.	OSM & Goods	Aug 5th. JV contingency material has not been quantified or procured.	(Carried in Entry ID 392)	$0	Verified Item	Includes with ID: 392
Chapter Report	443	31-Jul-15	Owner Specified Materials and Goods	There are several DECs that have been identified as OSM which the team does not believe should be. Please review and revise the list as required. Examples include 123402, 123404, 123336, 123337 etc.	OSM & Goods	DEC's have been reviewed with engineering and will be removed. JV to provide the latest DEC list and inform OPG which PCDs are included in the OSM/Goods. Aug 5. JV confirms any current signed PCD's currently in the JV space, that would effect any design modifications are currently in our design packages and are reflected in out current eqr's.	(Carried in Entry ID 392)	$0	Verified Item	Includes with ID: 392
Series and Onboarding Training DD	444	4-Aug-15	Training - Onboarding	Include Comments from JV Change Log.	Training	Increased electrician allowance for Fire Watch to 50%. (648 hrs - $45,750 increase) Corrected Sum Formula for PMT to include columns AQ to AU and Requal Cycles for SLN QA Program Requirements. (9188 hrs - $735,040 increase) Added Operator SF, Painter SF and Insulator SF applicable requalification and initial training hours. (18,768 hrs - $1,318,666 increase)	(Carried in Entry ID 114)	$0	Verified Item	Reference Entry ID 114
Basis Sheets	445	4-Aug-15	CWP 2168	There is a new requirement to link the corresponding waste processing activities to the series in P6. In addition, basis sheets will need to be created for all waste processing series	DFL - Remove/Inspect	(Aug 4) JV-OPG collaborative team, through discussion with management, determined that the waste processing activities for EF/PT/CT/CTI Removal need to be linked to their corresponding series in the R01 P6 schedule. In addition, basis sheet for Waste series have been created.	(Carried in Entry ID 232)	$0	Verified Item	included in id 232, cost adjustments shown
Subcontracts	446	6-Aug-15	Subcontracts	See Comment #133 in Change Log. What volume of laundry is expected (suits, rad. PPE)? This needs to be determined.	Subcontracts	JV to calculate RPPE requirements (including training) and send to OPG as submittal. JV agrees. July 27- RPPE including suits for training only will be quantified in the training series Chapter and be based on the Alara chapter per series or task requirements. The base principle will be to issue a suit per trainee for the duration of the training series, (cleaned as required with Alcohol wipes) and once the series is over send out for full laundering. Enough suits to be ordered to have a full set at the DEC in use the same quantity being cleaned and some spares on hand. There is still the issue of the use of a training suit to be resolved concerning the laundering of the as this was discussed. July 30: Bob to estimate number of suits and requirements for number of suits for training will be incorporated in the series training chapter. Cost of suits will go under OSM and Goods, and cost for laundering will go under subcontractor. August 20: Cost Estimate for laundering suits added.	This includes the Subcontractor savings for TMO of $8,884,834 and CWP Subcontractors of $11,741,342	($20,626,176)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Chapter Report	447	5-Aug-15	Preparations for Subsequent Units	Please include cost savings associated with all these opportunities. Action JV to incorporate cost estimates into Chapter.	Subsequent Units	July 27: Refer to Opportunities section (2.1.1.8) of the chapter report: First Bullet - No action required. Preparation of MECs by the JV to be removed - See comment 381. Second and Third bullet -This scope was not part of CL2 R0 submission. For the R1, it being added to OSM & Goods chapter. A similar reduction process was applied to this scope as the engineering portion of the subsequent units chapter. Fourth bullet - JV to estimate preparing separate DECs for subsequent units at the same time. (3 DEC's for each mod, but prepared at the same time). Cam MacLeod is OK with funding release for future units as soon as engineering work is complete. Fifth bullet - As per OPG request, an Open Market procurement strategy was used.	(Carried in Entry ID 390)	$0	Verified Item	Includes with ID: 390
Chapter Report	448	5-Aug-15	Owner Specified Materials and Goods	JV to investigate whether expanded market (for OSM)/Strategic Partnership (Goods) can lower the cost of procurement.	OSM & Goods	5% reduction has been agreed upon for OSM (expanded market). 1.5 % reduction has been agreed upon for Goods (strategic partnership)	(Carried in Entry ID 392)	$0	Verified Item	Reference entry 392
Chapter Report	449	5-Aug-15	Owner Specified Materials and Goods	JV to update the build up to include latest engineering input (EQR, DBOMs). Include the cost of LLW.	OSM & Goods	This has been complete.	(Carried in Entry ID 392)	$0	Verified Item	Reference entry 392
Pre-Req	450	7-Aug-15	Pre-Req	Reduce vault crane PM by replacing wire rope with new in preceding outage. Estimated Savings 2.5 day's firm for each unit for last three units, 2.5 days possible on first unit if work can be planned into vacuum building outage of 2015. (total of 7.5 firm excluding productivity factors, and 2.5 with a reduced probability.).	Special Initiatives	August 20: For R1 estimate this schedule reduction is going to be applied to the last three RFR Units.	No cost impact. Schedule impact only.	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Pre-Req	451	7-Aug-15	Pre-Req	Cut up FM Ballscrews to for faster removal OPG has requested the FM ballscrews be taken out full length. Since the ballscrews are considerably longer than the airlocks, their removal from the vault has to be delayed until after unit isolation. More problematic however is that to drive the screws out of the elevator nuts, the top end of the ballscrews will protrude into the feeder cabinet requiring removal of panels, which are needed in place for vacuum drying.	Special Initiatives	August 20: Estimate review team response. Doug Fertile, Rick Pettet, Jeff Palmateer The consensus is that cutting the ball screws has too high a risk factor to increase time due Hot Work mitigation. Currently strong back tooling design modifications are in progress which will improve removal duration. A one day reduction (per Unit) is being applied to R1 estimate.	Change Captured in Rev 1. Schedule Impact Only.	$0	Verified by OPG Scheduling	
Pre-Req	452	7-Aug-15	Pre-Req	Do not replace feeder cabinet panels A scoping decision was made by OPG to "replace all insulation in the feeder cabinet", other than that which is directly on the insulated frame pieces which are not removed. This was based on OPEX from Bruce that indicated a deterioration of the insulation.	Special Initiatives	August 20: Reduction in OSM and labour is being applied to all RFR Units. The reduction is based on only removing feeder cabinet structures needed for feeder replacement and then re-installing the same panels. Damaged items would be repaired / replaced as well as replacing all reactor face "jig saw" panels.There is no critical path savings associated with this change.	No Cost Impact. This Special Initiative has been cancelled, but was included in R01 and could not be removed before submission. This item has been added to the Rev 1 Errata List.	$0	Verified Item	There is no cost impact. Reference OPG-JV meeting notes
Pre-Req	453	7-Aug-15	Pre-Req	Delete the trial run of the 10 CTSB refurbishments followed by immediate CT installation, on last three units. The current Candu T5 for calandria tube sheet refurbishment, calls for completing 10 refurbishments followed by full installation of the calandria tubes including leak testing prior to continuing with the refurbishment of the remaining 950 tube sheet bores. These results in very inefficient processing with additional equipment transitions in and out that would otherwise not be required.	Special Initiatives	August 20: For R1 estimate this schedule reduction is going to be applied to the last three RFR Units.	Cost Carried in Item #206	$0	Verified Item	Included in CWP 2180
Post-Req	454	7-Aug-15	Post-Req	Re-sequence new fuel loading process Loading of fresh fuel is subject to appropriate safeguards security controls following IAEA guidelines and CSNC regulations. This means that in the act of loading fuel, a careful inventory is kept of location of all bundles, and when left unattended, there are barriers in place to prevent a loss of control. Traditionally on new fuel load, the placement of shield plugs and closure plugs in both ends of a channel containing fuel has been accepted as meeting the safeguards requirement, allowing an unattended state for the fuel. There is however other means that could be used to meet the requirements. The traditional practice requires an inefficient process of loading fuel from one work table, shifting the work tables over, and one closure plug and shield plug from the other table after the far side has installed plugs, before moving to the next channel. Thus there is significant time spent in work table logistics and end to end coordination.	Special Initiatives	August 20: For R1 estimate this schedule reduction is going to be applied to the all RFR Units.	No cost impact. Schedule impact only.	$0	Verified Item	Schedule impact only

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
Pre-Req	455	7-Aug-15	Pre-Req	Eliminate use of shielding plates on the bulkhead The shielding plates require 27 days on the critical path for installation and removal. Their purpose is to allow free transit of the FM trolley holding irradiated fuel under the bulkhead. During normal outages when reactor maintenance work is underway, a standard protocol is used to lock out the transit of the FM under the unit under maintenance, and evacuation protocol used to release the lock out and allow the trolley to run under unit. An actual time to conduct the verification of evacuation, and release the lock out, transit the trolley, and re-establish the lock out should be achievable in under2 hours based on OPEX from normal outages requiring reactor maintenance work. Given the high critical path time required to install and remove the shielding, not to mention the worker exposure that will realized, savings in critical path time and worker exposure might be achieved if the number of times the trolley needs to transit under the RFR unit is minimized, and evacuation of the RFR vault did not commence until the FM trolley was at the lock out hold point on the rails.	Special Initiatives	August 20: There are a high number of stakeholders that would need to approve. This change will not be included in the R1 estimate.	**No Cost Impact.**	$0	Verified Item	R1 estimate does not include changes. No cost impact at Rev 1.
Pre-Req	456	7-Aug-15	Pre-Req	Eliminate LT inspection and TS to TS measurement at every lattice site The current plan for the "Lattice Tube and Bellows Inspection Series", actually includes two series within running from two different work tables on each face at the same time. One table conducts a close visual examination of the lattice tube, and an end to end measurement of the distance between the E and W CSTS at every lattice site. The other table supports a manual crew conducting an inspection of the bellows and preparation of the weld surface for later welding. When each table is finished half the reactor, one table is lifted over the other and the remaining half completed. There is no justification to conduct the close examination of the lattice tube, as Darlington has not been subjected to any leaks into the AGS system, the thumb tack protects 90 % of the surface, and the remaining exposed area is planned to be inspected during the CSTB refurbishment series. There is no known active failure mechanism for the lattice tubes. The only OPEX related issue is two leaking welds on the C6 plants. The Darlington lattice tubes do not have these welds. In addition the final FME check of the lattice tube is done after the just before the new end fitting is installed. There is also no justification for conducting an end-to-end measurement on every lattice site involving high strength beams and complex triangulation methods using tracking lasers. The distance across every lattice position was measured during the original installation and can be found in the History Dockets. Any changes in position of the highly rigid end shields will be found in other measurements done just before CT installation, and interpolation of the change to every lattice site used to adjust the original numbers. Elimination of the LT inspect, and TS to TS measurements on every lattice site also eliminates the second table from this series, which can then be dedicated to duplicating the set up for Bellows Inspection and thus cut this series down by at least half.	Special Initiatives	August 20: This change is being included in the R1 estimate for all RFR Units.	**Cost Carried in Item #525**	$0	Verified Item	No Cost impact; Based on meeting; This change is being included in the R1 estimate for all RFR Units.
Pre-Req	457	7-Aug-15	General	Re-use cantilever supports The cantilever supports for the lower feeders on Darlington are the most robust and complex of any made to date on Candu units. There is no failure mechanism known. The supports are bolted to the end shields, unlike the Candu 6 plants that are welded. Thus they can be removed without requiring a TMOD to the reactor.	Special Initiatives	August 20: This change is being included in the R1 estimate for all RFR Units.	**No Cost Impact. Special Initiative Cancelled.**	$0	Verified Item	OPG-JV Meeting notes: No Cost impact
Removal/ Installation	458	7-Aug-15	General	Re-use Positioning Assemblies Rather than buy new PA hardware is NOT anticipated to have deteriorated in service.	Special Initiatives	August 20: This change is being included in the R1 estimate for all RFR Units.	**No Cost Impact. Special Initiative Cancelled.**	$0	Verified Item	OPG-JV Meeting notes: No Cost impact
Pre-Req	459	7-Aug-15	Pre-Req	Deletion of Manual Dummy Bundle removal series, by removing two dummy bundles per channel using flow defueling during the defueling operation. Removal of two dummy bundles from pressure tubes containing DBs, is required prior to the pressure tube cutting and removal operation. Currently that is planned to happen on approximately 124 channels over a 9 day series, on the reactor face with workers present.	Special Initiatives	August 20: Confirmation / agreement from stake holders was not obtained. This change will not be included in R1 estimate.	**No Cost Impact.**	$0	Verified Item	Agreed that; the change will not be included in R1 estimate
DFL/Parallel Pat	460	11-Aug-15	CWP 2171	Remove walk time-- Clean room is located in the warehouse	DFL - Install	07AUG: JV and OPG agreed to remove the walk time. The shift will be 4 on 4 off days only 10hrs per shift.	**This line item includes all monetary changes associated with this CWP.**	$538,450	Verified Item	The cost summary is matching the record. Multiplier has been corrected, and Walk factor have been removed causing additional cost.
DFL/Parallel Pat	461	11-Aug-15	CWP 2228	Remove these hours as contingency hours only.	DFL - Remove/Inspect	07AUG: JV and OPG agreed- Hours to be moved to risk only.	**This line item includes all monetary changes associated with this CWP.**	($3,452,394)	Verified Item	Deleted from Scope Of Work
DFL/Parallel Pat	462	11-Aug-15	CWP 2080	942 task estimate file multiple hours included for pre-post job, signon/signoff rep/permit, etc. 605 hours carried for all pre-jobs/post jobs, rep sign-on/off, permit sign-on/off - remove, develop crew across these packages to resolve this crew estimate to understand how workers/sub-foreman/foreman working on this package can also work on multiple packages what is the basis of the time estimates (included/excluded/basis)	DFL - Parallel Path	07AUG: JV and OPG agreed that this standard action is being completed in all CWPs. **No change to cost**	**Captured under ID 99**	$0	Verified Item	Reference Entry ID 99
DFL/Parallel Pat	463	11-Aug-15	CWP 2054	56.07 of 5496 hours for pre/post job, signon to rep/permits, >10% of estimated time, is this reasonable? crew estimate to understand how workers/sub-foreman/foreman working on this package can also work on multiple packages what is the basis of the time estimates (included/excluded/basis) Revise Prejob and post job hours	DFL - Parallel Path	07AUG: JV and OPG agreed that this standard action is being completed in all CWPs. **No change to Cost**	**Captured under ID 99**	$0	Verified Item	OPG-JV war room monetization not available, no change to the estimate at this time except for the rate increase (Holidays). Estimated cost is increased by $23.54K for all units. The increased amount is entered in the CWPs changes to Rev-01
DFL/Parallel Pat	464	11-Aug-15	CWP 2196	Remove Bump	DFL - Feeders	07AUG: JV/OPG Agreement to remove Bump Shift.	**Includes all monetary changes within this CWP**	($57,217)	Verified Item	Removed bump shift
DFL/Parallel Pat	465	11-Aug-15	CWP 2174	Contingency? - Remove? Remove these hours as contingency hours only.	DFL - Remove/Inspect	07AUG: Agreed- JV and OPG agreed to remove hours. Check if hours moved to risk only.	**Deleted from scope of work**	($192,510)	Verified Item	Deleted from Scope Of Work
Chapter Report	466	12-Aug-15	PMT	The current PMT Organization does not incorporate a FARO Technician. FARO Technicians should be added to the "Construction Support" organization as their own "branch" reporting directly to the Construction Support Services Manager. Full time coverage for the duration of the project will be required. It is suggested that 4 FARO Technicians and 1 FARO Technician Lead be added to provide 24 hour/day 7 day/week coverage (1 Technician on every shift, and 1 Lead on 1 shift capable of covering vacation/sick days of any of the 4 Technicians as required). Resource sharing with other projects (i.e. TGR) should be considered for these positions, as a FARO Technician will be required for TGR as well.	PMT	06AUG: Change agreed to at the WAR Room Level. 2496hrs x 505/hrx 5 resources x 9 years (project duration, 2017-2025). CHANGE SIGNED AND AGREED.	**(Carried in Entry ID 359)**	$0	Verified Item	Included in ID: 359
Chapter Report	467	13-Aug-15	Demobilization and Closeout	Section 4. Estimated cost of $4.5M just for the decontamination (not demolition) of the RWPB. Appears high to include some uncertainties about level of expected contamination. Has this estimate been benchmarked?	Other (CL2 Chapters)	This comment has been reviewed by the OPG-JV WAR Room Team and agreement has been reached that the basis of the Estimate for RWPB Decontamination is satisfactory for Class II Rev 1. **No Cost Impact**	**No Cost Impact**	$0	Verified Item	There is no impact on cost
Chapter Report	468	13-Aug-15	DFL - Summary	Review NPA for potential changes to the union agreement that will affect the estimate.	Other (CL2 Chapters)	This comment has been reviewed by the OPG-JV WAR Room Team and is not believed to have any impact on the estimate.	**No Cost Impact**	$0	Verified Item	There is no impact on cost
Chapter Report	469	13-Aug-15	All Chapters	Remove risk tables and scope control change items from chapter reports	Other (CL2 Chapters)	OPG-JV Agreement to implement changes. **No Cost Impact**	**No Cost Impact**	$0	Verified Item	There is no impact on cost
CWP Estimate	470	15-Aug-15	CWP 2201	The time to perform weld sample testing was not included in CWP estimate. Requires approx. $100k per Unit of additional cost	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	**(Carried in Entry ID 471)**	$0	Verified Item	Removed bump shift
CWP Estimate	471	15-Aug-15	CWP 2201	Remove bump shift	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	**Includes all monetary changes within this CWP**	($3,413,587)	Verified Item	Removed bump shift
Chapter Report	472	23-Jul-15	Preparations for Subsequent Units	Please include cost savings associated with all these opportunities. Action JV to incorporate cost estimates into Chapter.	Subsequent Units	July 27: Refer to Opportunities section (2.1.1.8) of the chapter report: First Bullet - No action required. Preparation of MECs by the JV to be removed - See comment 381. Second and Third bullet -This scope was not part of CL2 R0 submission. For the R1, it being added to OSM & Goods chapter. A similar reduction process was applied to this scope as the engineering portion of the subsequent units chapter. Fourth bullet - JV to estimate preparing separate DECs for subsequent units at the same time. (3 DEC's for each mod, but prepared at the same time). Cam Macleod is OK with funding release for future units as soon as engineering work is complete. Fifth bullet - As per OPG request, an Open Market procurement strategy was used. Repeat Comment. See #447.	**(Carried in Entry ID 390)**	$0	Verified Item	Includes with ID: 390
Chapter Report	473	5-Aug-15	Owner Specified Materials and Goods	JV to investigate whether expanded market (for OSM)/Strategic Partnership (Goods) can lower the cost of procurement.	OSM & Goods	5% reduction has been agreed upon for OSM (expanded market). 1.5 % reduction has been agreed upon for Goods (strategic partnership)	**(Carried in Entry ID 392)**	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
Chapter Report	474	5-Aug-15	Owner Specified Materials and Goods	JV to update the build up to include latest engineering input (EQR, DBOMs). Include the cost of LLW.	OSM & Goods	This has been complete.	**(Carried in Entry ID 392)**	$0	Verified Item	No cost impact, This has been complete.
CWP Estimate	475	21-Aug-15	CWP 2145	Removed bump factor from estimate.	DFL - Feeders	Bump factor removed. Agreed between OPG and JV.	**(Carried in Entry ID 415)**	$0	Verified Item	Bump factor removed
CWP Estimate	476	21-Aug-15	CWP 2145	Remove Pre and Post Job activities from DFL.	DFL - Feeders	Pre and Post Job Briefs removed. Agreed between OPG and JV.	**(Carried in Entry ID 415)**	$0	Verified Item	Note implemented; Pre and Post Job Briefs removed.
CWP Estimate	477	21-Aug-15	CWP 2145	DFL change due to schedule reduction (remove re-work tasks- weld repair, surface repair etc…) from basis sheet.	DFL - Feeders	Schedule reduction - refer to Basis Sheet. Agreed between OPG and JV.	**(Carried in Entry ID 415)**	$0	Verified Item	(re-work tasks- weld repair, surface repair etc…) removed from basis sheet.
CWP Estimate	478	21-Aug-15	CWP 2145	50% crew size reduction for Upper Feeder Installation due to revising Installation logistics (i.e. going from Centre to North/South to using the Centre Hoist well to install from North/South towards the centre). 7 personnel required per platform vs 14.	DFL - Feeders	Agreed between OPG and JV.	**(Carried in Entry ID 415)**	$0	Verified Item	Note implemented
CWP Estimate	479	25-Aug-15	CWP 2146	Add additional time for 4 scaffold builts during Lower Feeder Installation	DFL - Feeders	Agreed to additional time for construction the 4 suspended scaffolds required for middle installation	**(Carried in Entry ID 213)**	$0	Verified Item	Comments have been incorporated
CWP Estimate	480	25-Aug-15	CWP 2073	No Change to Rev 01 Except Stat Holiday Rates	DFL - Feeders	Agreed between JV and OPG CWP to be updated to include vendor OMs and Template details.	**No change was made to CWP 2073**	$0	Verified Item	No Cost Impact.
CWP Estimate	481	25-Aug-15	CWP 2074	No Change to Rev 01 Except Stat Holiday Rates	DFL - Feeders	Agreed between JV and OPG CWP to be updated to include vendor OMs and Template details	**No change was made to CWP 2074**	$0	Verified Item	No cost impact.
CWP Estimate	482	25-Aug-15	CWP 2074	Work Platform Fails while at Face requiring manual removal and replacement - identified on basis sheet as a risk	DFL - Feeders	Removed this risk from Basis sheet, as this is a Global Tool Failure Risk. Was a 0-2d consequence with a 10-30% chance of occurrence	**No change was made to CWP 2074**	$0	Verified Item	No cost impact.
CWP Estimate	483	25-Aug-15	CWP 2075	Bump Shift removed from estimate	DFL - Feeders	Agreed between JV and OPG	**This line item includes all monetary changes associated with this CWP.**	($38,219)	Verified Item	Bump Shift removed from estimate

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
CWP Estimate	484	25-Aug-15	CWP 2076	Bump Shift removed from estimate	DFL - Feeders	Agreed between JV and OPG	This line item includes all monetary changes associated with this CWP.	($37,448)	Verified Item	Bump Shift removed from estimate
CWP Estimate	485	25-Aug-15	CWP 2141	Risk - Bolt Breaking with more than 1/8th inch sticking out requiring grinding to pare the bolt back to be flush with the EF flange. Risk does not belong in this Series	DFL - Feeders	Remove this risk from 2141 Basis sheet and transfer to CWP 2142 basis sheet. This aligns with DFL estimate.	(Carried in Entry ID 43)	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
CWP Estimate	486	25-Aug-15	CWP 2141	Risk - If significant dust is present, then a large plume will be created, requiring vacuuming to remove it and possible backout. The schedule impact of this risk can be reduced by the addition of second vacuum (and associated labour)	DFL - Feeders	Agreed to reduce schedule impact consequence from 2-4day to 0-1day	(Carried in Entry ID 43)	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
CWP Estimate	487	25-Aug-15	CWP 2141	Risk - OPEX shows there will be one to two minor D2O egress events during the series - each event will require a stand-down on the platform while the D2O is cleaned up - approx 2 hours each. Consequence of event can be reduced by proper mitigation	DFL - Feeders	Agreed to reduce schedule impact consequence from 0-2day to 0-1day by properly mitigating couplin disconnect (i.e usage of catch containment)	(Carried in Entry ID 43)	$0	Verified Item	OPG-JV war room monetization is not available. Included in the above ID: 43
CWP Estimate	488	25-Aug-15	CWP 2142	Potential savings in critical path duration if lower feeder removal methodology review (i.e. use of an semi-automated cutting tool)	DFL - Feeders	JV & OPG agree to remove the learning curve, we feel it should balance out throughout the series. (B.G/B.C/R.P)	(Carried in Entry ID 161)	$0	Verified Item	This item is to be validated as this is global for "Learning Curve"
CWP Estimate	489	25-Aug-15	CWP 2142	Added cap screw grinding (moved from CWP 2141) - this was for DFL estimate	DFL - Feeders	JV & OPG agree to remove the learning curve, we feel it should balance out throughout the series. (B.G/B.C/R.P)	(Carried in Entry ID 161)	$0	Verified Item	This item is to be validated as this is global for "Learning Curve"
CWP Estimate	490	25-Aug-15	CWP 2142	Risk - Bolt Breaking with more than 1/8th inch sticking out requiring grinding to pare the bolt back to be flush with the EF flange. Risk transferred from 2141 basis sheet to 2142.	DFL - Feeders	Final decision is to delete this risk, and add a day of uncertainty - i.e. increase worst case duration by 1 day. Worst case is now 44 days	(Carried in Entry ID 161)	$0	Verified Item	This item is to be validated, risk items to be reviewed. No cost impact to the base cost.
CWP Estimate	491	25-Aug-15	CWP 2143	Added transition Out of SWA, and packup Tools/Equipment. Added ~$11K from estimate	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	492	25-Aug-15	CWP 2143	Multiplier of 1456 applies to weld prep measurements and inspection i.e. 960 + (248 x 2) = 1456 weld preps. These inspections need to increase from 1200 to 1456 inspections	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	493	25-Aug-15	CWP 2143	Multiplier of 960 applies to feeder hub and flange tasks. Reduced from 1200	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	494	25-Aug-15	CWP 2143	Multiplier of 1208 applies to material handling, internal/external cleaning and inspection. 960 + 248 = 1208 lower feeder pieces	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	495	25-Aug-15	CWP 2143	Multiplier of 12 increased to 80 as shipments (and loading of crates onto truck). Results in receiving 12 feeders per shipment (aligns with Upper Feeder shipments)	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	496	25-Aug-15	CWP 2143	Pre/Post job removed from estimate	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	497	25-Aug-15	CWP 2143	Removed SWA and trans in from estimate	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	498	25-Aug-15	CWP 2143	Added 1 Operating Engineer (OE) for craning and fork lift operations for every hoist task	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	499	25-Aug-15	CWP 2143	Revised estimate multipliers to reflect task based estimate (no monetary change, but makes the estimate easier to follow)	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 286)	$0	Verified Item	Includes with enter ID: 286
CWP Estimate	500	25-Aug-15	CWP 2147	Temporary removal of ducting on the South Side (east and west) of the reactor is required for ease of access to the South side wall panels that require removal. A new TMOD may be required to facilitate this access.	DFL - Feeders	This is required for side panel removal access. OPG/JV agree	(Carried in Entry ID 501)	$0	Verified Item	Includes with enter ID:501
CWP Estimate	501	25-Aug-15	CWP 2147	Large reduction in DFL due to Special Initiative's Team resolution to leave all feeder cabinet panels and frame in place that do not prohibit feeder replacement activities. This includes not replacing frame insulation, and shield tank insulation	DFL - Feeders	Agreed upon - refer to Special Initiatives	Includes all monetary changes within this CWP	($3,416,138)	Verified Item	Changes implemented due to scope change (due to special initiatives) and are entered in the CWPs changes to Rev-01 sheet.
CWP Estimate	502	25-Aug-15	CWP 2148	Temporary removal of ducting on the South Side of the reactor is required for ease of access to the South side wall panels that require removal. A new TMOD may be required to facilitate this access.	DFL - TMOD5 (Pre&Post)	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 427)	$0	Verified Item	Reference Entry ID 526
CWP Estimate	503	25-Aug-15	CWP 2148	Large reduction in DFL due to Special Initiative's Team resolution to leave all feeder cabinet panels and frame in place that do not prohibit feeder replacement activities. This includes not replacing frame insulation, and shield tank insulation	DFL - TMOD5 (Pre&Post)	Agreed upon - refer to Special Initiatives	(Carried in Entry ID 427)	$0	Verified Item	Reference Entry ID 526
CWP Estimate	504	25-Aug-15	CWP 2150	Jurisdictional change (no significant monetary impact). Pipefitters will perform GTA tube bending, not Boilermakers	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 419)	$0	Verified Item	Refer to ID # 419
CWP Estimate	505	25-Aug-15	CWP 2150	Removal of Bump shift	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 419)	$0	Verified Item	Refer to ID # 419
CWP Estimate	506	25-Aug-15	CWP 2189	Removed 11K per Unit from estimate as SWA and transition in of tools/equipment will have already been done for Lower Feeder Prep (2143). Note that 11K was added to Upper Feeder Prep.	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 152)	$0	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Estimate	507	25-Aug-15	CWP 2189	Added 1 Operating Engineer (OE) for craning and fork lift operations for every hoist task.	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 152)	$0	Verified Item	Done
CWP Estimate	508	25-Aug-15	CWP 2189	Revised estimate multipliers to reflect task based estimate. Resulted in crew reduction	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 152)	$0	Verified Item	Done.
CWP Estimate	509	25-Aug-15	CWP 2189	Removed walk factor from estimate	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 152)	$0	Verified Item	Walk factor has been removed.
CWP Estimate	510	25-Aug-15	CWP 2196	JV requests clarity of Feeder Scanner Drive Assembly storage location. Construction prefers that OPG removes the Scanner drive from the X Track and safely stores for re-use. Construction will cover the remaining X drive assembly for protection during other Removal/Install activities	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 464)	$0	Verified Item	Removed bump shift
CWP Estimate	511	25-Aug-15	CWP 2196	Removed bump shift from Feeder Scanner removal	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	(Carried in Entry ID 464)	$0	Verified Item	Removed bump shift
CWP Estimate	512	25-Aug-15	CWP 2197	Constructions requests that OPG re-install the Scanner Drive Assembly once the Feeder Cabinet has been fully re-installed.	DFL - Feeders	OPG/JV IN AGREEMENT WITH CHANGE/COMMENT	No Cost Impact.	$0	Verified Item	OPG-JV war room monetization not available, no change to the estimate at this time except for the rate increase (Holidays). Estimated cost is increased by $2.34K for all units. The increased amount is entered in the CWPs changes to Rev-01
Chapter Report	513	27-Aug-15	Contracts/Commercial	PMT Overtime multiplier-There is an error on how they calculated the hourly blended rate for Non-Trade. Overtime hours multiplied by 1.5 factor, instead of using the Overtime rate in Exhibit 1.1(fffffff) – Rate Tables which are based on 1.5 multiplier applies only to base rate (excluding burdens). For example (but not limited to); Based on the agreement; Mechanical Engineer- Normal rate is: $112.8 per hour. Mechanical Engineer- OT-1.5 rate is: $115.2 per hour. JV calculation for overtime multiplier generated from = Total Normal Hours (3932 hr's) + 1.5 x Total OT Hour's (328) /Total working hours (4260 Hr's). The multiplier factor is 1.038498 and the blended rate used is $117.143 per hr (= $112.8 x 1.038498). Based On the agreement rate; Normal Hr's should be multiplied by normal rate $112.8 per hr. OT rate will be multiplied by $115.2 per hr. After dividing the hour's summation by total working hours; the average blended rate is $112.98 per hr. Saving in this discipline only (Mechanical Engineer) with total hours (2,375,660 hr's) will be $2.3M.	Contracts/Commercial	Once JV assessment complete and meeting with OPG estimating results in agreed impact, result will be added to R01 Submission as part of Error/Errata line item adjustment.	No Cost Impact until Post R1.	$0	Verified Item	No cost impact until Post R1
Chapter Report	514	27-Aug-15	Contracts/Commercial	JV did not use the agreed rate for General Foremen. Based on Exhibit 1.1(fffffff) – Rate Tables; ; General foremen is categorized as PMT / non trade labour. However; in the estimate they categorized the General foremen as trade and used EPSCA rules instead of the agreement rules/ rates. Note; EPSCA does not include the general foremen in the trade categorize. For example; Electrical GF used normal rate is $90.385 per hours- 4 x 10 day shift. Based on agreement GF normal rate is $61.91 per hours- 4 x 10 day shift.	Contracts/Commercial	Once JV assessment complete and meeting with OPG estimating results in agreed impact, result will be added to R01 Submission as part of Error/Errata line item adjustment.	No Cost Impact until Post R1.	$0	Verified Item	No cost impact until Post R1
Chapter Report	515	27-Aug-15	Contracts/Commercial	Some of Non trade rates used in estimate are different from the rates in Exhibit 1.1(fffffff) , e.g. based on Exhibit 1.1(fffffff): SNC – Elec/ Mech estimator rate is $65.03/hr but in the estimate they used SNC – estimator $105.49/hr. Also some of the titles used in the estimate could not be found in Exhibit 1.1. For those, we used rates in Exhibit 1.1 (based on closest one as per job responsibility). The rates were different.	Contracts/Commercial	Once JV assessment complete and meeting with OPG estimating results in agreed impact, result will be added to R01 Submission as part of Error/Errata line item adjustment. Agreement on mapping will facilitate updated Exhibit 1.1 (fffffff) for Execution Phase Amendment.	No Cost Impact until Post R1.	$0	Verified Item	No cost impact until Post R1
Chapter Report	516	27-Aug-15	Contracts/Commercial	Trade Rates-Boilermaker rates used in JV chargeable rates have been escalated by 2.00% to 2.23% from 2014 to 2015. However, based on EPSCA rates there is no change from 2014 to 2015, JV should use the latest EPSCA rates for Boiler maker and remove the escalation.	Contracts/Commercial	Once JV assessment complete and meeting with OPG estimating results in agreed impact, result will be added to R01 Submission as part of Error/Errata line item adjustment.	No Cost Impact until Post R1.	$0	Verified Item	No cost impact until Post R1
Chapter Report	517	27-Aug-15	Contracts/Commercial	Foreman , sub-foreman, and Journeyman are used in the estimate. Apprentices rate have not been used in the estimate (CWP), Please confirm how third year Apprentices rates have been incorporated in estimate according to EPSCA rules.	Contracts/Commercial	Once JV assessment complete and meeting with OPG estimating results in agreed impact, result will be added to R01 Submission as part of Error/Errata line item adjustment.	No Cost Impact until Post R1.	$0	Verified Item	No cost impact until Post R1
CWP Estimate	518	29-Aug-15	General	Remove of Bump Shift from Parallel Path CWPs	DFL - Parallel Path	OPG-JV Agreement to implement changes.	The following CWPs are captured in this Log Item: 2039, 2062, 2063, 2064, 2065, 2067, 2077, 2079, 2085, 2092, 2099, 2107, 2122, 2123, 2127, 2128, 2129, 2130, 2131, 2132, 3233, 2134, 2185, 2186, 2194, 2210, 2221, 2222, 2236. This line item covers removal of Bump Shift for all CWPs where no other changes were made.	($5,524,953)	Verified Item	OPG-JV war room monetization is not available. Changes implemented (bump factor removed) and entered in the CWPs changes to Rev-01 sheet. Checked the reduced amount for five from 29 CWPs (63% of total reduction)
CWP Estimate	519	8/29/2015	General	Unit 2 - RCC Civil Installation part of Definition Phase, not Execution Phase	DFL - TMOD5 (Pre&Post)	OPG-JV Agreement to implement changes.	The following CWPs are captured in this Log Item: 2001, 2002, 2003, 2004, 2009, 2011 This item carries all cost variance associated with these CWPs for Removal of RCC Scope for U2.	($183,604)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Estimate	520	8/29/2015	CWP 2077, 2078	Many interferences identified on Unit 2 are not applicable to Units 1, 3 & 4	DFL - Parallel Path	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with this CWP.	($2,665,244)	Verified Item	OPG-JV war room monetization is not available, changes implemented, applies to units 1,3,4 only. The reduction in Unit-2 due to bump factor removal is included with ID: 518. The amount has been entered in the CWPs changes to Rev-01 sheet.
CWP Estimate	521	8/29/2015	CWP 2230	Removed Pre & Post Job Briefing Steps	DFL - Parallel Path	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with this CWP.	($92,677)	Verified Item	OPG-JV war room monetization is not available. The change is implemented and the reduced amount is entered in the CWPs change to Rev-01.
CWP Estimate	522	8/29/2015	CWP 2235	Revised methodology of maintaining labour coverage for Moderator Dry process	DFL - TMOD5 (Pre&Post)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with this CWP.	($55,643)	Verified Item	OPG-JV war room monetization is not available. The change is implemented, Bump factor removed and the reduced amount is entered in the CWPs change to Rev-01
CWP Estimate	523	8/29/2015	CWP 2170	Deleted from Execution Phase scope of work	DFL - Remove/Inspe	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with this CWP.	($319,819)	Verified Item	The CWP deleted from the scope of work. Change implemented and entered in the CWPs changes to Rev-01
CWP Estimate	524	8/29/2015	CWP 2173	Changed methodology for New Fuel Loading	DFL - TMOD5 (Pre&Post)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with this CWP.	$196,247	Verified Item	OPG-JV war room monetization is not available. Multipliers have been revised, total cost has increased and entered in the CWPs changes to Rev-01
CWP Estimate	525	8/29/2015	CWP 2179	Revised critical path duration due to War Room discussions	DFL - Remove/Inspe	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with this CWP.	($2,452,210)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Estimate	526	8/29/2015	CWP 2148	Removed Insulator tasks from CWP this is covered in Subcontractors	DFL - TMOD5 (Pre&Post)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with this CWP.	($6,724,632)	Verified Item	Changes implemented. Entry ID 288, 342, 427, 502, 503, 526 included in this line

Category	Entry ID	Added to the Log	Chapter Title/CWP Number	OPG/JV Working Session Comment	WAR ROOM TEAM	OPG - JV Meeting Notes (From Working Group)- July 21st to Present	OPG-JV Meeting Notes (May 8th to July 21st)	Class II Estimate Revision 0 to Revision 1 Delta	Validation results by OPG estimating team	Estimating team validation explanation
CWP Estimate	527	8/29/2015	Commissioning	Changed scope and duration of commission tasks	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with the Commissioning Chapter.	$3,840,570	Verified Item	OPG - JV war room monetization is not available. Change implemented and the increased amount entered in the CWPs change to Rev-01 sheet. For details, see "4 UNIT -OSM/Goods - Variance Report" of May 02, 2014 & Aug 31, 2015
CWP Estimate	528	8/29/2015	Radiation Work Allowance	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with Radiation Work Allowance.	($90,182)	Verified Item	OPG-JV war room monetization is not available. Changes implemented and entered in the CWPs changes to Rev-01 sheet.
CWP Estimate	529	8/29/2015	4% Spot O/T on DFL Only	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with DFL OT.	($3,613,079)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Estimate	530	8/29/2015	2% Spot O/T on PMT Only	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with PMT OT.	($1,304,768)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Estimate	531	8/29/2015	3% Rework Allowance on All Labour	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with Rework Allowance	($8,464,933)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Estimate	532	8/29/2015	Living Out Allowance EPSCA Craft	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with LOA for Craft.	($5,506,826)	Verified Item	OPG - JV war room monetization is not available. Change implemented and the amount entered in the CWPs change to Rev-01 sheet. For details, see ....33RA-0160 Rev-00 May 05, 2015
CWP Estimate	533	8/29/2015	Living Out Allowance JV Staff	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with LOA for JV Staff.	($3,769,371)	Verified Item	OPG - JV war room monetization is not available. Change implemented and the amount entered in the CWPs change to Rev-01 sheet. For details, see ....33RA-0160 Rev-00 May 05, 2015
CWP Estimate	534	8/29/2015	Project Line of Credit	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with Project Line of Credit.	($3,498,450)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Estimate	535	8/29/2015	RST on Health / Welfare Benefits	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with RST on Health and Welfare Benefits.	($485,631)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
CWP Estimate	536	8/29/2015	Project Insurance	Directly proportionate to DFL labour changes	Other (CL2 Chapters)	OPG-JV Agreement to implement changes.	This item carries all cost variance associated with Project Insurance.	($352,281)	Cost changed, more information required to properly validate the cost adjustment	Refer to Working Group (War Team) documentation in Class 2 Rev 01 Compliance Chapter, Appendix "K".
								($371,589,783)		
								370084629		
								(1,505,154)		

SNC·LAVALIN Nuclear | AECON Joint Venture

Document Identification	Revision
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Date Effective: 2015.08.31	Page 1 of 49

Title: **DNGS RFR Project – Class 2 Rev 01 – Summary Report**

Retain Until: 2030

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NOTICE: This document is "Confidential Information" as defined in the purchase agreement ("the Agreement") between SNC-Lavalin Nuclear Inc., Aecon Construction Group Inc., and Ontario Power Generation Inc. (OPG). Any disclosure of this Confidential Information must be made pursuant to the terms of the Agreement.

RECORD OF REVISION

Revision Number	Date	Description	Authorizing Signatures		
			Prepared By:	Reviewed By:	Approved By:
PA	2015.08.15	Internal Draft for Review	[redacted]		
PB	2015.08.29	For Review			
00	2015.08.31	Issued for Use			

This document is submitted in accordance with, solely for the purposes of, and is subject to the Engineering, Procurement and Construction, Darlington Refurbishment Retube and Feeder Replacement Project agreement between the joint venture composed of SNC-Lavalin Nuclear Inc. and AECON ("Contractor") and Ontario Power Generation Inc. ("OPG") Dated 1 March 2012 (the "Agreement"). Capitalized terms not defined herein have the meaning given to them in the Agreement. This document contains the expression of the Professional opinion of Contractor as to the matters set out herein, and was developed in accordance with the Agreement and Prudent Practices.

The Contractor disclaims any liability to OPG or any third parties for use of this document that is not in accordance with the Agreement.

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1 Executive Summary

This Estimate Summary report includes a summary of the four-unit Execution Phase Class 2 cost estimate, schedule and risk register required for the Retube and Feeder Replacement (RFR) Project.

The purpose of this submission is to meet the requirements of the EPC Agreement between OPG and the Joint Venture. This submission forms the basis for the establishment of the Target Cost for the Execution Phase. Although not required as per the EPC Agreement for this submission, a draft contingency computation is included. The contingency is to be reviewed and agreed upon by OPG and the Joint Venture prior to being finalized as part of the Execution Phase Target Cost and Target Schedule.

The work includes the primary activities of replacing the fuel channels and the feeder piping in all four units. To achieve these activities, supporting work is required such as the installation of bulkheads and the removal of structural interferences. All work required to achieve the prescribed scope is captured in the estimate and schedule.

The Darlington station is achieving end of life nominally in the 2018-2020 timeframe and to accommodate the refurbishment of all four units, the refurbishment start date for the first Unit is October 2016 (Unit 2). Following the successful return to service of this unit, the subsequent three units will be refurbished (Unit 3, Unit 1, Unit 4) which will include overlap to minimize overall project duration, as shown in Figure 1.

Through the effort of the definition phase work spanning 2012 and into 2015, the total project cost is estimated to be $2.7B with a total schedule duration of 108 months for all four units. On average, the duration of each unit's refurbishment outage is 1120 days breaker to breaker.

The base schedule was constructed, as per the EPC Agreement, to exclude rework and contingency which resulted in an optimistic estimate. The total schedule durations are based on the base durations plus the contingency and rework durations.

Table 1: Total Project Cost

Estimate Component	Cost
Base Cost	**$1,218,651,640**
SS&E	**$67,302,866**
Reimbursable Cost	**$527,068,508**
Contingency	[redacted]
Fixed Fee	**$531,810,735**
Total Project Costs	**$2,713,233,749**

Table 2: Unit Schedule Durations

Unit Sequence	Base Schedule Duration (Days)	Contingency (Allowance Days)	Breaker Open Date
1st Unit	834	305	October 15, 2016
2nd Unit	847	303	October 15, 2019
3rd Unit	847	250	March 15, 2021
4th Unit	847	248	October 15, 2022

The overall execution durations for all four units are shown in Figure 1 below:

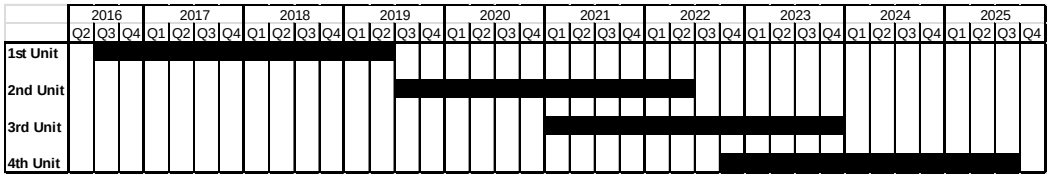

Figure 1: Overview of Execution Schedule

To ensure a realistic cost estimate and to incorporate the significant lessons learned from past refurbishment projects and other mega projects, significant effort was applied to developing a risk register covering all four units and analyzing unit over unit differences to establish a per unit risk profile. The work was jointly developed between OPG and the Joint Venture. The risk register is the input to the Monte Carlo Simulation to establish contingency at a P50 confidence level.

This submission is a Class 2 Estimate for the refurbishment of all four units, supported by a cost and resource loaded Level 5 schedule.

The basis of the submission is formed by a detailed level of planning to include:

- Detailed Logic Flow Diagrams for each unit which sets the critical path sequence and interfaces with OPG. Incorporates lessons learned from past refurbishments and developed over several iterations spanning three years;
- Comprehensive Work Packages comprised of detailed work instructions developed by tooling and construction leads responsible for performing the work;
- Utilization of the full-scale reactor mockup training facility for base feeder and fuel channel replacement activities which validates the fabricated tooling and the work packages
- Utilization of the full-scale reactor mockup training facility to validate the construction approach to performing first-of-a-kind activities such as installing the Retube Tooling Platform in a Darlington vault.
- All engineering modification packages for RFR are at 90%+ completion;
- Iterative reviews by three sets of independent parties to ensure the results are consistent with industry best practices;
- Detailed Project Management Team Organization (PMT) charts with fully developed schedule-based personnel forecasts based on outage duration and shift structure appropriate to each position;
- Detailed direct field labour estimate based on a bottoms-up estimate of each CWP at a step-by-step level;
- Detailed Training estimate based on an established on-boarding training plan, and a work-specific training matrix proven out through the Tooling testing program;
- Detailed Support Services estimates based on a series of Execution Phase window reviews
- Placed purchase orders for Owner Specified Material (OSM) for Unit 2 only, and completed bills of material for items required for each of the detailed engineering packages;

- Tooling lifecycle management program based on lessons learned from four (4) previous CANDU Retube projects;

As a result of the extensive planning and work detailed above, the Joint Venture has a high level of confidence in the feasibility and achievability of the estimate and schedule.

Subsequent to the issue of this report, the Joint Venture will provide the balance of the Milestone Report predominantly as reference and backup material that will comprise the final Class 2 Milestone Report Rev 01. The JV plans to deliver the final Class 2 Milestone Report Rev 01 to OPG in late September 2015 in the form of a Contract Submittal.

2 Introduction

This Class 2 Rev 01 Summary Report is the fourth of a series of successive estimates for the RFR Project, and a substantial progression over the preceding Class 3 Estimate. This estimate relies upon a significant amount of planning, preparatory, design, and testing activities resulting from successful implementation of the Definition Phase. The schedule and estimate are based on Darlington-specific work packages that have been completed with 90% complete engineering information, including Tool performance data obtained from Mock-up testing at the Darlington Energy Centre.

The staged work planning approach uses “Stage 3” CWPs which are based on the product of engineering and Tooling inputs. Stage 3 CWPs are the final step in the staged work planning process prior to releasing the CWPs for construction. The Stage 3 CWPs identify ‘operations’ that are detailed into work ‘steps’ from which the JV prepared the corresponding estimates. This level of detail provides a high level of confidence in the work steps and cost estimate. During the work planning process, the Stage 3 CWPs were reviewed in the context of the overall Darlington Refurbishment work program including non-RFR activities.

The Report is organized into five sections, shown below:

a) Schedule Report (See Section 3): provides the overall schedule highlights as well as stating the determining key basis for logic, constraints, OPG interfaces, resourcing and explaining compliance with the requirements. The start dates for the individual Unit refurbishments are in accordance with OPG’s direction, but maintaining the constraint that no more than two units are off line the same time.
b) Cost Report (See Section 4): summarizes the basis of estimate and the results, including variance analysis against the previous estimate. The Report also includes a new Chapter addressing the Target Cost development with Contingency and Fees.
c) Risks and Contingencies (See Section 5): provides an overview of the progression of the risk management process from Class 3 to Class 2 Rev 01. Highlights and conclusions of this Chapter is the quantification process that ultimately yields recommendations for schedule and cost contingencies via a rigorous Monte Carlo Analysis. Furthermore, the schedule and cost uncertainties excluded from the Risk Register but still representing a level of risk, were addressed in ’three point’ or ‘range’ analyses also leading to Contingency recommendations via Monte Carlo Analysis.
d) Compliance (See Section 6): is addressing the accomplishment of specific mandatory requirements for the Class 2 Rev 01 Estimate, Level 5 Schedule and the Risk Register. The high level compliance requirements are represented in the following documentation:
    - The Agreement and Exhibits;
    - AACEi and OPG Governance documents;
    - JV Project Specific and Corporate documentation;
    - Industry “Best Practice” documents.
e) Scope: The main scope of the estimate was packaged into a series of Chapters[1] for the purposes of estimating. Each of these Chapters includes a specific scope and a Class 2 compliant estimate basis. This estimate report captures the summaries of the Chapters, while Appendix E includes all the Chapters in their entirety. The Chapters represent the estimate packages in a logical breakdown of the scope, such as the Series Work Direct Field Labour (DFL), Project Management Team and Supervision (PMT), Training, OSM, SS&E, etc. The process of producing the individual Chapters was

[1] For clarity, this Summary Report is an abbreviated version of the Class 2 Submission and contains only 5 of the Chapters. The Class 2 Milestone Report is the expanded version of the Class 2 Submission and includes the full set of Chapters.

followed by a rigorous due diligence review and comment process, similar to Class 3, involving several layers of reviews, including OPG's review.

Additionally, this report includes a summary of the draft Amendment pricing tables, including Fees calculated based the Class 2 Rev 01 Estimate presented herein.

This estimate is representative of all Scope Control Issues identified in the Scope Change Control Chapter 509407-0000-00000-33RA-0162. The estimate is also representative of incorporating certain key "Negotiating Strategy" concepts dated July 30th agreed to in principle between OPG and the JV. Specifically, the incorporation of an RP protocol, the elimination of the Productivity Gains, and an increase in Neutral Band to $75M have been incorporated in this estimate. Any changes to these items may require re-assessment of risks and ranges.

3 Schedule Report

Ref: 509407-0000-00000-33RA-0145 "Schedule Report"

- P6 Schedule derived from Logic Flow Diagram (LFD) and Series Execution Plans (SEP's)
- Bottoms up Stage 3 CWPs based on LFDs and Steps, including Tool Performance durations from DEC adjusted to Expected Conditions
- P6 Schedule fully resource and cost loaded
- Critical Path and Cash Flow defined
- Previous Retube projects OPEX benchmarking
- Critical Path 4x10 shift basis as agreed with OPG
- Schedule contingency included (per Agreement) derived from Monte Carlo Analysis

The Class 2 Rev 01 Estimate, Level 5 Schedule has been developed based on the following key inputs:

- Timed tool performance testing at the Mock-up;
- Validation testing of non-tooling specific work at the Mock-up;
- Comprehensive Work Packages (CWP) developed by the JV construction team. For each aspect of the work, logic ties for each series of work, and the logic dependencies between different series of work have been developed;
- A detailed Logic Flow Diagram (LFD) which illustrates the overall logic flow of the critical path, and non-critical path work for each unit, inclusive of the key interrelationships between the JV work scope and OPG work scope.

The resulting base schedule is fully resourced and cost loaded, detailed to the individual operations for each of the CWPs.

The overall execution durations for all four units are shown in Figure 2 below:

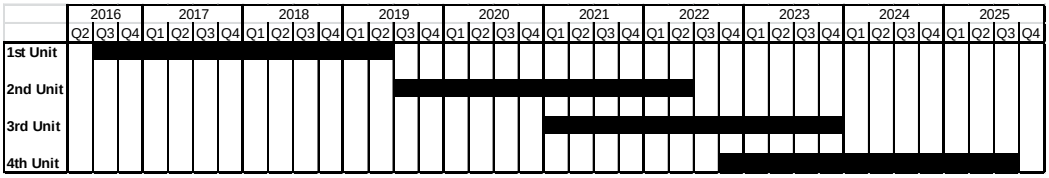

Figure 2: Overview of Execution Schedule

Significant benchmarking has been completed during all phases of preparation of the schedule basis and resultant Level 5 schedule. Comparisons to Wolsong, Point Lepreau, and Bruce Unit 1 and Unit 2 have been made at the individual series level, as well as at an overall project level.

The result of the planning and preparation of the Definition Phase of the Darlington RFR project has resulted in a planned duration much less than any actuals of previous Candu refurbishments. Understanding and rationalization of the issues that resulted in the actual results of previous refurbishments being greater than the planned schedule durations was a component of the inputs to the Darlington schedule.

The Level 5 Schedule has been developed with sufficient detail to be compliant with the AACEi Recommended Practice guidelines No. 37R-06 and No.18R-97. These guidelines state that for Class 2 Rev 01 Estimates:

- Methodology is based on “a high degree of deterministic estimating methods”;
- Level 5 Schedules shall be “schedules that reflect hourly, daily or weekly work requirements”;
- “Level 5 Schedules are used to plan and schedule utilization of resources”.

As such, the schedule includes execution activities that are at the Calandria row-by-row level of detail, including the specific resource loading required for the completion of these activities, and includes the logic ties between interfacing activities of different disciplines, which represents the true critical path while still capturing logic relationships between different distinct work packages.

As outlined in the Estimate Plan, the durations in the Level 5 Schedule are based on either a detailed Stage 3 CWP (Reference Appendix G), or where appropriate, they are based on the as-performed Tool Performance Guarantee (TPG) time (for the activities listed in the Agreement Exhibit 1.1 (qqqqqqq)), adjusted to account for differences between the Tool Proving performed in the Mock-up and the manner in which this work will be performed in the field. The process of performing this adjustment is documented in the Schedule Management Plan, and involves taking the as-performed TPG times, and making item by item adjustments to account for the differences followed by a review in the collaborative Working Groups.

The logical ties in the schedule are defined by the latest revision of the LFDs for each unit. The LFD has been developed in concert with OPG scheduling and operations staff and includes allowances for major schedule interactions between the JV scope and OPG activities within the vault during the outage and other Refurbishment outage scope.

The DFL resource loading and cost profile in the schedule are based on individual Stage 3 CWP's based on estimates of crew size, man-hours and resource requirements estimated per the Agreement, Exhibit 1.1 (ffffff) – Rate tables – Labour Schedule. The details associated with this are documented in the DFL Chapters.

There are a small number of scheduled activities and logic ties that have been included or excluded from the Class 2 Rev 01 Estimate that are inconsistent with the as-written scope in the RFR Agreement. These items have all been discussed with

OPG and are in the process of being dispositioned. They are listed in the Scope Control section of this report.

The following table shows the durations for the first unit (exclusive of contingency).

Table 3: Deterministic Critical Path Summary

	Darlington Class 2 - Days		
	Total Duration*	**JV Activity Duration**	**OPG Activity Duration**
Prep Activities to Vault Turnover	152	54	98
RTP install Feeder and Fuel Channel Removal	260	260	
Inspections	38	38	
Fuel Channel and Lower Feeder Install	245	245	
Post-Requisites	106	104	2
Return to Service Activities	33		33
Total	**834**	**701**	**133**

The deterministic/best case durations shown above are the product of the collaborative Working Groups' input, which includes significant benchmarking across all previous Candu nuclear refurbishment projects. It should be noted the above deterministic/best case durations are completely devoid of any uncertainty or risk contingency durations. For a comprehensive summary of each best case, most likely, worst case, and P50 duration of each task, please refer to Appendix A of this report.

4 Cost Report

- Bottoms up, DNGS-specific estimate from CWPs & Tool Performance Guarantee (TPG) amended per Tool Performance testing at the DEC
- PMT based on Org. Chart & Staffing Plan and schedule driven by DFL requirements
- Firm long-lead OSM PO's (Unit 2 only) & Infrastructure Plan
- Variances reconciled to Class 3
- Estimated in 2015 Canadian dollars
- 3% rework on labour included (per Agreement)
- Contingency derived from Monte Carlo Analysis and Fixed Fee included (per Agreement)

The Class 2 Rev 01 Estimate has been developed based on the following key inputs:

- Detailed Project Management Team Organization (PMT) charts with fully developed schedule-based personnel forecasts based on outage duration and shift structure appropriate to each position;
- Detailed DFL estimate based on a bottoms-up estimate of the CWP at a step-by-step level;
- Detailed Training estimate based on an established on-boarding training plan, and a work-specific training matrix proven out through the Tooling testing program;
- Detailed Support Services estimates based on a series of Execution Phase window reviews with OPG detailing the specific activities performed by the support services group at different times in the outage;
- Placed purchase orders for Owner Specified Material (OSM) for Unit 2 only, and completed bills of material for items required for each of the detailed engineering packages that are at least 90% completion;
- Tooling lifecycle management program based on lessons learned from four (4) previous CANDU Retube projects;
- 3% rework on labour included (after exclusion of scheduled rework durations);
- The JV will self-perform the vast majority of the RFR scope of work. Limited subcontracting of this work is anticipated.

The Target Price for the Execution Phase is built up as shown in Figure 3 below, in accordance with Exhibit 3.5 of the Agreement.

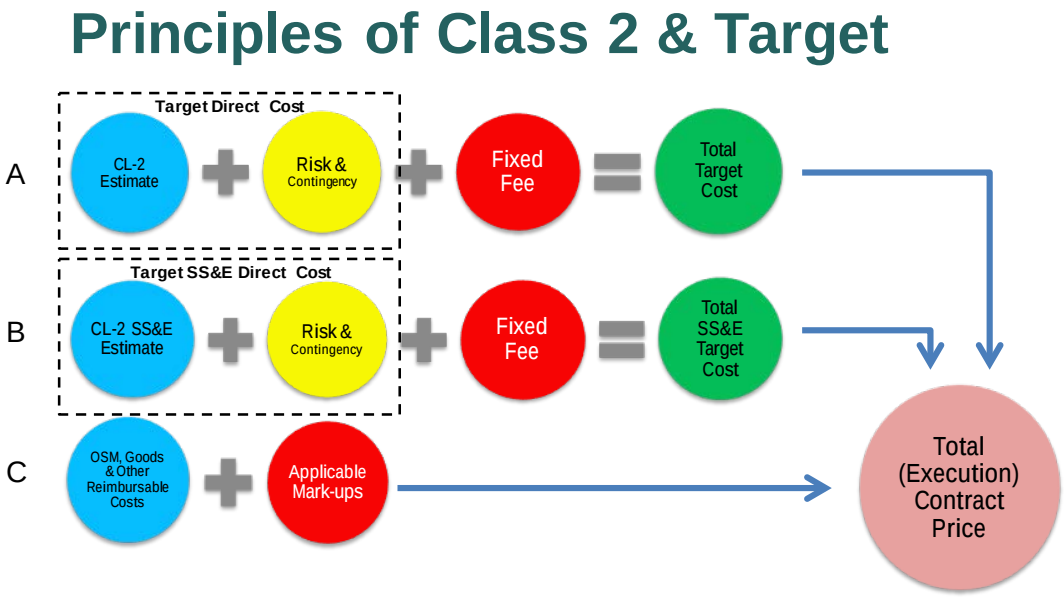

Figure 3: Base Cost Estimate, Final Cost and Fixed Fee Connections

As illustrated above, the Total (Execution) Contract Price is made up of three (3) streams of cost:

1) Stream "A" is the Target Direct Cost, comprising the Direct Field Labour and the Project Management, inclusive of contingency.

2) Stream "B" is the Target SS&E direct cost, comprising the support services and equipment items such as equipment rentals and IT.

3) Stream "C" is the Reimbursable Costs, some with mark-up and some without, largely made up of OSM and Labour Travel and Living Out Allowances (LOA).

Previous estimate submittals have only included the Direct Costs (blue circles in **Error! Reference source not found.** above). The full build-up of the Total (Execution) Contract Price (blue, yellow and red circles) is shown in Section 6.

All "costs" are in Canadian dollars and include economic adjustment to 2015 in accordance with the Agreement.

4.1 Cost Basis

The Basis of Estimate (BoE) was developed with focus on the requirements specified by:

- The Agreement, Exhibit 3.5;
- AACEi Recommended Practice No. 34R-05 "Basis of Estimate";
- OPG Instruction N-INS-00400-10001, "Estimate Developing".

The Estimate Plan was updated to include specific requirements of the Class 3 Estimate including lessons learned. The Class 2 Rev 01 Estimate was built upon and consistent with the results and recommendations of its predecessor; the Class 3 Estimate, Level 4

Schedule and Risk Report, and it contains cost and schedule variance reconciliations between the two Classes of Estimates.

The Class 2 Rev 01 Estimate and Level 5 Schedule process meets the requirements as recommended by AACEi [R40]. Specifically for a Class 2 Rev 01 Estimate:

> *"Typical accuracy ranges for Class 2 Estimate s are -5% to -15% on the low side, and +5% to +20% on the high side, depending on the technological complexity of the project."*

Furthermore:

> *"The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of (non) contingency (typically at a 50% level of confidence) for given scope."*

As indicated above, the accuracy band is intended to be applied after the addition of contingency.

Furthermore, the accuracy range table specified in AACEi 18R-97: Cost Estimate Classification System covers the whole cost estimate, which includes all uncertainties and risks.

The Estimate can be classified into two (2) major categories of costs: **primary cost drivers** and **secondary cost drivers**, which support the primaries and, therefore, are dependent on derivatives of the primary costs drivers.

Primary Cost Drivers are the following:

- The critical path schedule of the RFR project. The schedule is comprised of the series work activities carried out mostly in the reactor vault in a well-defined sequence.
- The reactor components and material (OSM and Goods). While these costs do not drive the critical path of the project schedule, and are thus time independent costs, they are a significant component of the overall project cost.

Secondary Cost Drivers are those costs required to support the DFL or other DFL dependent estimate details. These include the following:

- Supervision / PMT;
- Support services (Trade Support);
- Training;
- Tool Management;
- SS&E;
- LOA & JV Travel;
- Demolition, Tool Disposal and Close-out;
- Commissioning Support

It is important to acknowledge the scope of the RFR Definition Phase allowed for performing the detailed engineering, procurement, and work planning for the first of the four operating units only. However, the JV has created a four-unit cost estimate and critical path

schedule by way of accurately projecting the highly detailed Unit 2 planning into a full four-unit study and report. This was accomplished by:

- Maintaining a design basis as identical as practical for all four units;
- Performing walkdowns to identify subtle differences unit-over-unit;
    - The Project Management Team (PMT) estimate and Manpower Forecast Leveling (MFL) is based on four units complete with dwells and overlaps;
- Customizing the Range and Risk Analysis to specifically address each unit;
- Providing the Goods and OSM cost estimate completed for all units, with OPEX from the first unit;
- Providing a fully-detailed, resource and cost loaded, four Unit integrated critical path Level 5 Schedule;
- Creating a separate Chapter as part of the Class 2 Milestone report to address "Subsequent Units" (Units 3, 1, & 4);
- Creating a separate Chapter as part of the Class 2 Milestone report to address "Demobilization & Project Closeout", including decontamination and demolition of the Retube Waste Processing Building (RWPB).

The inputs to the overall Class 2 cost estimate are well-defined across all elements of engineering, procurement, and construction (EPC). The figures below give representative metrics on the level of development of each EPC segment.

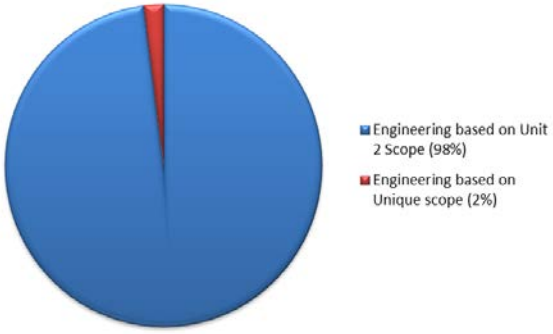

Figure 4: Engineering Development for Subsequent Units (Engineering)

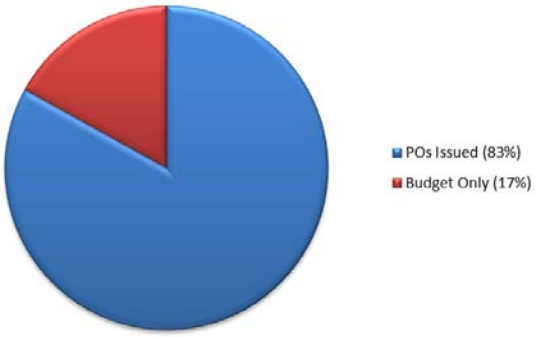

Figure 5: OSM Price Accuracy Status (Procurement)

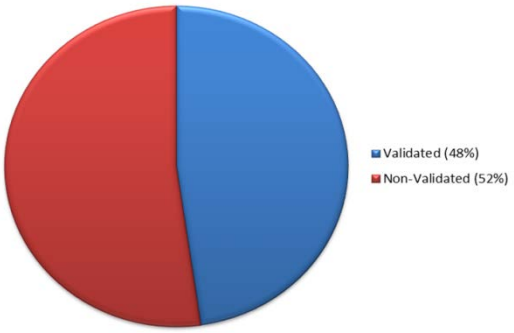

Figure 6: DFL Data Validation (TPG and DEC) Status (Construction)

5 Risk & Contingency

5.1 Risk

Ref: 509407-0000-00000-33RA-0165 "Class 2 – Risk Report"

- Refined Risks and Opportunities per the approved Risk Management Plan
- Risk Register updated from Stage 3 CWPs & OPEX
- Uncertainties and ranges established through collaborative workshops
- Selected risks retired with mitigation actions
- Mitigation strategies defined and some implemented
- Industry accepted proven risk methodology and infrastructure utilized
- Contingency derived from Risk Register and schedule/cost range analysis using Monte Carlo Analysis

The Risk Report Chapter summarizes the inputs to the Monte Carlo simulation that establishes the P50 cost and schedule. Regular series risk workshops were conducted, and the Risk Register evolved between the submission of the Class 3 Estimate and the Class 2 Rev 01 Estimate following the process as prescribed by the Risk Management Plan (RMP), 509407-0000-00000-30IM-0005. The established process lays out the framework for managing risk, which ultimately leads to the development of the contingency to establish the Execution Phase Target Cost and Execution Phase Target Schedule. The outputs of the Monte Carlo calculations are documented in the Contingency Target Cost and Target Schedule Development Chapter, 509407-0000-00000-33RA-0172.

The three (3) major unit-specific inputs to the Monte Carlo simulation are:

- 3-point range (uncertainty) assessments, for both cost and schedule;
- Mapped risks (cost and schedule), which are associated with specific tasks;
- Global risks (cost and schedule) that apply broadly to all tasks.

In order to obtain the inputs to the contingency development process, collaborative review sessions were held over the course of the Definition Phase. These sessions focussed on identification first, and as development of the project and time progressed, the quantification and assessment of the inputs was performed.

The collaborative series risk workshops were conducted to:

- identify and qualitatively assess risks;
- identify risk responses (i.e. mitigations, avoidance, etc.);
- review and track mitigation actions;
- determine whether risks were 'JV risks', or 'OPG risks' – the

basis of which determines who carries the P50 contingency.

During these series risk workshops, threats were either:

- retired if mitigations completely eliminated the risk;
- reduced if mitigations actions did not completely eliminate the risk and accepted where mitigation actions approved by the JV and OPG; or
- transferred between OPG and the JV based on the clauses outlined in the Agreement and managed internally by each company who will ultimately be responsible for the direct impact should the risk occur.

The schedule basis sheets, shown in Appendix A of 509407-0000-00000-33RA-0145, Schedule Report, were used to document the quantitative assessment for Execution Phase ranges and risks for each required activity and cost estimate line item used to develop the Monte Carlo risk models.

Opportunities proven to be cost beneficial were approved and implemented as part of the execution plan where practical. There exist remaining opportunities that require additional engineering or regulatory approvals that have been flagged for subsequent optimization of the cost and schedule should the business case exist.

During the collaborative Working Group team reviews, the 3-point ranges, mapped risks, and global risks were discussed and agreed upon. Subsequent scrutiny by the management review team resulted challenge sessions being established with the Working Group teams to ensure no duplication and no omissions were made in the range and risk assessments.

5.2 Contingency Target Cost and Target Schedule Development

Ref: 509407-0000-00000-33RA-0172 "Contingency Target Cost and Target Schedule Development"

The Contingency Target Cost and Target Schedule Development Chapter summarizes the outputs of the Monte Carlo simulation performed using the inputs described in the previous section.

Section 6 of the Risk Management Plan (RMP), 509407-0000-00000-30IM-0005, outlines the process for contingency development, which conforms to the requirements of the Agreement per Exhibit 3.5, Section 18. As stated in the Exhibit, the amount or level of contingency to be included in the Execution Phase Target Cost (excluding the Execution Phase Support Services and Equipment (SS&E) Target Cost for purposes of this Section 18) and the Execution Phase Target Schedule will be at a level sufficient to provide the Contractor with the following confidence levels of achieving each of the contract objectives as described:

1) a 50% level of confidence as to completion of Execution Phase Work for each Unit at a cost within the Execution Phase Target Unit Cost (including the contingency) for that Unit; and

2) a 50% level of confidence as to completion of Execution Phase Work for each Unit within the Target Unit Outage Duration for that Unit.

Using the inputs from the previous section, the time dependent and independent risks along with three point estimates required for developing contingency at a 50% level of confidence (i.e. P50), were identified, reviewed and quantitatively assessed. A visual representation of the inputs and outputs is shown below in Figure 7:

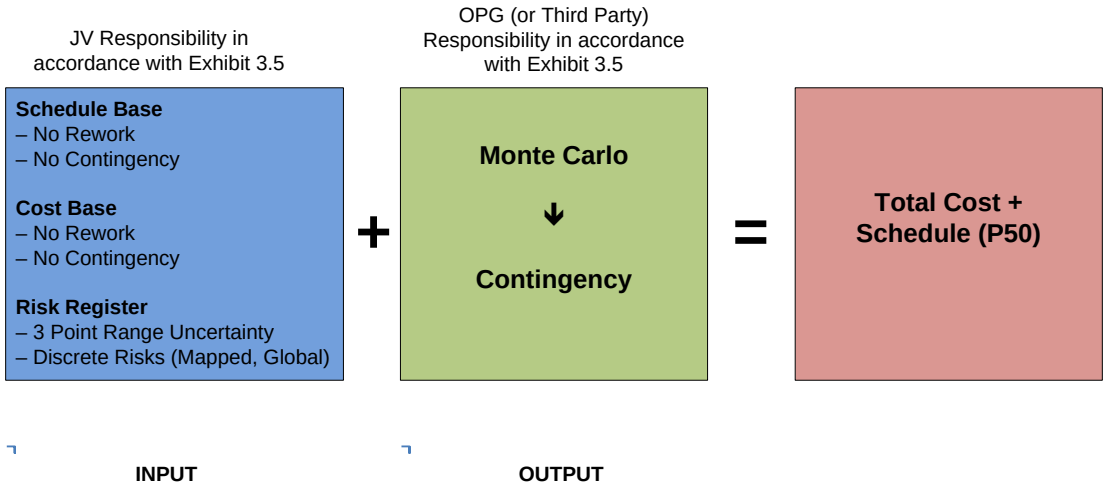

Figure 7: Contingency Build Up

As described fully in the Schedule Chapter, the base schedule and cost has been populated using the deterministic/best case results of the range analysis workshops. It should be noted that this will produce exceptionally high contingency percentage results, in comparison to benchmarked projects where contingency is compared to a base cost and schedule comprised of most likely/expected durations.

The schedule dependent costs consist of:

- DFL Labour;
- PMT Labour;
- Subcontractors.

It should be noted that SS&E time dependent costs are extrapolated directly based on P50 results.

Although the Risk Management Plan outlines the development of Contingency based on burn rate, it was determined that for accuracy and to be in accordance with Exhibit 3.5 of the EPC Agreement, the Monte Carlo simulation is to be performed by OPG or a third-party. The methodology utilized by OPG in the calculation of contingency is:

1) The Level 5 Schedule (with the correct logic, no risk, and no rework) is rolled up to series level/CWP level to create the Risk Model Schedule in Primavera Risk Analysis (Pertmaster).

2) The indirect cost items such as PMT, Support Services etc. are represented by creating hammocks of the series work to determine the contingency required with variations of critical path.

3) The JV Risks are mapped to CWPs for discrete risks and to multiple series for global risks with the jointly agreed quantification data.

4) Quantification data of schedule uncertainty are based on (1) the distribution ranges of the basis sheets assessed jointly by JV and OPG SMEs and (2) the distribution ranges of the OPG tasks, supplied by OPG Outage Program and entered to CWP level tasks.

5) We enforce that no rework is entered as part of the base, or part of uncertainty ranges. The 3% Rework allowance will be compared with the aggregate impacts of the Rework risks to calculate the final adjustment on cost.

6) The quantification data of cost uncertainty are jointly developed by JV and OPG collaboratively and mapped to the corresponding tasks as cost uncertainty/resource uncertainty as appropriate.

7) The output of the risk model provides the schedule contingency at P50, cost contingency at P50 and the monthly cash flow based on P50 cost per Unit.

Schedule Contingencies from OPG Risk Model and JV Risk Model are based on the same level of details (CWP levels) and the same mapping of risks and uncertainties. They are expected to have very similar results, though they are processed in two different software tools.

Cost Contingencies from OPG Risk Model are coming from the rolled up costs loaded in the Risk Model driven by the Schedule variations in Monte Carlo, whereas the Cost Contingencies from JV Risk Model are coming from Schedule Contingency multiplied by the average burn rate of the Unit.

The Class 2 Rev 01 cost and schedule is based on the build-up of 'base' plus contingency, with Unit 2 illustrated as an example in Figure 8.

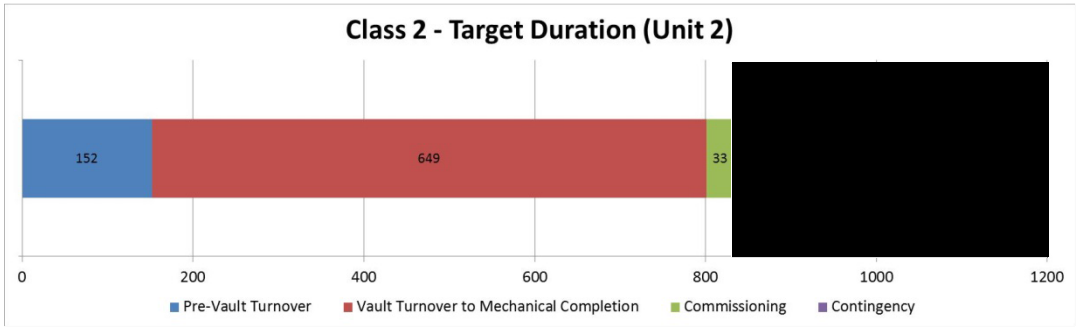

Figure 8: Execution Phase Class 2 Schedule Representation with Contingency & Risk (Unit 2 Shown)

Below, in Table 4, is a summary of the resulting four-unit Execution Phase Schedule and Cost contingency to establish the Execution Phase Target Schedule and Execution Phase Target Cost.

Table 4: Summary of Resulting P50 Contingency for each Unit

Contingency Requirement	First Unit	Second Unit	Third Unit	Fourth Unit
Base (Deterministic) Duration	[redacted]			
P50 Duration				
Base (Deterministic) Cost				
P50 Cost (without Fees)				

Note: a detailed (task level) summary of 3-point ranges and risks is shown in Appendix H

In accordance with Exhibit 3.5 of the EPC Agreement, the P50 Monte Carlo simulation results must be agreed upon by both parties, and at the time of issuance of this report there remains final validation of the model by both parties.

6 Compliance

Ref: 509407-0000-00000-33RA-0173 "Class 2 Milestone - Compliance"

- Compliance to the Estimate Plan
- TPG testing at DEC completed
- Per the Agreement including Tool Performance Proving Data, adjusted to Vault Expected Conditions and engineering at 90% completion
- Achieved AACEi confidence and accuracy goals
- Governing (Contractor) documents
- ALARA incorporated into plans
- Integration of tooling design & tool proving
- Quality Processes, including multi-tier reviews and over sight
- Adopted OPG refurbishment WBS
- Established Code of Accounts across all systems

The Class 2 Summary Report captures the final output of the Class 2 Rev 01 Estimate effort for the Execution Phase, carried out during the Definition Phase under the mandate in the Agreement and related contractual and other approved documentation.

This Chapter outlines how the Class 2 Rev 01 Estimate and Level 5 Schedule complies with the Agreement for all requirements of scope, process, contents and quality.

The following are the required high level compliance requirement documents in no particular order of precedence:

- Exhibit 3.5 of the Agreement
- AACEi Class 2 Estimate Recommended Practice
- RFR Project Estimate Plan and supporting JV documentation
- OPG's procedural requirements, and
- Project QA program
- OPG Change Log

The Class 2 estimate compliance with the above documents was verified by independent 3rd party reviewers: Berkeley Research Group (BRG), JV partner corporate Bid and Investment Approval Committee (BIAC), JV partner Proposal Review Committee (PRC), JV partner corporate Risk Evaluation Committee (REC).

In addition to being compliant with the requirements, the rigour and level of detail incorporated in the overall product gives the JV a considerable degree of confidence that the estimate (cost and schedule) is representative of the Execution Phase Plan.

6.1 Class 2 Revision 0 Review Process

6.1.1 Organization and Purpose

Independent and joint OPG/JV reviews of the completed Class 2 Milestone Submittal Rev 00 began after submission of the Milestone Summary in May 2015.

Over 100 staff, including Subject Matter Experts (SME's), Estimators, Planners, Schedulers, Engineers, Technicians, Trade Superintendents, Department Managers, and Independent Consultants participated in independent, joint, and collaborative reviews of the Class 2 Rev 00 as representatives of the following organizations:

- The OPG/JV Joint RFR Project Work Group;
- OPG DNGS Refurbishment Program Team;
- The 3rd Party Expert Panel;
- Berkeley Research Group (BRG).

To maintain control and organization of the detailed review process, comment sheets and Change Logs were created by the various reviewing parties. These documents included:

- The 'OPG Change Log';
- The 'JV Change Log';
- The 3rd Party Expert Panel comments;
- BRG comments.

The comments in the documents above were merged together as part of the detailed review process, and the OPG Change Log became the master document in which all changes to the Class 2 Rev 00 submission were recorded and agreed upon.

The originally planned Class 2 Rev 00 review and comment process that began in mid-May 2015 was effective, but it was agreed that a more focused approach was required. Consequently, the decision was made to organize a significant number of Subject Matter experts (SME's) and create joint OPG/JV "Working Group" teams that would bring the Class 2 Rev 00 review and revision process to completion. It was this group that completed the final detailed reviews leading to this Class 2 Rev 01 Summary Report.

The Working Groups were organized into 21 sub-committees (shown in Table 5 below), each with OPG and JV representation, reporting to a joint OPG/JV management team. The Working Groups are comprised of industry expert team members with experience in planning and executing the refurbishments of Bruce 1, Bruce 2, Wolsong, Point Lepreau, as well as extensive experience in other large-scale nuclear and non-nuclear projects. The individual skill sets of the team members covered areas such as reactor engineering, health physics, construction, estimating, risk management, logistics, project management and project controls.

Table 5: The Working Group Teams

Team	Area of Assignment
1	Management & Oversight
2	ALARA & Dose
3	DFL - Summary
4	DFL - Remove/Inspect
5	DFL - Install
6	DFL - TMODS (Pre & Post)
7	DFL - Parallel Path
8	DFL - Feeders
9	Waste/Volume Reduction
10	Support Services & Infra
11	Tooling
12	SS&E
13	Training
14	PMT
15	OSM & Goods
16	Subcontractors
17	Subsequent Units
18	Schedule & LFD
19	Risk/Contingency
20	Special Initiatives
21	Contracts/Commercial

6.1.2 Scope & Mandate of the Working Group Teams

The Working Group teams were assembled and given the mandate to ensure there was a consistent and aligned (OPG and JV) approach in the creation of the deterministic / 'base' project schedule, cost and risk components of the estimate. They were further tasked to ensure there is no duplication and no omissions in the cost, schedule, and risk components of the estimate.

In the review of the 'base' schedule and costs, the Working Groups were given the mandate to ensure the deterministic schedule and cost was representative of the best-case duration and manpower for each scope element. The intent of this directive was to ensure compliance with the EPC Agreement requirement of ensuring the 'base' schedule and cost is devoid of any risk or contingency amounts.

Their specific deliverables included the following:

- Review all items listed on the OPG Change Log and reach OPG/JV agreement on the method of disposition of each log item;
- Review all items listed on the JV Change Log, assess the applicability of each Log Item, and reach OPG/JV agreement on the method of disposition of each Log Item. As

applicable, the JV Change Log items would either be consolidated into the OPG Change Log or eliminated;

- Review all items listed on the 3rd Party Expert Panel report, assess the applicability of each Report Item, and reach OPG/JV agreement on the method of disposition of each Log Item;
- Review all basis of estimate documents (schedule 'basis sheets', CWP estimates, etc.), and subsequently agree on any changes required;
- Review all schedule uncertainty and risk elements of each task, and agree on any changes required;
- Create a special initiatives committee to investigate and recommend certain scope and methodology changes to accomplish Execution Phase cost and critical path optimization;
- Oversee the implementation of agreed revisions to the Class 2 Rev 01 Estimate and Level 5 Critical Path Schedule, including oversight of data integrity and arithmetic QC checking, and confirmation that all required revisions were duly implemented in the final Class 2 Rev 01 product;

All resulting changes were recorded as part of the Working Group documentation, with special care taken to highlight any decisions that would necessitate a revision to JV Plans, the RFR EPC Agreement, the Scope of Work (SOW), or OPG Governance by way of a modified procedure. Care was taken to not alter the intended assignment and sharing of risk between OPG and the JV to respect the original intent of the RFR EPC Agreement.

6.1.3 Work Group Team Documentation

The results of the Working Group effort has been documented and appended to this Report, including:

- OPG Change Log monetized by estimators and agreed upon by the Working Groups;
- Revised Logic Flow Diagram (LFD) documenting the overall RFR process and sequence for each of the four units;
- Signed Schedule Basis Sheets and assumptions;
- Signed Risk Sheets by each of the Work Groups;
- Supporting documentation by each of the Work Groups.

6.2 Scope Change Control

Ref: 509407-0000-00000-33RA-0162 "Scope Change Control"

As a result of the Class 2 Execution Planning process during the Definition Phase, a number of Scope items have been identified that require final clarification by OPG and the JV and/or formal adoption into the Contract Documents prior to execution of an amendment incorporating the Execution Phase Plan into the Agreement.

The Scope items have been divided into technical and commercial scope change control categories. An inventory has been provided in Table format, annotated to indicate the circumstance or status of each item. It is anticipated that OPG and the JV will continue to expedite the disposition of these items on an urgent basis for inclusion into the subsequent Amendment. The listing set out in the Tables could have an impact on the final RFR Execution Phase Plan.

In the context of the Class 2 Milestone submission, the objective of this Chapter is to document an accurate account of technical scope and contractual inclusions or exclusions that differ from the Agreement but have been included or excluded as the case may be, in the basis for the Execution Phase Class 2 Rev 01 Estimate and Level 5 Schedule.

7 Cost, Contingency and Fee Summary

Further to the rollup cost summary provided in the Executive Summary Section, Table 7: RFR Execution Phase – Total Target Cost Summary, Table 8: RFR Execution Phase – Cost Variance from Class 3 to Class 2 Rev 01 and Table 9: Class 2 Rev. 01 Total Target Cost including Contingency and Fixed Fee Summary - RFR Execution Phase provide the Unit-by-Unit breakdown, variance data and the overall Project Target Cost, including cost, contingency and fee.

The four-unit estimate also includes a 3% rework allowance on all labour hours, without duplication on schedule rework durations.

All “costs” are Canadian dollars and do not include escalation beyond 2015.

Fixed Fees and markups are applied as per Exhibit 6.1 of the EPC Agreement.

As stated elsewhere in this report, in order for the Class 2 Summary Report to reflect the true expected scope, efforts have been made to include all scope items in the Class 2 Rev 01 Estimate and Level 5 Schedule even if the given item of scope has not yet been formally adopted into the Contract Documents by an Amendment and/or Project Change Directive (PCD). This action was taken in the instances where both OPG and the JV expected, with reasonable certainty, the given item of scope will be formally adopted. For an itemized list of such items please refer to Chapter “Scope Change Control” Ref. 509407-0000-00000-33RA-0162.

There are certain items that, as of the date of issuance of this report, are known to the JV to be variances/omissions from the costs and schedule contained in this document. Table 6 below shows a summary of those known items. There are several items in the list below that remain unquantified, however indicative values will be submitted with the detailed files planned for September 2015. The total cost of the quantified items amounts to approximately $12M and 0.5 days increase per unit.

Table 6: Omissions List from August 31st Submission

	Description	War Team	Trend	Per Unit Cost	Critical Path
1	Rabbit Run between RWPB and U4 Powerhouse is not part of RWPB or RFR estimates. To be added to the RFR estimate.	N/A	↑	Unquantified as of Aug 31	N/A
2	Feeder cabinet replacement to be incorporated into the estimate. Special Initiatives “Remove Feeder Cabinet Replacement from SOW” has been cancelled.	Special Initiatives	↑	7 million	N/A
3	Include budgetary goods estimate of the “Unpriced DECs” (6 DECs) and update prices for any firm quote received.	OSM and Goods	↑	$5 million	N/A

	Description	War Team	Trend	Per Unit Cost	Critical Path
4	Review the "Rate Table Reconciliation" to be provided by JV on August 31st. Modify estimate as necessary. For example, application of Statuary Holiday and Overtime to PMT to be corrected (1.5 base rate instead of burdened rate).	Commercial		Unquantified as of August 31st	N/A
7	For bulkhead shielding removal duration of 8.3 days was inserted into P6 for critical path. The correct number should have been 11 days. There is no impact on DFL labour given that this estimate was task based.	Pre and Post	↑	$ 3.6 million	+ 2.7 days
8	Containment Removal Pressure Test – Steps have been eliminated in the pressure test reducing the duration by 2.2 days on critical path but not able to implemented prior to freeze of critical path.	Pre and Post	↓	$ -2.9 million	-2.2 days
9	Containment Commissioning Pressure Test – Steps have been eliminated in the pressure test reducing the duration by 2 days on critical path but not able to implemented for freeze of critical path.	Pre and Post	↓	$ -2.6 million	-2 days
10	For RA bridge removal was 8 days was inserted into P6 for critical path. The critical path duration should have been 9 days. There is no impact on DFL labour given that this estimate was task based.	Pre and Post	↑	$ 1.3 million	+ 1 day
6	Incorporate QC findings into the Onboarding Training chapter	Training	↑	$ 0.85 million	N/A
11	TMOD waste processing to be incorporated into the estimate.	Pre and Post	↑	Unquantified as of August 31st	Unquantified as of August 31st

Table 7: RFR Execution Phase – Total Target Cost Summary

CLASS 2 Rev. 01 RFR Execution Phase Total Target Cost

Ref. No.	Cost Component	1st Unit		2nd Unit		3rd unit		4th Unit		Totals	
		Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost
1	**Vault**	[redacted]									
1.1	Direct Field Labour										
1.2	Spot Overtime Allowance for DFL - 4%										
1.3	Indirect Field Labour Support Services										
1.4	Indirect Field Labour TMO										
1.5	Radiation Work Allowance - under EPSCA Agreements for working in radiated areas in plastic suits.										
1.6	Subcontractors										
1.7	Subcontractors - Offsite Facilities										
1.8	Commissioning - part of Target Cost										
2	**Training**										
2.1	**On-boarding**										
2.1.1	DFL On-boarding Training										
2.1.2	PMT On-boarding Training										
2.2	**Series Training**										
2.2.1	DFL Series Training										
2.2.2	PMT Series Training included in Site PMT										
3	**PMT**										
3.1	PMT Site Labour										
3.2	PMT Home Office Labour										
3.3	Subsequent Units Site Labour										
3.4	Subsequent Units Home Office Labour										
3.5	Spot Overtime Allowance for PMT - 2%										
4	**Rework**										
4.1	Rework on Base Labour Target Cost (3%)										
4.2	Rework due to Contingency on Base Schedule (3%)										
4.3	Rework deducted from Contingency (3%)										
5	**Contingency**										
5.1	Target Labour Cost Contingency										
6	**SS&E**										
6.1	SS&E Target Cost (Base Schedule)										
6.2	SS&E (due to Contingency on Base Schedule)										
7	**Reimbursable with mark-up**										

CLASS 2 Rev. 01 RFR Execution Phase Total Target Cost

Ref. No.	Cost Component	1st Unit		2nd Unit		3rd unit		4th Unit		Totals	
		Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost
7.1	OSM	[redacted]									
7.2	Goods										
8	**Reimbursable without mark-up**										
8.1	Prudently incurred travel, accommodation and subsistence costs for EPSCA unionised resources, in accordance with the collective agreement.										
8.2	Prudently incurred travel, accommodation and subsistence costs for unionised and non-unionised Project staff (all grades up to and including Project Director), in accordance with the JV expenses policy that is valid at the time the expense is incurred										
8.3	Other JV Travel expenses than Site										
8.4	Value of Project LC										
8.5	RST on Health/Welfare Benefits - applies to Trades only - based on 8% of DFL welfare paid to EPSCA resources										
8.6	Value of Project Insurance										
Class 2 RFR Execution Phase Total Target Cost		**3,240,631**	**$476,283,422**	**3,238,654**	**$576,963,096**	**3,020,795**	**$543,729,244**	**3,378,882**	**$578,432,606**	**12,878,961**	**$2,175,408,369**
9	**Commissioning - not part of the Target Cost**	**17,904**	**$1,503,661**	**17,904**	**$1,503,661**	**17,904**	**$1,503,661**	**17,904**	**$1,503,661**	**71,614**	**$6,014,645**

Table 8: RFR Execution Phase – Cost Variance from Class 3 to Class 2 to be Replaced

Cost Variance Report from Class 3 to Class 2 Rev. 01								
Ref. No.	Cost Component	Class 3		Class 2 Rev. 01		Delta between Class 3 and Class 2 Rev. 01		Comments Rev. 01
		Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost	
1	Vault	[redacted]						-
1.1	Direct Field Labour							DEC TPG Test data was used as the basis for the critical path durations reducing the overall time and cost. Non TPG CWPs were estimated using detailed Work Instructions, thereby removing assumptions and reducing labour hours.
1.2	Spot Overtime Allowance for DFL - 4%							Directly proportionate to the overall DFL manhours.
1.3	Indirect Field Labour Support Services							The Variance to the Class 3 estimate for support services can be attributed to the transfer of Vault Coordinators, FME coordinators, Holders of Record, and RCC supervisors from the PMT organization to the Support Services DFL.
1.4	Indirect Field Labour TMO Previously known as TTMU							The strategy of estimating the TMO Labour in class 3 was based on one constant number of people working around the clock from the start of the outage to the finish. In Class 2 the activities for TMO labour are clearly defined with proper assigned budget and durations task based.
1.5	Radiation Work Allowance - under EPSCA Agreements for working in radiated areas in plastic suits.							New cost addition to Class 2 Rev. 01 Estimate. Not previously accounted for in the Class 3.
1.6	Subcontractors							Phased Array, NDE, Packaging & Preservation moved from SS&E. Tooling disposal carried as subcontractor for Class 2 Rev. 01, was part of reimbursable with markup in the previous submission. Detailed work instructions identified the need for various new subcontractors to perform specialized tasks.
1.7	Subcontractors - Offsite Facilities							Moved from Reimbursable with Markup to Target Cost.
1.8	Commissioning - part of Target Cost							
2	Training							
2.1	On-boarding							
2.1.1	DFL On-boarding Training							DFL On-boarding Class 3 assumed all DFL will on-board once during Unit 2. No on-boarding was estimated for the subsequent Units. Therefore, only requalification hours were applied to the remainder of the units. In Class 2, total on-boarding manpower follows DFL labour requirements for each unit. Initial on-boarding hours are carried for each unit and requalification hours properly allocated to 100 % on-boarded DFL. Also, On-Boarding Qualification Training matrix has been reevaluated and revised to meet Class 2 requirements. In Class 3, PMT On-boarding training was included in the overall PMT labour. For Class 2 the PMT on-boarding estimate is based on a Qualification Training matrix and latest manpower and is identified as a separate number. The estimated number of returning employees increased from Class 3 to Class 2 rev 1, resulting in an substantial reduction to the number of new hires onboarding that will require initial training.
2.1.2	PMT On-boarding Training							In Class 3, PMT On-boarding training was included in the overall PMT labour. For Class 2 the PMT on-boarding estimate is based on a Qualification Training matrix and latest manpower and is identified as a separate number
2.2	Series Training							
2.2.1	DFL Series Training							The variance in Series Training Hours and the associated Series Training Cost results directly from a reduction in the number of hours of DFL training provided, and a revised strategy for cross-training for selected activities. The reduction of almost 25 percent was achieved through a review of training requirements on a course-by-course basis, and an estimation of the percentage of the total DFL that would require full training for the assigned activity or CWP.

Cost Variance Report from Class 3 to Class 2 Rev. 01

Ref. No.	Cost Component	Class 3		Class 2 Rev. 01		Delta between Class 3 and Class 2 Rev. 01		Comments Rev. 01
		Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost	
2.2.2	PMT Series Training	[redacted]						Included in PMT Site Labour
3	**PMT**							
3.1	PMT Site Labour							The overall changes from Class 3 to Class 2 Rev 01 on PMT is based on reviewing and realigning certain groups requiring additional support and reducing certain staff positions including consolidating some responsibilities. The main driver for the variance is the reduction of the overall construction schedule. The PMT is now a bottoms up methodology estimate. All staff is tied to critical path start stop milestone dates in P6, thereby enhancing their availability for other deployment possibilities.
3.2	PMT Home Office Labour							
3.3	Subsequent Units Site Labour							
3.4	Subsequent Units Home Office Labour							The Class 3 Estimate was being developed on a level of support for subsequent units based on the knowledge of effort hours spent and the projections to completion of Definition Unit 2. However, the current Class 2 Rev 01 approach reflects producing three units of engineering and procurement at the same time reducing the efforts required. The CWP and Quality Control process has also been streamlined to support three unit packages for construction and procurement following the revised process.
3.5	Spot Overtime Allowance for PMT - 2%							Directly proportionate to the overall PMT manhours.
4	**Rework**							
4.1	Rework Allowance - 3%							Directly proportionate to the total project manhours.
5	**Contingency**							
5.1	Target Labour Cost Contingency							
6	**SS&E**							
6.1	SS&E Target Cost (Base Schedule)							Phased Array, NDE, Packaging & Preservation, part of SS&E for Class 3 now are moved to subcontractors. Construction equipment is based on the latest requirements updated by more indepth understanding and changes in scope.
6.2	SS&E (due to Contingency on Base Schedule)							
7	**Reimbursable with mark-up**							
7.1	OSM							Additional OSM material and revised purchase orders increased overall costs.
7.2	Goods							Detailed bills of material identified Goods for TMODS. Tooling and Training identified required goods.
7.3	Offsite Facilities							Moved from Reimbursable with Markup to Target Cost.
8	**Reimbursable without mark-up**							
8.1	Prudently incurred travel, accommodation and subsistence costs for EPSCA unionised resources, in accordance with the collective agreement.							Directly proportionate to the total project manhours.
8.2	Prudently incurred travel, accommodation and subsistence costs for unionised and non-unionised Project staff (all grades up to and including Project Director), in accordance with the OPG expenses policy that is valid at the time the expense is incurred							Directly proportionate to the total project manhours.

Cost Variance Report from Class 3 to Class 2 Rev. 01

Ref. No.	Cost Component	Class 3		Class 2 Rev. 01		Delta between Class 3 and Class 2 Rev. 01		Comments Rev. 01
		Manhours	Total Cost	Manhours	Total Cost	Manhours	Total Cost	
8.3	JV Travel expenses, other than Site	[redacted]						The basis are unchanged.
8.4	Value of Project LC							Directly proportionate to the total project value.
8.5	RST on Health/Welfare Benefits - applies to Trades only - based on 8% of DFL welfare paid to EPSCA resources							Directly proportionate to the total EPSCA manhours.
8.6	Value of Project Insurance							
RFR Execution Phase Total Target Cost		**16,162,681**	**$2,016,519,917**	**12,878,961**	**$2,175,408,369**	**-3,283,720**	**$187,211,295**	

Table 9: Class 2 Rev. 01 Total Target Cost including Contingency and Fixed Fee Summary - RFR Execution Phase

Estimate Component	AACEi Class 2 Scope Mhrs	AACEi Class 2 Scope Target Cost A	Overhead		Profit		Fee			Total G = A + F
								Fee at Risk		
			% B	$ C = A x B	% D	$ E = D x (A+C)	Total F = C + E $	G %	H= F x G $	
Direct Hire - Home Office PMT	[redacted]									
Direct Hire - Site PMT										
Direct Hire - Craft										
Subcontractors										
Subcontractors - Offsite Facilities										
Commissioning support - part of target cost										
Subtotal										
Escalation										
Rework on Base Labour Target Cost (3%)										
Rework due to Contingency on Base Schedule (3%)										
Rework deducted from Contingency (3%)										
Contingency										
Subtotal										
SS&E (Base Schedule)										
Escalation										
SS&E (due to Contingency on Base Schedule)										
Subtotal										
Execution Phase Target Cost										

Table 10: Class 2 Rev. 01 Reimbursable with and without Markup - RFR Execution Phase

Estimate Component	AACEi Class 2 Scope Mhrs	AACEi Class 2 Scope Target Cost A	Overhead As Applicable		Markup and Fixed Fee as applicable		Total Markup and Fixed Fee F = C + E	Total G = A + F
			% B	$ C = A x B	% D	$ E = D x A		
OSM	[redacted]							
Goods								
COMMISSIONING SUPPORT - not part of target costs								
Subtotal								
REIMBURSABLE COSTS w/o M/U								
Execution Phase Target Cost								

Table 11: Class 2 Rev. 01 Total Project Summary - RFR Execution Phase

Estimate Component	AACEi Class 2 Scope Mhrs	AACEi Class 2 Scope Target Cost	Overhead	Profit and Markup	Total Fixed Fee and Markup	Fee at Risk	Total
Total Target Cost including Contingency and Fixed Fee	[redacted]						
Reimbursable with and without Markup							
Execution Phase Total Cost							

8 References

Basis of compliance is the following list of specific governance documentation:

8.1 Contract Documents

Engineering, Procurement and Construction Agreement (for) Darlington Refurbishment Retube and Feeder Replacement Project between OPG and JV, dated March 1, 2012. The reader is referred to the Estimate Plan [R76] Project Documents table that includes specific Plan Section number references for compliance with the Agreement.

[R1]	Article 2.5 (b)(4)	Access to Audit estimating Records
[R2]	Article 3.5 (i)	Implementation of the Execution Phase Plan
[R3]	Article 3.11 (a)	Productivity Gain Expectations
[R4]	Article 4.3	Changes Requested by Contractor ref. “Productivity Gain Percentages”
[R5]	Article 6.3 (a)(3)	Rework Allowance
[R6]	Exhibit 1.1 (fffffff)	Rate Tables
[R7]	Exhibit 1.1 (qqqqqqq)	Tooling Performance Guarantee
[R8]	Exhibit 2.1	RFR Scope of Work
[R9]	Exhibit 2.1, Section 9	Commissioning
[R10]	Exhibit 2.8(b)	OPG Approvals
[R11]	Exhibit 2.9(a)	Submittal Review Periods
[R12]	Exhibit 2.9(b)	Submittal Requirements
[R13]	Exhibit 2.9(j)	Project Controls
[R14]	Exhibit 3.1(a)	Definition Phase Milestone Schedule
[R15]	Exhibit 3.1(b)	Execution Phase Milestone Schedule
[R16]	Exhibit 3.1(c)(A)	Target Schedule for Definition Phase Work
[R17]	Exhibit 3.1(c)(B)	Target Schedule for Execution Phase Work
[R18]	Exhibit 3.1(d)(A)	Submittal Schedule for Definition Phase
[R19]	Exhibit 3.1(d)(B)	Submittal Schedule for Execution Phase
[R20]	Exhibit 3.5	Development of the Execution Phase Target Schedule and Execution Phase Target Cost and Execution Phase Fixed Fee
[R21]	Exhibit 3.5, Sections 1-6	Execution Phase Schedule Requirements
[R22]	Exhibit 3.5, Section 7	Requirements for all Execution Phase Estimates

[R23]	Exhibit 3.5, Section 8	OPG Review of All Execution Phase Cost Estimates
[R24]	Exhibit 3.5, Section 9	Requirements for Class 2 Execution Phase Cost Estimate
[R25]	Exhibit 3.5, Section 10	Review of Class 2 Execution Phase Cost Estimate
[R26]	Exhibit 3.5, Section 11	Execution Phase Target Cost
[R27]	Exhibit 3.5, Section 12	Calculation of Execution Phase Fixed Fee
[R28]	Exhibit 3.5, Sections 13-17	Requirements for Risk Register development, etc.
[R29]	Exhibit 3.5, Section 18	Contingency
[R30]	Exhibit 3.5, Section 19	Execution Phase SS&E Target Cost
[R31]	Exhibit 3.5, Section 20	Calculation of Execution Phase SS&E Fixed Fee
[R32]	Exhibit 3.11	Sample Calculations for Productivity Gains
[R33]	Exhibit 4.7	Economic Cost Adjustments
[R34]	Exhibit 6.1	Pricing
[R35]	Exhibit 6.3(a)	Cost Allocation Table
[R36]	Amendment No. 1	Including related Project Change Directives
[R37]	Amendment No. 2	Including related Project Change Directives

8.2 Standards and OPG Procedures

8.2.1 AACEi Recommended Practices

[R38]	No. 10S-90	Cost Engineering Terminology
[R39]	No. 17R-97	Cost Estimate Classification System
[R40]	No. 18R-97	Cost Estimate Classification System
[R41]	No. 27R-03	Schedule Classification System
[R42]	No. 32R-04	Determining Activity Durations
[R43]	No. 34R-05	Basis of Estimate
[R44]	No. 36R-08	Development of Cost Estimate Plans
[R45]	No. 37R-06	Schedule Levels of Detail
[R46]	No. 57R-09	Integrated Cost and Schedule Risk Analysis using Monte Carlo Simulation of a CPM Model.
[R47]	AACEi Total Cost Management framework	Chapter 7 – Schedule Planning and Development

8.2.2 OPG Procedural References

OPG is currently preparing a contract Amendment revising the reference document section. Until such time the Amendment is approved, the Project shall utilize the documents referenced in the original Agreement.

[R48]	N-GUID-09701-10008	Nuclear Refurbishment – Gated Process
[R49]	N-INS-00120-10022	Cost and Schedule Change Control
[R50]	N-INS-09701-10001	Risk Management
[R51]	NK38-GUID-09701-10006	Project Work Breakdown Structure Guide
[R52]	NK38-INS-00400-10001	Nuclear Refurbishment Cost Estimating
[R53]	NK38-PLAN-09701-10003	Scope Management
[R54]	N-PROC-LE-0008	Assumptions, Issues and Decisions Management
[R55]	N-PROC-LE-0010	Cost and Schedule Change Control
[R56]	N-PROC-LE-0011	Cost Estimating
[R57]	N-PROC-LE-0012	Cost Management and Project Reporting
[R58]	OPG-PROC-0025	Risk and Contingency Management
[R59]	N-PROC-LE-009	Schedule Management
[R60]	N-INS-00120-10022	Cost and Schedule Change Control
[R61]	N-PROC-LE-0013	Contingency Development and Management
[R62]	OPG-STD-0062	Project Risk Management Standard (Replacing OPG-PROC-0025) – Subject to formal confirmation by OPG by Change Directive.
[R63]	NK38-SOW-31100-10016	Darlington Retube and Feeder Replacement Scope of Work, Exhibit 2.1 [R8].

8.3 JV References

8.3.1 Previous Class Estimates

[R64]	509407-0000-00000-33RA-0001	Execution Phase Class 5 Estimate, Level 2 Schedule and Risk Report, with exhibits.
[R65]	509407-0000-00000-33RA-0089	Execution Phase Class 4 Estimate, Level 3 Schedule and Risk Report, with exhibits.
[R66]	509407-0000-00000-33RA-0097	Execution Phase Class 3 Estimate, Level 4 Schedule and Risk Report, with exhibits.
	509407-0000-00000-33RA-0XXX	Execution Phase Class 2 Rev 00 Estimate, Level 5 Schedule and Risk Report, with exhibits

8.3.2 Project Documents

The JV has developed a set of RFR Project specific complimentary procedural documents for managing the Work:

[R67]	509407-0000-00000-30AG-0001	Travel and Per Diem Policy – Darlington RFR
[R68]	509407-0000-00000-30IM-0001	Project Controls Plan
[R69]	509407-0000-00000-30IM-0002	Resource Management Plan
[R70]	509407-0000-00000-30IM-0003	Scope and Change Management Plan
[R71]	509407-0000-00000-30IM-0004	Deliverables Plan
[R72]	509407-0000-00000-30IM-0005	Risk Management Plan
[R73]	509407-0000-00000-30IM-0006	Project Management Plan
[R74]	509407-0000-00000-30IM-0024	Project Management Plan (Execution Phase)
[R75]	509407-0000-00000-32IM-0001	Schedule Management Plan
[R76]	509407-0000-00000-33IM-0001	Project Estimate Plan
[R77]	509407-0000-00000-34IM-0001	Cost Management Plan
[R78]	509407-0000-00000-38QP-0001	Project Quality Assurance Plan
[R79]	509407-0000-00000-40EP-0001	Engineering Plan
[R80]	509407-0000-00000-50IM-0001	Procurement and Material/Procurement Management Plan
[R81]	509407-0000-00000-51IM-0001	Contract Management Plan
[R82]	509407-1234-00000-38QP-0001	Project Quality Assurance Plan
[R83]	509407-0000-00000-60IM-0019	Execution Phase – CWP Preparation Planning
[R84]	509407-0000-00000-33RA-0141	Class 2 Rev 00 Estimate Flow Diagram (EFD)
[R85]	509407-0000-00000-60IM-0001	Infrastructure and Space Allocation Plan
[R86]	509412-0000-00000-30IM-0006	Tool Management Plan
[R87]	509412-0000-00000-30RA-0002	RFR Tool Quantities Strategy Report
[R88]	509412-30CC-I-0044	Letter from JV to OPG “RFR Tooling Quantities Strategy” dated October 1, 2013
[R89]	509407-0000-00000-73IM-0001	Training Plan

[R90]	509407-0000-00000-30IM-0009	Communications Plan
[R91]	509407-33GA-I--0001	Class 3 / Level 4 Communication Protocol
[R92]	Engineering WBS	1st Unit Plant Modifications & Darlington Energy Centre Engineering Scopes Work Breakdown Structure

8.3.3 Corporate Procedures (Selected Processes as Required)

[R93]	2206-05-10-OP-0001	Project Planning and Execution
[R94]	2206-05-10-OP-0002	Cost Engineering and Estimating
[R95]	2206-05-10-OP-0003	Cost Control and Accounting

8.3.4 Series Execution Plans

[R96]	509407-0000-00000-60IM-0037	Feeder Removal
[R97]	509407-0000-00000-60IM-0026	Remove Closure Plugs, PA Hardware, and Trapping Feeders
[R98]	509407-0000-00000-60IM-0029	CTI Removal
[R99]	509407-0000-00000-60IM-0048	Lower Feeder Install
[R100]	509407-0000-00000-60IM-0036	Install Temp Power Distribution System
[R101]	509407-0000-00000-60IM-0025	RTP Installation & Set Up
[R102]	509407-0000-00000-60IM-0031	PT Severing
[R103]	509407-0000-00000-60IM-0032	Bellows Severing
[R104]	509407-0000-00000-60IM-0035	Feeder Preparation
[R105]	509407-0000-00000-60IM-0052	Clean Room
[R106]	509407-0000-00000-60IM-0047	Upper Feeder Install
[R107]	509407-0000-00000-60IM-0033	End Fitting Removal
[R108]	509407-0000-00000-60IM-0039	Pressure Tube Removal
[R109]	509407-0000-00000-60IM-0040	CTI Release
[R110]	509407-0000-00000-60IM-0042	CT Removal
[R111]	509407-0000-00000-60IM-0044	CT Installation
[R112]	509407-0000-00000-60IM-0045	FC Installation
[R113]	509407-0000-00000-60IM-0049	Shield Plug & Closure Plug Installation
[R114]	509407-0000-00000-60IM-0043	RTP Removal & Restoration
[R115]	509407-0000-00000-60IM-0030	Misc. Out of Vault Pre-Reqs

[R116] 509407-0000-00000-60IM-0028	Misc. In-Vault Pre-Reqs
[R117] 509407-0000-00000-60IM-0057	Removal of Temp Power Distribution System
[R118] 509407-0000-00000-60IM-0027	Installation of Containment Isolations
[R119] 509407-0000-00000-60IM-0034	Install Vault Systems
[R120] 509407-0000-00000-60IM-0038	Install RCC Building Incl. Services
[R121] 509407-0000-00000-60IM-0041	Fuel Channel Drain
[R122] 509407-0000-00000-60IM-0046	PHT Vacuum Drying
[R123] 509407-0000-00000-60IM-0050	Hook-Up Mod Dry Equipment Perform Mod Dry
[R124] 509407-0000-00000-60IM-0051	Inspection
[R125] 509407-0000-00000-60IM-0062	FME Plan
[R126] 509407-0000-00000-60IM-0054	Removal of Moderator Dry Equipment
[R127] 509407-0000-00000-60IM-0055	Misc. In-Vault Post-Reqs
[R128] 509407-0000-00000-60IM-0056	Misc. Out of Vault Post-Reqs
[R129] 509407-0000-00000-60IM-0058	Removal of Containment Isolations

8.3.5 Chapter Reports

[R130] 509407-0000-00000-33RA-0144	Execution Phase Class 2 Rev 00 Milestone Report
[R131] 509407-0000-00000-33RA-0145	Schedule Report
[R132] 509407-0000-00000-33RA-0146	Owner Specified Materials (OSM)
[R133] 509407-0000-00000-33RA-0147	DFL Summary Report- Series
[R134] 509407-0000-00000-33RA-0148	Pre-Requirements
[R135] 509407-0000-00000-33RA-0149	Feeder Removal
[R136] 509407-0000-00000-33RA-0150	Fuel Channel Removal
[R137] 509407-0000-00000-33RA-0151	Inspection
[R138] 509407-0000-00000-33RA-0152	Fuel Channel Installation
[R139] 509407-0000-00000-33RA-0153	Post-Requirements
[R140] 509407-0000-00000-33RA-0154	Waste Volume Reduction
[R141] 509407-0000-00000-33RA-0155	Supervision (EPSCA) and Project Management Team (PMT)
[R142] 509407-0000-00000-33RA-0156	Trades Support
[R143] 509407-0000-00000-33RA-0157	Training – Series
[R144] 509407-0000-00000-33RA-0158	Training - Onboarding

[R145] 509407-0000-00000-33RA-0159 Preparations for Subsequent Units (Unitized Engineering, CWP's and Procurement)

[R146] 509407-0000-00000-33RA-0160 Living Out Allowance (LOA) Craft and Staff and JV Travel

[R147] 509407-0000-00000-33RA-0161 Support Services & Equipment (SS&E)

[R148] 509407-0000-00000-33RA-0162 Scope Change Control Issues

[R149] 509407-0000-00000-33RA-0163 Tool Management

[R150] 509407-0000-00000-33RA-0164 Demobilization and Project Closeout

[R151] 509407-0000-00000-33RA-0165 Risk Report

[R152] 509407-0000-00000-33RA-0166 Feeder Installation

[R153] 509407-0000-00000-33RA-0167 ALARA & Dose Analysis

[R154] 509407-0000-00000-33RA-0168 Labour Productivity Factors

[R155] 509407-0000-00000-33RA-0169 "What If" Scenarios

[R156] 509407-0000-00000-33RA-0170 PMT and DFL Manpower Levelling

[R157] 509407-0000-00000-33RA-0171 Commissioning Support

[R158] 509407-0000-00000-33RA-0172 Contingency Target Cost & Target Schedule Development

[R159] 509407-0000-00000-33RA-0173 Compliance

9 Acronyms

Acronym	Definition
AACEi	Association for the Advancement of Cost Engineering International
Agreement	The Agreement for the RFR Project Between OPG and the Contractor
AIR	Action Items Registry
ALARA	As Low As Reasonably Achievable
ARO	After Receipt of Order - The date of the Agreement
AS	Annulus Spacer
BM	Boilermaker
BoE	Basis of Estimate
BP1	Bruce Power Unit 1
BP2	Bruce Power Unit 2
BST	Bellows Severing Tool

Acronym	Definition
CAT	Cost Allocation Table (Exhibit 6.3(a))
CBS	Cost Breakdown Structure
CDS	Comment Disposition Sheet
CL 3	Class 3
CL 4	Class 4
CL 5	Class 5
CoA	Code of Accounts or Charge Codes (for type of charges to be estimated and tracked separately)
COMs	Constructability, Operations, and Maintenance
Contractor	The SLN-Aecon Joint Venture
CP	Critical Path
CPI	Cost Performance Index
CT	Calandria Tube
CTI	Calandria Tube Insert
CTSB	Calandria Tube & Sheet Bore
CV	Calandria Vessel
CVI	Calandria Vessel Inspection
CVIT	Calandria Vessel Inspection Tool
CWP	Comprehensive Work Package
D_2O	Deuterium Oxide
DEC	Darlington Energy Complex
DFL	Direct Field Labour
DNGS	Darlington Nuclear Generating Station
DOR	Division of Responsibility
DRT	Debris Removal Tool
DWI	Detailed Work Instruction
E/W	East/West
EAC	Estimate (or forecast) At Completion
ECI	Emergency Cooling Injection
eCMS	AECON's Project Management System
EF	End Fitting

Acronym	Definition
EP	Engineered Penetration
EPC	Engineering, Procurement and Construction
EPSCA	Electrical Power Systems Construction Association
FARO	Scanning/Coordinate System
FAT	Factory Accepted Tested
FC	Fuel Channel
FCP	Fuel Channel Platform
FM	Foreman
FME	Foreign Material Exclusion
FP	Feeder Platform
FROB	Flow Restricting Orifice Bundle
GCS	Global Control System
GCS	Global Coordinate System
GF	General Foreman
GTCS	Generic Tool Control System
HWT	Heavy Work Table
IT	Information Technology
IWT	Installation Work Table
JM	Journeyman
JV	Joint Venture (the Contractor)
L	Level
LISS	Liquid Injection Safety System
LLW	Low Level Waste
LMS	Learning Management System
LSA	Lattice Sleeve Assembly
LT	Lattice Tube
LTGS	Lattice Tube Guide Sleeve
LTSP	Lattice Tube Shield Plug
LT-SPIRT	Lattice Tube Shield Plug insert Removal Tool
MFL	Manpower Forecast Leveling
MODS	Modifications (to be Implemented During Definition Phase)

Acronym	Definition
MOM	Minutes of Meeting
MSA	Master Services Agreement
MW	Millwright
N/C	No Changes
NDE	Non-Destructive Examination
NFL	New Fuel Loading
N-INS	OPG Procedural Document - "N-INS" designation
OBS	Organization Breakdown Structure
OEM	Original Equipment Manufacturer
OP&P	Operating Policies and Procedures
OPEX	Operating Experience
OPG	Ontario Power Generation
OSM	Owner Specified Material
PA	Purchase Agreement
Page / Means/NECA	Refers to three sources for estimating: - John S. page: “Estimators Piping Man-Hour manual”, fifth edition, dated 2011. - RS Means: “Estimating Handbook, third edition, dated August 2009. - NECA – National Electrical Contractors Association
PAUT	Phased Array Ultrasonic Testing
PCM	Project Controls Manager
PCP	Project Controls Plan
PD	Project Director
PDMC	Project Document Management and Control
PDS	Power Distribution System
PFD	Process Flow Diagram
PHT	Primary Heat Transport
PHTS	Primary Heat Transport System
PIMS	Program Integrated Management System
Plan	The present Estimate Plan (Execution Phase)
PLP	Point Lepreau
PM	Project Manager

Acronym	Definition
PM+	The SNC Project Management System
PMC	Project Management and Controls
PMOD	Permanent Modification
PMP	Project Management Plan
PMT	Project Management Team
PO	Purchase Order
PP	Parallel Path
PT	Pressure Tube
PT/FE	Pressure Transmitter/Flow Element
PTST	Pressure Tube Serving Tool
PTZ	Pano-Tidt-Zoom
QA	Quality Assurance
QC	Quality Control
R&C	Review and Comment
RA	Reactor Area
RCC	Retube Control Center
RFR	Retube and Feeder Replacement
RP	Radiation Protection
RPA	Radiation Protection Assistant
RQE	Release Quality Estimate (define what this term is - an OPG term not defined in the Agreement)
RTD	Resistance Temperature Detectors
RTP	Retube Tooling Platform
RWPB	Retube Waste Processing Building
SA	Sub-Assembly
SCP	Series Concept Plan
SDC	Shutdown Cooling
SFCR	Single Fuel Channel Replacement
SFM	Sub-Foreman
SLN	SNC-Lavalin Nuclear Inc.
SLN-Aecon	SNC-Lavalin Nuclear, Aecon Joint Venture, The Contractor

Acronym	Definition
SME	Subject Matter Experts
SOW	Scope of Work
SP	Shield Plug
SPEA	The Society of Professional Engineers and Associates
SPI	Schedule Performance Index
SPOC	Single Point of Contact
SS&E	Support Services and Equipment
T&M	Time & Material
T/O	Turnover
TMOD	Temporary Modification
TPG	Tool Performance Guarantee (per Agreement)
TSB	Tube Sheet Bore
USI	Unified Subject Index
VAS	Vault Alignment System
VCS	Vault Communication System
VOS	Vault Observation System
W1	Wolsong Unit 1
WBS	Work Breakdown Structure includes all work scope related to the Project, including those by OPG and Others

Appendix A –Series Schedule Durations

Appendix B – Intentionally Left Blank

Appendix C – Intentionally Left Blank

Appendix D – RFR Logic Flow Diagram (LFD)

D.1 Vault Preparation and Removal Series

D.2 Inspection, Installation and Vault Series Rehabilitation

Appendix E – Intentionally Left Blank

Appendix F – Chapter Reports

Document Number	Class 2 Chapter Title	Chapter Status
509407-0000-00000-33RA-0145	Schedule Report	Appended to this Report
509407-0000-00000-33RA-0146	Owner Specified Materials (OSM)	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0147	DFL Summary Report- Series	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0148	Pre-Requirements – Containment Isolation	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0149	Feeder Removal	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0150	Fuel Channel Removal	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0151	Inspection	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0152	Fuel Channel Installation	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0153	Post-Requirements – Containment Removal	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0154	Waste Volume Reduction	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0155	Supervision (EPSCA) and Project Management Team (PMT)	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0156	Support Services (Trades Support)	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0157	Training – Series	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0158	Training – Onboarding	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0159	Preparations for Subsequent Units (Unitized Engineering, CWP's and Procurement)	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0160	Living Out Allowance (LOA) Craft and Staff and JV Travel	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0161	Support Services & Equipment (SS&E)	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0162	Scope Change Control	Appended to this Report
509407-0000-00000-33RA-0163	Tool Management	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0164	Demobilization & Project Closeout	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0165	Risk Report	Appended to this Report
509407-0000-00000-33RA-0166	Feeder Installation	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0167	ALARA & Dose Analysis	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0168	Labour Productivity Factors	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0169	"What-If" Scenarios	To follow in Class 2 Milestone Report

Document Number	Class 2 Chapter Title	Chapter Status
509407-0000-00000-33RA-0170	PMT and DFL Manpower Leveling (Intentionally Omitted)	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0171	Commissioning Support	To follow in Class 2 Milestone Report
509407-0000-00000-33RA-0172	Contingency Target Cost and Target Schedule Development	Appended to this Report
509407-0000-00000-33RA-0173	Compliance	Appended to this Report

Appendix G – Comprehensive Work Package (CWP's) Estimates

CWP #	Description
0010	Waste Volume Reduction, Tooling Operations
0038	Install Waste Tooling System Civil – Platform Installation
0039	Install Waste Tooling System Mechanical – Waste Processing Units Install and Commission
0040	Install Waste Tooling System - Electrical
0041	Install Waste Tooling System - I&C
0042	Waste Tooling System – Platform, Lidding Station, Rail Station, Rail System and Hardware Station Removal
0043	Waste Tooling System - Mechanical Removal and Decommissioning, Tooling
0044	Remove Waste Tooling System - Electrical
0045	Remove Waste Tooling System - I&C
2001	Tie-In of RCC to Public Address Equipment (SCI 60215)
2002	Tie-In of RCC to Telecommunication Leased Facilities (SCI 60220)
2003	Tie-In of RCC to Local Information Facilities (OPG LAN) (SCI 08188)
2004	Tie-In of RCC to Fire & Smoke Detection (SCI 67870)
2005	Removal RCC Public Address Equipment Tie-In (SCI 60215)
2006	Removal of RCC to Telecommunication Leased Facilities (SCI 60220)
2007	Removal of RCC to Local Information Facilities (OPG LAN) (SCI 08188)
2008	Removal of RCC to Fire & Smoke Detection (SCI 67870)
2009	Tie-In of RCC to 600 VAC Power Distribution Panel
2010	Removal of RCC to 600 VAC PDS Power Distribution Panel
2011	Civil Installation of RCC Trailer
2012	Civil Removal of RCC Trailer
2013	Installation of RCC Internals
2014	Removal of RCC Internals
2017	Install RTP Columns / Decking c/w anchors / Structural Bracing & Stiffeners
2018	Install Access Stairs / Landings (Scaffolding)
2019	Remove Access Stairs / Landings (Scaffolding)
2020	Removal of Retube Tooling Platform
2023	Provide Staging and Storage areas Communication
2024	Remove Staging and Storage areas Communication
2026	Provide Breathing Air and Service Air to Staging and Storage Areas
2027	Setup Off Gas Tent for Staging and Storage Areas
2029	Remove Breathing Air and Service Air from Staging and Storage Areas
2030	Remove Off Gas Tent from Staging and Storage Areas
2031	Provide Manufacturing of RFR Power Carts and Provide Temporary Lighting to Vault During RFR Work
2033	Remove Temporary Lighting From Vault After RFR Work

CWP #	Description
2035	Increase Shielding Wall Opening and Remove Shielding Door
2036	Repair Shield Wall Opening and Reinstall Shielding Door
2037	Vent Riser Mod & Floor Opening Cover Install
2038	Vent Riser Mod & Floor Opening Cover Removal
2039	Reinforce AL-1 Structural Steel Floor Deck
2040	Remove AL-1 Structural Steel Floor Deck
2041	Floor Hatch and Trench Reinforcement
2042	Configure Depressed Area of Shielding Sliding Door to Match Existing Floor Elevation
2043	Remove Floor Hatch and Trench Reinforcement
2044	Re-Establish Depressed Area of Shielding Sliding Door
2045	Install AGV System
2046	Remove AGV System
2047	Install 20 Ton Gantry Crane
2048	Install Buffer Nests
2049	Remove 20 Ton Gantry Crane
2050	Remove Buffer Nests
2051	Installation of Weather Shield Enclosure
2052	Removal of Weather Shield Enclosure
2053	Install 4.16KV Switchgear and Transformers, Main 600V and 480V Panels, Switchgear Charger, Cables and Tie-In to 4.16KV Bus
2054	Remove 4.16KV Switchgear and Transformers, Main 600V and 480V Panels, Switchgear Charger, Cables and Tie-In to 4.16KV Bus
2055	Install TPDS 600V Panels, Power Carts, and Cables in RAB
2056	Remove TPDS 600V Panels, Power Carts, and Cables in RAB
2057	Install Structural Tie-ins for Temporary Power Distribution Equipment (Civil)
2058	Remove Structural Tie-ins for Temporary Power Distribution Equipment (Civil)
2059	Remove Staircase Towers and Associated Platforms
2060	Replace Staircase Towers and Associated Platforms
2061	Remove Miscellaneous Steel Within Tooling Envelope
2062	Replace Miscellaneous Steel Within Tooling Envelope
2063	Structural Interference Removal Supporting Mechanical and Electrical
2064	Reinstallation of Structural Interference Supporting Mechanical and Electrical
2065	Containment Vault Cranes Upgrade
2066	Vacuum Drying of PHT main circuit
2067	Primary Heat Transfer Vacuum Dry Equipment Electrical Tie In
2073	Feeder Platform Install

CWP #	Description
2074	Feeder Platforms and Template Removal
2075	Monorail Installation
2076	Monorail Removal
2077	Remove Tooling Electrical Interferences
2078	Restore Tooling Electrical Interferences
2079	Remove RA Bridge Electrical Interferences
2080	Restore Electrical Interferences Related to RA Bridge Motors and Cables
~~2081~~	~~Remove Electrical Interferences related to SDS2 cables~~
~~2082~~	~~Restore Electrical Interferences related to SDS2 cables~~
2083	Installation of Temporary Argon Supply to RTP
2084	Removal of Temporary Argon Supply to RTP
2085	Installation of Temporary Service Air Supply to RTP
2086	Removal of Temporary Service Air Supply to RTP
2087	Provide Breathing Air to Retube Tooling Platforms
2092	Reinstall Gland Seal Line 2-3334-L60 Between 2-3341-L6 and 2-3334-HV7
2094	Replace HT Shutdown Cooling 3341-L2, L4, L6 & L8 and 3334-L60 Located SE Corner of Vault (SCI 33410)
2095	Protect Emergency Coolant Injection System 0-34320-L50-A12SA Located Outside Overhead Door
2096	Protect Liquid Injection Shutdown System 3471-L106, L107 & L108 Located Inside Bunker
2097	Removal protection from Emergency Cooling Injection Vent
2098	Removal of Protection from Liquid Injection Shutdown System Piping
2099	Remove Vault Periscopes 2-35651-VP1 & VP2 @ Col’s FZ-13.7 & OX-13.7 (SCI 35651)
2100	Remove Reactor Area Bridge, Carriage & Suspension Including (2) Beams, (8) Ball Screws & (2) Carriages (SCI 35220)
2101	Reinstall Vault Periscopes 2-35651-VP1 & VP2 @ Col’s FZ-13.7 & OX-13.7 (SCI 35651)
2102	Reinstall Reactor Area Bridge, Carriage, Elevators, Ball Screws and other Components (SCI 35220)
~~2103~~	~~Relocate Reactor Vault and Fueling Duct Vapour Recovery L8-A8B @ Col's OX-14.2 (SCI 38310)~~
~~2104~~	~~Replace Reactor Vault and Fueling Duct Vapour Recovery L8-A8B @ Col's OX-14.2 (SCI 38310)~~
2105	Relocate Powerhouse Heating - Ducting System (SCI 73230)
2106	Relocate Powerhouse Heating - Condensate System (SCI 73230)
2107	Relocate Reactor Vault Atmosphere System (SCI 73720)
2108	Reinstall Powerhouse Heating - Ducting System (SCI 73230)
2109	Replace Powerhouse Heating - Condensate System (SCI 73230)
2110	Replace Reactor Vault Atmosphere System (SCI 73720)
2112	Removal of Instrument Air Interferences
2113	Removal of Existing Breathing Air Stations
2115	Reinstallation of Instrument Air Interferences

CWP #	Description
2116	Removal of Temporary Breathing Air Piping and Reinstallation of Existing Breathing Air Stations
2119	Remove Air Winch Under East and West Staircase Tower
2120	Replace Air Winch Under East and West Staircase Tower
2121	Install, Operate and Remove Upper Moderator Dry Systems (SCI 38310)
2122	Install Moderator Drying System Tie-in to VVRS (SCI 38310)
2123	Install Electrical Tie-Ins for Moderator Drying System
2124	Installation of Bulkheads, Welding of Seal Plates and Installation of Shielding
2125	Remove Bulkheads, Remove Seal Plates and, Remove Shielding
2126	Calandria Seal Interspace Pressure-Leak Test
2127	Remove and Isolate RVAS Ducts Connecting Reactor Vault to Fuelling Duct
2128	Install Seal Plugs in Three SDC Rooms Flood Drains
2129	Isolate Multiple Drains to D2O Recovery from Reactor Vault to Fuelling Duct
2130	Modify & Isolate Multiple EPs from SDC to Fuelling Duct
2131	Reconnect RVAS Ducts Connecting Reactor Vault to Fuelling Duct
2132	Remove Isolation from Multiple DPs from Lower SDC to Fuelling Duct
2133	Remove Isolations from Drains to D2O Recovery (Reactor Vault to Fuelling Duct)
2134	Remove Seal Plugs from Multiple EPs (SDC to Fuelling Duct)
2135	Pre-Isolation Containment Equipment Tie-Ins (Installation)
2136	Post-Isolation Containment Equipment Tie-Ins (Installation)
2137	Pre-Isolation Containment Instrumentation (Installation)
2138	Post-Isolation Containment Instrumentation (Installation)
2141	Feeder Coupling Disconnect
2142	Feeder Removal
2143	Lower Feeder Preparation
2144	Header Nozzle Inspection, Repair and Weld Preparation
2145	Upper Feeder Install
2146	Lower Feeder Installation
2147	Feeder Cabinet Removal
2148	Feeder Cabinet Installation
2149	Instrumentation Tubing – Channel Monitor Removal
2150	Feeder Instrumentation - Channel Monitor Installation
2161	GCS Establishment
2164	Positioning Assembly Hardware and Fuel Channel Closure Plug Removal, Helicoil Replacement and Trapping Feeder Removal
2166	PT Sever
2167	Bellows Severing

CWP #	Description
2168	End Fitting Removal (SCI 31100)
2169	PT Removal
2170	Bellows Replacement (Contingency)
2171	FC Component Preparation
2172	Fuel Channel Installation
2173	Shield Plug / Closure Cap Installation & New Fuel Loading
2174	Single Fuel Channel Replacement (Contingency)
2175	Calandria Tube Insert Release
2176	Calandria Tube Removal
2177	CT Removal
2178	Calandria Vessel Inspection
2179	Lattice Tube and Bellows Inspection
2180	Tube sheet Bore Cleaning and Inspection
2181	Final FME Inspection and Debris Retrieval
2182	CT and CTI Component Preparation
2183	CT Installation
2185	Modify & Isolate EPs with Process Line (SCI 34200)
2186	Remove Isolation Multiple EPs from Process Lines (SCI 34200)
2187	Temporary Containment Boundary Commissioning Pressure Test
2188	Return to Service Pressure Test
2189	Upper Feeder Preparation
2191	Install Protective Relays to 4.16 KV Class IV Bus
2192	Install TPDS 600V Panels and Power Carts, 480V Panels and Power Carts, and Cables in RB
2193	Remove TPDS 600V Panels and Power Carts, 480V Panels and Power Carts, and Cables in RB
2194	Install CTI Transformers, Panels and Cables in RB
2195	Remove CTI Transformers, Panels and Cables in RB
2196	Feeder Scanner Removal
2197	Feeder Scanner Installation
2198	Vault Communication Network (VOS Cameras, VCS Base Stations, Cabling) Installation
2199	Vault Communication Network (VOS Cameras, VCS Base Stations, Cabling) Removal
2201	Feeder Instrumentation Tubing Installation
2202	Primary Heat Transfer Auxiliary Circuit Vacuum Dry Operation and Maintenance
2203	Install, Operate and Remove Lower Moderator Vacuum Dry Systems (SCI 32110)
2205	Install New Cable Tray System in RAB
2206	Remove New Cable Tray System in RAB

CWP #	Description
2207	Install New Cable Tray System in RB
2208	Remove New Cable Tray System in RB (Reactor Building)
2209	Primary Heat Transfer Auxiliary Circuit Vacuum Dry
2210	Install Isolations between Upper and Lower Moderator Systems
2211	Remove Electrical Tie-Ins for Moderator Drying System
2212	East Control Cabling Installation
2213	West Control Cabling Installation
2214	East Control Cabling Removal
2215	RTP Electrical Installation – East Side
2216	RTP Electrical Installation – West Side
2217	RTP Electrical Removal – East Side
2218	RTP Electrical Removal – West Side
2219	Remove Lighting Interferences Related to Tooling Installation & Operations
2220	Restore Lighting Interferences Related to Tooling Installation & Operations
2221	Pre Isolation Containment Equipment Tie-Ins and Test (Removal)
2222	Post Isolation Containment Equipment Tie-Ins and Test (Removal)
2223	Pre-Isolation Containment Instrumentation (Removal)
2224	Post-Isolation Containment Instrumentation (Removal)
2227	FROBS and Dummy Bundles Removal
2228	Calandria Tube Removal Contingency
2229	Install, Operate and Remove Munters
2230	Install, Operate and Remove Temporary Vault ACUs
2231	Install Power Supply for Feeder Welding Equip
2232	Remove Power Supply for Feeder Welding Equip
2235	Remove Moderator Drying System tie-in to VVRS
2236	Remove Isolations between Upper and Lower Moderator Systems
2237	Primary Heat Transfer Auxiliary Circuit Vacuum Dry
2238	Cooling coil and fan motor replacement for ACU #1
2239	Cooling coil and fan motor replacement for ACU #2
2240	Cooling coil and fan motor replacement for ACU #3
2241	Cooling coil and fan motor replacement for ACU #4
2242	Install Temporary Power for RFR Misc. Loads
2243	Remove Temporary Power for RFR Misc. Loads
2244	West Control Cabling Removal
2245	End Fitting Seal Caps & Mini-platform (T-1756) Installation

CWP #	Description
2246	Remove Protective Relays to 4.16 KV Class IV

Appendix H – ISEP's

Appendix I – Supporting Documentation

RFR Class 2 Rev 01 Native File Mapping
Aug-24-15 DRAFT

Legend
: Included in Class 2 Rev 01 Aug 31/15 Report Submission
: To follow in the Sept 18/15 Class 2 Rev 01 Milestone Submission

ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
Submission							CD-xxxx.pdf
							509407 RFR Definition - Transmittal CD-0775 - DNGS RFR Project - Class 2 - Summary
							509407-30CC-I-0893-Letter-Submission of Class 2 Estimate Schedule and Risk
							FW: New VenDM message: Queued Transmittal 'NR-SLNA-R-IDC-xxx-xxxx' has been
							CWP Summary Spreadsheet - Class 2 - Copy (OPG).xlsx
							CWP Variance Reports Rev 1 - Class 2.xlsx
							RFR Execution Phase (Class 2 Estimate) (Rxx)for OPG submission Aug 31, 2015.xlsx
							509407-0000-00000-33RA-xxxx R00 Execution Phase Class 2 Rev 01 Summary Report_F
							509407-0000-00000-33RA-xxxx R00 Execution Phase Class 2 Rev 01 Summary Report_F
	Appendix A						
	Appendix B						Appendix B - RFR Engineering Scopes Work Breakdown Structure R10 17-APR-2015.pdf
	Appendix C						APPENDIX C - ESTIMATE FLOW DIAGRAM (EFD).pdf
	Appendix D						509407-0002-00000-30FS-0001_05.pdf
							509407-0002-00000-30FS-0002_05.pdf
							APPENDIX D-RFR LOGIC FLOW DIAGRAM(LFD).pdf
	Appendix E						APPENDIX E - 509412-0000-00000-30RA-0002_00.pdf
	Appendix F	509407-0000-00000-33RA-0145					509407-0000-00000-33RA-0145_00_FINAL.docx
							509407-0000-00000-33RA-0145_00_FINAL.docx
							Appendix B LFD sheet 1.pdf
							Appendix B LFD Sheet 2.pdf
							Appendix F Acumen Fuse Report All 5 Files - Schedule Quality.pdf
							Appendix G - Schedule Management QC Checks.pdf
							Appendix H Schedule Basis Meeting Record Sheets.pdf
							Appendix I Schedule Basis Meeting Minutes.pdf
							Appendix J Milestone table.pdf
			Compilation of Basis Sheets				1 EF Seal Caps.xlsx
							2 Bulkhead Install.xlsx
							3 Containment Test.xlsx
							4 Bulkhead Shielding Install.xlsx
							6 Remove FM Bridge.xlsx
							7 Install RTP Class 2 duration Basis Sheet CWP 2017 rev2.xlsx
							8 Feeder Cabinet Removal.xlsx
							9 Install Feeder Platform.xlsx
							10 Remove FC Closure Plugs.xlsx
							11 Feeder Coupling Disconnect TRANSITION IN.xlsx
							12 Feeder Coupling Disconnect.xlsx
							13 Feeder Coupling Disconnect TRANSITION OUT.xlsx
							14 Feeder Removal.xlsx
							15 Dummy Bundle Retrieval.xlsx
							16 PT Cut TRANSITION IN.xlsx
							17 PT Cut.xlsx
							18 PT Cut TRANSITION OUT.xlsx
							19 Bellows Cut TRANSITION IN.xlsx
							20 Bellows Cut.xlsx
							21 Bellows Cut TRANSITION OUT.xlsx
							22 EF Removal TRANSITION IN.xlsx
							23 EF Removal.xlsx
							24 EF Removal TRANSITION OUT.xlsx
							25 PT Removal TRANSITION IN.xlsx
							26 PT Removal.xlsx
							27 PT Removal TRANSITION OUT.xlsx
							28 CTI Release TRANSITION IN.xlsx
							29 CTI Release.xlsx
							30 CTI Release TRANSITION OUT.xlsx
							31 CTI Removal TRANSITION IN.xlsx
							32 CTI Removal.xlsx
							33 CTI Removal TRANSITION OUT.xlsx
							34 LT and Bellows Inspection TRANSITION IN.xlsx
							35 LT and Bellows Inspection.xlsx
							36 LT and Bellows Inspection TRANSITION OUT.xlsx
							40 Bellows Replacement.xlsx
							41 CTSB Inspection TRANSITION IN.xlsx
							42 CTSB Inspection.xlsx
							43 CTSB Inspection TRANSITION OUT.xlsx
							44 CT Installation TRANSITION IN.xlsx
							45 CT Installation.xlsx
							46 FME Inspection.xlsx
							47 CT Installation TRANSITION OUT.xlsx
							48 FC Installation TRANSITION IN.xlsx
							49 FC Install CWP 2172 Basis Sheet rev4.xlsx
							50 FC Installation TRANSITION OUT.xlsx
							51 Remove Feeder Platforms.xlsx
							52 Lower Feeder Installation.xlsx
							53 Lower Feeder Installation TRANSITION OUT.xlsx
							54 Upper Feeder Installation.xlsx
							55 New Fuel Load.xlsx
							56 Feeder Cabinet Install.xlsx
							57 Remove RTP Class 2 duration Basis Sheet CWP 2020 rev1.xlsx
							58 Restore FM Bridge.xlsx
							59 Install Staircase.xlsx
							61 AFS Containment Test.xlsx
							All basis sheets together.pdf
							CT Removal CWP 2177 Basis Sheet rev6.xlsx
							CWP 2177 Basis Sheet Transition IN.xlsx
							CWP 2177 Basis Sheet Transition OUT.xlsx
			Justin Alizadeh				General L5 Backup 20150509.xer
							L5 Backup 20150509.xer
							L5Backup 20141202.xer
				2015-05-09			Level 5 Schedule to be uploaded to OPG.msg
							P6 files .msg
							P6 Native Files.msg
							RE: Level 5 Schedule to be uploaded to OPG.msg
							Re: P6 files .msg
							RE: XER Backup.msg
					PMT		PMT U1 20150514.xer
							PMT U2 20150514.xer
							PMT U3 20150514.xer
							PMT U4 20150514.xer
					Schedule Log		DNG-RFR-LSU0-1 R0 - 20150514.pdf
							DNG-RFR-LSU1-1 R0 - 20150514.pdf
							DNG-RFR-LSU2-4 R0 - 20150514.pdf
							DNG-RFR-LSU3-1 R0 - 20150514.pdf
							DNG-RFR-LSU4-1 R0 - 20150514.pdf
					XER		DNG-RFR LSU0-1 R0 20150514.xer
							DNG-RFR LSU1-1 R0 20150514.xer
							DNG-RFR LSU2-4 R0 20150514.xer
							DNG-RFR LSU3-1 R0 20150514.xer
							DNG-RFR LSU4-1 R0 20150514.xer
							L5Backup 20150511.xer
					XML		DNG-RFR-LSU0.xml
							DNG-RFR-LSU0-1 R0 20150514.zip
							DNG-RFR-LSU1.xml
							DNG-RFR-LSU1-1 R0 20150514.zip
							DNG-RFR-LSU2.xml
							DNG-RFR-LSU2-4 - R0 20150514.zip
							DNG-RFR-LSU3.xml
							DNG-RFR-LSU3-1 R0 20150514.zip
							DNG-RFR-LSU4.xml
							DNG-RFR-LSU4-1 - R0 20150514.zip
				2015-05-09 General XML.zip			2015-05-09 General XML.xml
		509407-0000-00000-33RA-0146					509407-0000-00000-33RA-0146_00_FINAL.docx
							509407-0000-00000-33RA-0146_00_FINAL.docx
							Appendix C - Reconciliation of OSM 00.docx
		509407-0000-00000-33RA-0147					OSM Material Spreadsheet (Class 2) May 02, 2014 (0H).xlsx
		509407-0000-00000-33RA-0148					
		509407-0000-00000-33RA-0149					
		509407-0000-00000-33RA-0150					
		509407-0000-00000-33RA-0151					
		509407-0000-00000-33RA-0152					
		509407-0000-00000-33RA-0153					
		509407-0000-00000-33RA-0154					
							WT3 Current Manpower Schedule.pdf
							WT3 MANPOWER ALLOCATION.pdf
							WT3 Processing Schedule for Chapter 0154.pdf
		509407-0000-00000-33RA-0155					

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Legend
: Included in Class 2 Rev 01 Aug 31/15 Report Submission
: To follow in the Sept 18/15 Class 2 Rev 01 Milestone Submission

ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
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							S09407-0000-00000-33RA-0155 R00 Construction Support - Appendix F11.docx
							S09407-0000-00000-33RA-0155 R00 EHS - Appendix F2.docx
							S09407-0000-00000-33RA-0155 R00 Engineering - Appendix F3.docx
							S09407-0000-00000-33RA-0155 R00 HR_Labour Relations - Appendix F10.docx
							S09407-0000-00000-33RA-0155 R00 Materials Management - Appendix F12.docx
							S09407-0000-00000-33RA-0155 R00 Procurement - Appendix F5.docx
							S09407-0000-00000-33RA-0155 R00 Project Controls - Appendix F8.docx
							S09407-0000-00000-33RA-0155 R00 Project Management - Appendix F6.docx
							S09407-0000-00000-33RA-0155 R00 Tooling Management- Appendix F7.docx
							S09407-0000-00000-33RA-0155 R00 Training - Appendix F9.docx
							S09407-0000-00000-33RA-0155 Rev 00 02_PMT Shift Patterns_April 30th.vsd
							S09407-0000-00000-33RA-0155 Rev 00 11_Training Organization Chart_April 30th.vsd
							S09407-0000-00000-33RA-0155 REV 00 12_Safety Organization Chart_April 30th.vsd
							Shift Command and Control N2_April29th.vsd
							Shift Command and Control N2_Dec11th-2017_April29th.vsd
							Shift Command and Control N2_May 15it-2017_April29th.vsd
							Shift Command and Control N2_October 1st-2018_April29th.vsd
							PMT Resource Profiles r2.xlsx
							PMT U1 20150514.xer
							PMT U2 20150514.xer
							PMT U3 20150514.xer
							PMT U4 20150514.xer
							Total PMT Manhours 20150503.xlsx
		S09407-0000-00000-33RA-0156					
		S09407-0000-00000-33RA-0157					
							FINAL MAY 8 CL2 Series Rev 1.xlsx
		S09407-0000-00000-33RA-0158					
							FINAL MAY 8th CL2 On-Boarding.xlsx
		S09407-0000-00000-33RA-0159					
							S09407-0000-00000-33RA-0159 Rev 00 Engineering Organization Chart_May 1st.vsd
							S09407-0000-00000-33RA-0159 Rev 00 Procurement Organization Chart_May 1st.vsd
							S09407-0000-00000-33RA-0159 Rev 00 Procurement Organization Chart_May1st.vsd
							CWPs (2)R2.xlsx
							EngineeringCostCheck.xlsx
							PMT DEFINITION 0159 May-03-15 Rev 5.xlsx
							RFR Subsequent Procurement Unit Estimates (2).xlsx
							RFR Subsequent Quality Unit Estimates May 02, 2015 Rev 02.xlsx
		S09407-0000-00000-33RA-0160					
		S09407-0000-00000-33RA-0161					
		S09407-0000-00000-33RA-0162					
							S09407-0000-00000-33RA-0162_00_FINAL.docx
							SLNPricing11102011_for 30-June-14 Sub. Labour Only 01-20-15.xlsx
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							Tool Management Class 2 Estimate Buildup R00.xlsx
			Tooling	Consumables			RD10 20150326 R1.xlsx
							RD10 20150326 R1_Totals.pdf
					Archive		Tooling_Consumable_D4.xlsx
							Tooling_Consumable_D4_Totals.pdf
							Tooling_Consumable_D10.xlsx
							Tooling_Consumable_D10_R1.xlsx
							Tooling_Consumable_D10_R1_Totals.pdf
							Tooling_Consumable_D10_Totals.pdf
				Expenses			TE - Unit 1 20150504 R2.xls
							TE - Unit 1 20150504 R2_TS.xlsx
							TE - Unit 1 20150504 R2_TS_Totals.pdf
							TE - Unit 2 20150504 R2.xls
							TE - Unit 2 20150504 R2_TS.xlsx
							TE - Unit 2 20150504 R2_TS_Totals.pdf
							TE - Unit 3 20150504 R2.xls
							TE - Unit 3 20150504 R2_TS.xlsx
							TE - Unit 3 20150504 R2_TS_Totals.pdf
							TE - Unit 4 20150504 R2_TS.xlsx
							TE - Unit 4 20150504 R2_TS_Totals.pdf
							TE - Unit 4 20150504 R3.xls
				Manpower	U1	Rev 6	TM - Unit 1 20150504 R5.xls
							TM - Unit 1 20150504 R5_TS(GH)(MB).xlsx
							TM - Unit 1 20150504 R5_TS(GH)(MB)_Totals.pdf
					U2	Rev 6	TM - Unit 2 20150504 R5.xls
							TM - Unit 2 20150504 R5_TS(GH)(MB).xlsx
							TM - Unit 2 20150504 R5_TS(GH)(MB)_Totals.pdf
					U3	Rev 6	TM - Unit 3 20150504 R5.xls
							TM - Unit 3 20150504 R5_TS(GH)(MB).xlsx
							TM - Unit 3 20150504 R5_TS(GH)(MB)_Totals.pdf
					U4	Rev 6	TM - Unit 4 20150504 R5.xls
							TM - Unit 4 20150504 R5_TS(GH)(MB).xlsx
							TM - Unit 4 20150504 R5_TS(GH)(MB)_Totals.pdf
				Storage		Rev 4	TSE - Unit 1 20150414 R3_TS.xlsx
							TSE - Unit 1 20150414 R3_TS_Totals.pdf
							TSE - Unit 2 20150414 R3_TS.xlsx
							TSE - Unit 2 20150414 R3_TS_Totals.pdf
							TSE - Unit 3 20150414 R3_TS.xlsx
							TSE - Unit 3 20150414 R3_TS_Totals.pdf
							TSE - Unit 4 20150414 R3_TS.xlsx
							TSE - Unit 4 20150414 R3_TS_Totals.pdf
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		S09407-0000-00000-33RA-0165					
							S09407-0000-00000-33RA-0165_00_FINAL.docx
							Aximen Risk Model Rev.00.afw
							Class 2 Risk Schedule Unit 2 3 1 4 20150428R2.xer
							Cost Risk Analysis Submittal Rev. 00.xlsx
							DN0-RFR-CL2 Risk-U2 - Execution Phase Target Schedule - Risk Register Rev.00.xls
							Results for Target Cost and Target Outage Duration.xlsx
							Risk Register Native File.docx
		S09407-0000-00000-33RA-0166					
		S09407-0000-00000-33RA-0167					
							S09407-0000-00000-33RA-0167_00 Boilermaker-Journeyman.xlsm
							S09407-0000-00000-33RA-0167_00 Collective Dose.xlsm
							S09407-0000-00000-33RA-0167_00 Cumulative 4 Units.xlsm
							S09407-0000-00000-33RA-0167_00 Electrician-Journeyman.xlsm
							S09407-0000-00000-33RA-0167_00 Millwright-Journeyman.xlsm
							33PF-0360-A10-004-SUN_may29.docx
		S09407-0000-00000-33RA-0168					
		S09407-0000-00000-33RA-0169					
		S09407-0000-00000-33RA-0170					
		S09407-0000-00000-33RA-0171					
		S09407-0000-00000-33RA-0172					
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		S09407-0000-00000-33RA-0173					
							S09407-0000-00000-33RA-0173_00_FINAL.docx
							Appendix A - RFR Technical Scope Verification SummaryCompliance DM.docx
							Appendix B - AACEI Recommended Practice No. 18R-97 - Compliance.pdf

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ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
							Appendix E - Project Peer Review for Class 3 Estimate - List of Actions.pdf
							Appendix F Narrative BIM 1.docx
							Appendix F Table F-1 BIM 2.xlsx
							Appendix I.1 - Class 2 Data Flow Mar-24-15 Rev 5.xls
							Appendix I.2-1.6 - Estimates QA Check List May 3 2015.xlsx
							Appendix I.2-1.6 - Estimates QA Check List May 3 2015.xlsx
							Appendix I.2-1.6 - Estimates QA Check List May 3 2015.xlsx
							Appendix I.2-1.6 - Estimates QA Check List May 3 2015.xlsx
							Appendix I.2-1.6 - Estimates QA Check List May 3 2015.xlsx
							Appendix I.2-1.6 - Estimates QA Check List May 3 2015.xlsx
	Appendix G						Stage_3_CWP_0010 _Rev_01.pdf
							Stage_3_CWP_0016 _Rev_01.pdf
							Stage_3_CWP_0030_Rev_01.pdf
							Stage_3_CWP_0040 _Rev_01.pdf
							Stage_3_CWP_0041_Rev_01.pdf
							Stage_3_CWP_0042 _Rev_01.pdf
							Stage_3_CWP_0043 _Rev_01.pdf
							Stage_3_CWP_0044 _Rev_01.pdf
							Stage_3_CWP_0045 _Rev_01.pdf
							Stage_3_CWP_0048 _Rev_01.pdf
							Stage_3_CWP_0049_Rev_01.pdf
							Stage_3_CWP_2001 _Rev_01.pdf
							Stage_3_CWP_2002_Rev_01.pdf
							Stage_3_CWP_2003_Rev_01.pdf
							Stage_3_CWP_2004_Rev_01.pdf
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							Stage_3_CWP_2019_Rev_01.pdf
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							Stage_3_CWP_2183_Rev_01.pdf
							Stage_3_CWP_2185_Rev_01.pdf
							Stage_3_CWP_2186_Rev_01.pdf

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ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
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							Stage_3_CWP_2189_Rev_01.pdf
							Stage_3_CWP_2191_Rev_01.pdf
							Stage_3_CWP_2192_Rev_01.pdf
							Stage_3_CWP_2193_Rev_01.pdf
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							Stage_3_CWP_2195_Rev_01.pdf
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							Stage_3_CWP_2246_Rev_01.pdf
							Stage_3_CWP_2247_Rev_01.pdf
							Stage_3_CWP_2249_Rev_01.pdf
							Variance Reports for CWPs Deleted from Scope.pdf
		pdf's	0010				0010 March-19-15.pdf
							0010 Stage 3 CWP Check List.pdf
							CDS - CWP 0010 -TO JV.pdf
							CWP_0010_S3 0_R0(GHR4)(MBR1)(WG2)-U2 (Final).pdf
							CWP Variance Reports CWP 0010 Rev 4.pdf
			0038				CDS - CWP 0038 - TO JV.pdf
							CWP Variance Reports CWP 0038 Rev 3.pdf
							CWP_0038_S3 0_R1(GHR3)(MB).pdf
							CWP-2-4-0038.pdf
							WTS Platform Install Stage 3 CWP Check List - Rev. 0.pdf
			0039				CDS - CWP 0039 - TO JV.pdf
							CWP Variance Reports CWP 0039 Rev 3.pdf
							CWP_0039_S3 1_R1(GHR3)(MB).pdf
							CWP-2-4-0039.pdf
							WTS Mechanical Install Stage 3 CWP Check List - Rev. 0.pdf
			0040				CDS - CWP 0040 - Stage 3 with JV Dispositions.pdf
							CWP Variance Reports CWP 0040 Rev 3.pdf
							CWP_0040_S3 1_R1(GHR2)(MB).pdf
							CWP-0-01-0040.pdf
							Stage 3 CWP Check List 0040.pdf
			0041				CDS - CWP 0041 - Stage 3 with JV Dispositions.pdf
							CWP Variance Reports CWP 0041 Rev 3.pdf
							CWP_0041_S3 0_R1(GHR2)(MB).pdf
							CWP-0-01-0041.pdf
							Stage 3 CWP 0041 Check List - Rev. 0.pdf
			0042				0042 Stage 3 CWP Check List.pdf
							CDS - CWP 0042 - TO JV.pdf
							CWP Variance Reports CWP 0042 Rev 2.pdf
							CWP_0042_S3 0_R1(GHR1)(MBR1).pdf
							CWP-1-01-0043.pdf
			0043				CDS - CWP 0043 -TO JV.pdf
							0043 April 02 15.pdf
							0043 Stage 3 CWP Check List.pdf
							CWP Variance Reports CWP 0043 Rev 2.pdf
							CWP_0043_S3 0_R1(GHR1)(MB).pdf
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							CWP Variance Reports CWP 0044 Rev 2.pdf
							CWP_0044_S3 1_R1(GHR1)(MB).pdf
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			0045				CDS - CWP 0045 - Stage 3 with JV Dispositions.pdf
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							CWP-0-11-0045.pdf
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			2001				6440-60215-2-2001.pdf
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			2003				CDS - CWP 2003 - Stage 3 with JV Dispositions.pdf
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			2008				CDS - CWP 2008 - Stage 3 with JV Disposition.pdf
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							CWP_2008_S3 2_R1(GHR4)(MB).pdf
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			2010				CDS - CWP 2010 - Stage 3 with JV Disposition.pdf
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			2011				CDS - CWP 2011 - TO JV complete.pdf
							CWP Variance Reports CWP 2011 Rev 4.pdf
							CWP 2011.pdf
							CWP_2011_S3 0_R1(GHR2)(MB).pdf
							Stage 3 CWP Check List - 2011.pdf
			2012				CDS - CWP 2012 - TO JV complete.pdf
							CWP Variance Reports CWP 2012 Rev 3.pdf
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							CWP_2012_S3 1_R1(GHR2)(MB).pdf
							Stage 3 CWP Check List - 2012.pdf
			2013				CDS - CWP 2013 - Stage 3 with JV Disposition.pdf

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			2014				CDS - CWP 2014 - Stage 3 with JV Disposition.pdf
							CWP Variance Reports CWP 2014 Rev 3.pdf
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							CWP-2-11-2014.pdf
							Stage 3 CWP 2014 Check List - Rev. 0.pdf
			2017				CDS - CWP 2017.pdf
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							CWP_2017_S3.4_R1(GHR3)(MB).pdf
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							Stage 3 CWP RTP Install.pdf
			2018				CDS - CWP 2018 - complete.pdf
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							CWP_2018_S3.0_R1(GHR3)(MB).pdf
							Stage 3 CWP Check List - 2018.pdf
			2019				CDS - CWP 2019 - complete.pdf
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			2020				CDS - CWP 2020 - TO JV.PDF
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			2023				CDS - CWP 2023 - Stage 3 with JV dispositions.pdf
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			2026				2026 - Stage 3 CWP Check List - Rev. 0.pdf
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							Drawings 2 CWP2041.pdf
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							Drawings 2 CWP2043.pdf
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							Stage 3 CWP Check List - 2044.pdf
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			2046				2046 - Stage 1 Planning-Assessing Check List.pdf
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			2086				CDS - CWP 2086.pdf
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							CDS - CWP 2092.pdf
							CWP Variance Reports CWP 2092 Rev 2.pdf
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							CWP-2-02-2092 S3.0.pdf
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							CDS - CWP 2099.pdf
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							CWP_2099_S3.1_R2(GHR4)(MB).pdf
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							CWP-2-02-2100 S3.pdf
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							CWP Variance Reports CWP 2126 Rev 2.pdf
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RFR Class 2 Rev 01 Native File Mapping
Aug-24-15 DRAFT

Legend
: Included in Class 2 Rev 01 Aug 31/15 Report Submission
: To follow in the Sept 18/15 Class 2 Rev 01 Milestone Submission

ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
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							CWP 2141 - Feeder Coupling Disconnect S3.pdf
							CWP Variance Reports CWP 2141 Rev 4.pdf
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			2142				2142 S3 Checklist - Feeder Removal .pdf
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							CWP 2142 - Feeder Removal S5.pdf
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							CWP_2142_S3.3_R1(GHR6)(M6).pdf
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RFR Class 2 Rev 01 Native File Mapping
Aug-24-15 DRAFT

Legend
: Included in Class 2 Rev 01 Aug 31/15 Report Submission
: To follow in the Sept 18/15 Class 2 Rev 01 Milestone Submission

ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
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							Stage 3 CWP Check List 2208.pdf
			2209				CD5 - CWP 2209.pdf
							CWP Variance Reports CWP 2209 Rev 2.pdf
							CWP_2209_S3.0_R1(GHR1)(MB).pdf
							Stage 3 CWP Check List - Rev. 0 CWP 2209.pdf
							Stage 3 submission CWP 2209.pdf
			2210				2210 - Stage 3 CWP Check List - Rev. 0.pdf
							CD5 - CWP 2210.pdf
							CWP Variance Reports CWP 2210 Rev 2.pdf
							CWP_2210_S3.0_R1(GHR2)(MB).pdf
							CWP-2-02-2210 S3.0.pdf
			2211				2211 - Stage 3 CWP Check List - Rev. 0.pdf
							CD5 - CWP 2211.pdf
							CWP Variance Reports CWP 2211 Rev 2.pdf
							CWP_2211_S3.0_R1(GHR1)(MB).pdf
							CWP-2-09-2211 S3.0.pdf
			2212				CD5 - CWP 2212-2213 - Stage 3 with JV Dispositions.pdf
							CWP Variance Reports CWP 2212 Rev 2.pdf
							CWP_2212_S3.0_R1(GHR1)(MB).pdf
							CWP-2-02-2212.pdf
							Stage 3 CWP 2212 Check List - Rev. 0.pdf
			2213				CD5 - CWP 2212-2213 - Stage 3 with JV Dispositions.pdf
							CWP Variance Reports CWP 2213 Rev 2.pdf
							CWP_2213_S3.0_R1(GHR2)(MB).pdf
							CWP-3-02-2213.pdf
							Stage 3 CWP 2213 Check List - Rev. 0.pdf
			2214				CD5 - CWP 2214-2244 - Stage 3 with JV Dispositions.pdf
							CWP Variance Reports CWP 2214 Rev 2.pdf
							CWP_2214_S3.0_R1(GHR2)(MB).pdf
							CWP-2-10-2214.pdf
							Stage 3 CWP 2214 Check List - Rev. 0.pdf
			2215				CD5 - CWP 2215-2216-2217-2218 - Stage 3 with JV Disposition.pdf
							CWP Variance Reports CWP 2215 Rev 2.pdf
							CWP_2215_S3.0_R1(GHR1)(MB).pdf
							CWP-3-04-2215.pdf
							Stage 3 CWP 2215 Check List - Rev. 0.pdf
			2216				CD5 - CWP 2215-2216-2217-2218 - Stage 3 with JV Disposition.pdf
							CWP Variance Reports CWP 2216 Rev 2.pdf
							CWP_2216_S3.0_R1(GHR1)(MB).pdf
							CWP-3-04-2216.pdf
							Stage 3 CWP 2216 Check List - Rev. 0.pdf
			2217				CD5 - CWP 2215-2216-2217-2218 - Stage 3 with JV Disposition.pdf
							CWP Variance Reports CWP 2217 Rev 2.pdf
							CWP_2217_S3.0_R1(GHR1)(MB).pdf
							CWP-3-10-2217.pdf
							Stage 3 CWP 2217 Check List - Rev. 0.pdf
			2218				CD5 - CWP 2215-2216-2217-2218 - Stage 3 with JV Disposition.pdf

RFR Class 2 Rev 01 Native File Mapping
Aug-24-15 DRAFT

Legend
: Included in Class 2 Rev 01 Aug 31/15 Report Submission
: To follow in the Sept 18/15 Class 2 Rev 01 Milestone Submission

ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
							CWP Variance Reports CWP 2218 Rev 2.pdf
							CWP_2218_S3.0_R1(GHR1)(MB).pdf
							CWP-2-10-2218.pdf
							Stage 3 CWP 2218 Check List - Rev. 0.pdf
			2219				CDS - CWP 2219 - Stage 3 with JV dispositions.pdf
							CWP Variance Reports CWP 2219 Rev 2.pdf
							CWP_2219_S3.0_R2(GHR3)(MB).pdf
							CWP-2-02-2219.pdf
							Stage 3 CWP Check List 2219.pdf
			2220				CDS - CWP 2220 - Stage 3 with JV dispositions.pdf
							CWP Variance Reports CWP 2220 Rev 2.pdf
							CWP_2220_S3.0_R2(GHR3)(MB).pdf
							CWP-2-10-2220.pdf
							Stage 3 CWP Check List 2220.pdf
			2221				CDS - CWP 2221 - JV disposition.pdf
							CWP 2221 - S3.pdf
							CWP Variance Reports CWP 2221 Rev 2.pdf
							CWP_2221_S3.2_R1(GHR2)(MB).pdf
							Stage 3 CWP 2221 Check List - Rev. 0.pdf
			2222				CDS - CWP 2222 - JV disposition.pdf
							CWP 2222 - S3.pdf
							CWP Variance Reports CWP 2222 Rev 2.pdf
							CWP_2222_S3.2_R1(GHR2)(MB).pdf
							Stage 3 CWP 2222 Check List - Rev. 0.pdf
			2223				CDS - CWP 2223 - Stage 3 with JV Disposition.pdf
							CWP 2223 - S3.pdf
							CWP Variance Reports CWP 2223 Rev 2.pdf
							CWP_2223_S3.0_R1(GHR1)(MB).pdf
							Stage 3 CWP 2223 Check List - Rev. 0.pdf
			2224				CDS - CWP 2224 - Stage 3 with JV Disposition.pdf
							CWP 2224 - S3.pdf
							CWP Variance Reports CWP 2224 Rev 2.pdf
							CWP_2224_S3.0_R1(GHR1)(MB).pdf
							Stage 3 CWP 2224 Check List - Rev. 0.pdf
			2227				CDS - CWP 2227 - TO JV.pdf
							CWP Variance Reports CWP 2227 Rev 2.pdf
							CWP 2227 Stage 3.pdf
							CWP_2227_S3.0_R1(GHR3)(MB).pdf
							Stage 3 CWP Check List FROB and Dummy Bundle Removal.pdf
			2229				CDS - CWP 2229.pdf
							CWP Variance Reports CWP 2229 Rev 2.pdf
							CWP_2229_S3.1_R1(GHR3)(MB).pdf
							Stage 3 CWP Check List - Rev. 0 CWP 2229.pdf
							Stage 3 submission CWP 2229.pdf
			2230				CDS - CWP 2230.pdf
							CWP Variance Reports CWP 2230 Rev 2.pdf
							CWP_2230_S3.1_R1(GHR2)(MB).pdf
							Stage 3 CWP 2230 Check List - Rev. 0.pdf
							Stage 3 CWP 2230.pdf
			2231				CDS - CWP 2231 - Stage 3 with JV dispositions.pdf
							CWP Variance Reports CWP 2231 Rev 2.pdf
							CWP_2231_S3.0_R1(GHR2)(MB).pdf
							CWP-2-02-2231.pdf
							Stage 3 CWP Check List -2231.pdf
			2232				CDS - CWP 2232 - Stage 3 with JV dispositions.pdf
							CWP Variance Reports CWP 2232 Rev 2.pdf
							CWP_2232_S3.0_R1(GHR2)(MB).pdf
							CWP-2-10-2232.pdf
							Stage 3 CWP Check List -2232.pdf
			2235				2235 - Stage 3 CWP Check List - Rev. 0.pdf
							CDS - CWP 2235.pdf
							CWP Variance Reports CWP 2235 Rev 2.pdf
							CWP_2235_S3.0_R1(GHR3)(MB).pdf
							CWP-2-11-2235 S3.0.pdf
			2236				2236 - Stage 3 CWP Check List - Rev. 0.pdf
							CDS - CWP 2236.pdf
							CWP Variance Reports CWP 2236 Rev 2.pdf
							CWP_2236_S3.0_R1(GHR3)(MB).pdf
							CWP-2-09-2236 S3.pdf
			2237				CDS - CWP 2237.pdf
							CWP Variance Reports CWP 2237 Rev 2.pdf
							CWP 2237 Stage 3 Submission.pdf
							CWP_2237_S3.0_R1(GHR3)(MB).pdf
							Stage 3 CWP Check List - Rev. 0 2237.pdf
			2238				CWP Variance Reports CWP 2238 Rev 2.pdf
							CWP_2238_S3.1_R1(GHR1)(MB).pdf
							Stage 3 CWP Check List - Rev. 0 CWP 2238.pdf
							Stage 3 submission 2238.pdf
							CDS - CWP 2238 to 2241 (PCD 13).pdf
			2239				CWP Variance Reports CWP 2239 Rev 2.pdf
							CWP_2239_S3.1_R1(GHR1)(MB).pdf
							Stage 3 CWP Check List - Rev. 0 CWP 2239.pdf
							Stage 3 submission 2239.pdf
							CDS - CWP 2238 to 2241 (PCD 13).pdf
			2240				CWP Variance Reports CWP 2240 Rev 2.pdf
							CWP_2240_S3.1_R1(GHR1)(MB).pdf
							Stage 3 CWP Check List - Rev. 0 CWP 2240.pdf
							Stage 3 submission 2240.pdf
							CDS - CWP 2238 to 2241 (PCD 13).pdf
			2241				CWP Variance Reports CWP 2241 Rev 2.pdf
							CWP_2241_S3.1_R1(GHR1)(MB).pdf
							Stage 3 CWP Check List - Rev. 0 CWP 2241.pdf
							Stage 3 submission 2241.pdf
							CDS - CWP 2238 to 2241 (PCD 13).pdf
			2242				CDS - CWP 2242 - Stage 3 with JV dispositions.pdf
							CWP Variance Reports CWP 2242 Rev 2.pdf
							CWP_2242_S3.0_R1(GHR2)(MB).pdf
							CWP-2-02-2242.pdf
							Stage 3 CWP Check List -2242.pdf
			2243				CDS - CWP 2243 - Stage 3 with JV dispositions.pdf
							CWP Variance Reports CWP 2243 Rev 2.pdf
							CWP_2243_S3.1_R1(GHR2)(MB).pdf
							CWP-2-10-2243.pdf
							Stage 3 CWP Check List -2243.pdf
			2244				CDS - CWP 2214-2244 - Stage 3 with JV Dispositions.pdf
							CWP Variance Reports CWP 2244 Rev 2.pdf
							CWP_2244_S3.0_R1(GHR2)(MB).pdf
							CWP-2-10-2244.pdf
							Stage 3 CWP 2244 Check List - Rev. 0.pdf
							CDS - CWP 2214-2244 - Stage 3 with JV Dispositions.pdf
			2245				CDS - CWP 2245 - TO OFO.pdf
							CWP Variance Reports CWP 2245 Rev 3.pdf
							CWP 2245.pdf
							CWP_2245_S3.1_R1(GHR1)(MB).pdf
							Stage 3 CWP Check List - Rev. 0.pdf
			2246				CDS - CWP 2246 - Stage 3 with JV Dispositions.pdf
							CWP Variance Reports CWP 2246 Rev 2.pdf
							CWP_2246_S3.0_R1(GHR1)(MB).pdf
							CWP-2-10-2246.pdf
							Stage 3 CWP 2246 Check List - Rev. 0.pdf
			2247				CWP_2247_S3.0_R1(GHR1)(MB).pdf
							CWP Variance Reports CWP 2247 Rev 2.pdf
			2249				CWP_2249_S3.0_R1(GHR2)(MB).pdf
							CWP Variance Reports CWP 2249 Rev 2.pdf
			Variance Reports for CWPs Deleted from Scope				CWP Variance Reports CWP 2015 Rev 2.pdf
							CWP Variance Reports CWP 2016 Rev 2.pdf
							CWP Variance Reports CWP 2021 Rev 2.pdf
							CWP Variance Reports CWP 2022 Rev 2.pdf
							CWP Variance Reports CWP 2025 Rev 2.pdf
							CWP Variance Reports CWP 2028 Rev 2.pdf
							CWP Variance Reports CWP 2032 Rev 2.pdf
							CWP Variance Reports CWP 2034 Rev 2.pdf
							CWP Variance Reports CWP 3081 Rev 3.pdf
							CWP Variance Reports CWP 2082 Rev 2.pdf
							CWP Variance Reports CWP 2088 Rev 2.pdf
							CWP Variance Reports CWP 2103 Rev 2.pdf
							CWP Variance Reports CWP 2104 Rev 2.pdf
							CWP Variance Reports CWP 2165 Rev 2.pdf
							CWP Variance Reports CWP 2170 Rev 2.pdf
							CWP Variance Reports CWP 2174 Rev 2.pdf
							CWP Variance Reports CWP 2184 Rev 2.pdf
							CWP Variance Reports CWP 2190 Rev 2.pdf
							CWP Variance Reports CWP 2204 Rev 2.pdf
							CWP Variance Reports CWP 2228 Rev 2.pdf
		native files					
			0010				CDS - CWP 0010 -TO JV.xlsx
							CWP_0010_S3.0_R0(GHR4)(MBPA)(WW32)-U2 (Final).xlsx
			0038				CDS - CWP 0038 - TO JV.xlsx
							CWP_0038_S3.0_R1(GHR3)(MB).xlsx
			0039				CDS - CWP 0039 - TO JV.xlsx
							CWP_0039_S3.1_R1(GHR1)(MB).xlsx
			0040				CDS - CWP 0040 - Stage 3 with JV Dispositions.xlsx
							CWP_0040_S3.1_R1(GHR2)(MB).xlsx
			0041				CDS - CWP 0041 - Stage 3 with JV Dispositions.xlsx
							CWP_0041_S3.0_R1(GHR2)(MB).xlsx
			0042				CDS - CWP 0042 - TO JV.xlsx
							CWP_0042_S3.0_R1(GHR1)(MMR1).xlsx
			0043				CDS - CWP 0043 -TO JV.xlsx
							CWP_0043_S3.0_R1(GHR1)(MB).xlsx
			0044				CDS - CWP 0044 - Stage 3 with JV Dispositions.xlsx
							CWP_0044_S3.1_R1(GHR1)(MB).xlsx
			0045				CDS - CWP 0045 - Stage 3 with JV Dispositions.xlsx
							CWP_0045_S3.0_R1(GHR1)(MB).xlsx
			0048				CWP_0048_S3.0_R1(GHR1)(MB).xlsx
			0049				CWP_0049_S3.0_R1(GHR1)(MB).xlsx

RFR Class 2 Rev 01 Native File Mapping
Aug-24-15 DRAFT

Legend
: Included in Class 2 Rev 01 Aug 31/15 Report Submission
: To follow in the Sept 18/15 Class 2 Rev 01 Milestone Submission

ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
			2001				CDS - CWP 2001 - Stage 3 with JV disposition.xlsx
							CWP_2001_S3.2_R4(GHR4)(MB).xlsx
			2002				CDS - CWP 2002 - Stage 3 with JV Disposition.xlsx
							CWP_2002_S3.2_R4(GHR4)(MB).xlsx
			2003				CDS - CWP 2003 - Stage 3 with JV Dispositions.xlsx
							CWP_2003_S3.2_R4(GHR4)(MB).xlsx
			2004				CDS - CWP 2004 - Stage 3 with JV Dispositions.xlsx
							CWP_2004_S3.2_R4(GHR4)(MB).xlsx
			2005				CDS - CWP 2005 - Stage 3 with JV Dispositions.xlsx
							CWP_2005_S3.2_R3(GHR4)(MB).xlsx
			2006				CDS - CWP 2006 - Stage 3 with JV Dispositions.xlsx
							CWP_2006_S3.2_R2(GHR4)(MB).xlsx
			2007				CDS - CWP 2007 - Stage 3 with JV Disposition.xlsx
							CWP_2007_S3.2_R4(GHR4)(MB)(1).xlsx
			2008				CDS - CWP 2008 - Stage 3 with JV Dispositions.xlsx
							CWP_2008_S3.2_R1(GHR4)(MB).xlsx
			2009				CDS - CWP 2009 - Stage 3 with JV Disposition
							CWP_2009_S3.1_R4(GHR4)(MB).xlsx
			2010				CDS - CWP 2010 - Stage 3 with JV Disposition.xlsx
							CWP_2010 S3.1_R2(GHR4)(MB).xlsx
			2011				CDS - CWP 2011 - TO JV complete.xlsx
							CWP_2011_S3.0_R1(GHR2)(MB).xlsx
			2012				CDS - CWP 2012 - TO JV complete.xlsx
							CWP_2012_S3.3_R1(GHR2)(MB).xlsx
			2013				CDS - CWP 2013 - Stage 3 with JV Disposition.xlsx
							CWP_2013_S3.1_R1(GHR2)(MB).xlsx
			2014				CDS - CWP 2014 - Stage 3 with JV Disposition.xlsx
							CWP_2014_S3.1_R1(GHR2)(MB).xlsx
			2017				CDS - CWP 2017.xlsx
							CWP_2017_S3.4_R1(GHR1)(MB).xlsx
			2018				CDS - CWP 2018 - complete.xlsx
							CWP_2018_S3.0_R1(GHR1)(MB).xlsx
			2019				CDS - CWP 2019 - complete.xlsx
							CWP_2019_S3.0_R1(GHR1)(MB).xlsx
			2020				CDS - CWP 2020 - TO JV.xlsx
							CWP_2020_S3.1_R1(GHR1)(MB).xlsx
			2023				CDS - CWP 2023 - Stage 3 with JV dispositions.xlsx
							CWP_2023_S3.1_R1(GHR1)(MB).xlsx
			2024				CDS - CWP 2024 - Stage 3 with JV dispositions.xlsx
							CWP_2024_S3.0_R1(GHR1)(MB).xlsx
			2026				CDS - CWP 2026.xlsx
							CWP_2026_S3.1_R1(GHR1)(MB).xlsx
			2027				CDS - CWP 2027.xlsx
							CWP_2027_S3.2_R1(GHR4)(MB).xlsx
			2029				CDS - CWP 2029.xlsx
							CWP_2029_S3.1_R1(GHR1)(MB).xlsx
			2030				CDS - CWP 2030.xlsx
							CWP_2030_S3.2_R1(GHR4)(MB).xlsx
			2031				CDS - CWP 2031 - Stage 3 with JV dispositions.xlsx
							CWP_2031_S3.0_R1(GHR1)(MB).xlsx
			2033				CDS - CWP 2033 - Stage 3 with JV dispositions.xlsx
							CWP_2033_S3.1(GHR1)(MB).xlsx
			2035				CDS - CWP 2035 - complete.xlsx
							CWP_2035_S3.1_R1(GHR1)(MB).xlsx
			2036				CDS - CWP 2036 - complete.xlsx
							CWP_2036_S3.1_R1(GHR1)(MB).xlsx
			2037				CDS - CWP 2037 - complete.xlsx
							CWP_2037_S3.0_R1(GHR1)(MB).xlsx
			2038				CDS - CWP 2038 - complete.xlsx
							CWP_2038_S3.0_R1(GHR1)(MB).xlsx
			2039				CDS - CWP 2039-complete.xlsx
							CWP_2039_S3.4_R1(GHR5)(MB).xlsx
			2040				CDS - CWP 2040-complete.xlsx
							CWP_2040_S3.4_R1(GHR1)(MB).xlsx
			2041				CDS - CWP 2041-complete.xlsx
							CWP_2041_S3.2_R2(GHR4)(MB).xlsx
			2042				CDS - CWP 2042 - complete.xlsx
							CWP_2042_S3.3_R2(GHR4)(MBR1).xlsx
			2043				CDS - CWP 2043-complete.xlsx
							CWP_2043_S3.1_R1(GHR1)(MB).xlsx
			2044				CDS - CWP 2044 - complete.xlsx
							CWP_2044_S3.0_R2(GHR1)(MB).xlsx
			2045				CDS - CWP 2045 - Stage 3 with JV Disposition.xlsx
							CWP_2045_S3.1_R1(GHR1)(MB).xlsx
			2046				CDS - CWP 2046 - Stage 3 with JV Disposition.xlsx
							CWP_2046_S3.1_R1(GHR1)(MB).xlsx
			2047				CDS - CWP 2047 -complete.xlsx
							CWP_2047_S3.0_R1(GHR1)(MB).xlsx
			2048				CDS - CWP 2048 - complete.xlsx
							CWP_2048_S3.0_R1(GHR1)(MBR1).xlsx
			2049				CDS - CWP 2049 -complete.xlsx
							CWP_2049_S3.0_R1(GHR1)(MB).xlsx
			2050				CDS - CWP 2050 - complete.xlsx
							CWP_2050_S3.0_R1(GHR1)(MB).xlsx
			2051				CDS - CWP 2051 - TO JV complete.xlsx
							CWP_2051_S3.0_R1(GHR2)(MB).xlsx
			2052				CDS - CWP 2051 - TO JV complete.xlsx
							CWP_2052_S3.0_R1(GHR2)(MB).xlsx
			2053				CDS - CWP 2053 - Stage 3 with JV Disposition.xlsx
							CWP_2053_S3.1_R1(GHR2)(MB).xlsx
			2054				CDS - CWP 2054 - Stage 3 with JV Disposition.xlsx
							CWP_2054_S3.0_R1(GHR2)(MB).xlsx
			2055				CDS - CWP 2055 - Stage 3 with JV Disposition.xlsx
							CWP_2055_S3.1_R1(GHR2)(MB).xlsx
			2056				CDS - CWP 2056 - Stage 3 with JV Disposition.xlsx
							CWP_2056_S3.0_R1(GHR3)(MB).xlsx
			2057				CDS - CWP 2057-complete.xlsx
							CWP_2057_S3.0_R1(GHR3)(MB).xlsx
			2058				CDS - CWP 2058-complete.xlsx
							CWP_2058_S3.0_R1(GHR3)(MB).xlsx
			2059				CDS - CWP 2059_AR.xlsx
							CWP_2059_S3.4_R1(GHR2)(MB).xlsx
			2060				CDS - CWP 2060 -complete.xlsx
							CWP_2060_S3.4_R2(GHR4)(MB).xlsx
			2061				CDS - CWP 2061-complete.xlsx
							CWP_2061_S3.8_R3(GHR3)(MBR2).xlsx
			2062				CDS - CWP 2062-complete.xlsx
							CWP_2062_S3.2_R3(GHR4)(MB).xlsx
			2063				CDS - CWP 2063 - TO JV complete.xlsx
							CWP_2063_S3.0_R1(GHR3)(MB).xlsx
			2064				CDS - CWP 2064 -complete.xlsx
							CWP_2064_S3.0_R1(GHR2)(MB).xlsx
			2065				CDS - CWP 2065 - Stage 3 with JV dispositions.xlsx
							CWP_2065_S3.1_R1(GHR2)(MB).xlsx
			2066				CWP- CDS 2066.xlsx
							CWP_2066_S3.1_R2(GHR3)(MBR1).xlsx
			2067				CDS - CWP 2067.xlsx
							CWP_2067_S3.0_R1(GHR2)(MB).xlsx
			3071				CDS - CWP 3071 - TO OPG.xlsx
							CWP_3071_S3.2_R1(GHR1)(MB).xlsx
			3074				CDS - CWP 3074 - TO OPG).xlsx
							CWP_3074_S3.2_R1(GHR1)(MB).xlsx
			3075				CDS - CWP 3075 - TO OPG.xlsx
							CWP_3075_S3.3_R1(GHR1)(MB).xlsx
			3076				CDS - CWP 3076 - TO OPG.xlsx
							CWP_3076_S3.0_R1(GHR2)(MB).xlsx
			3077				CDS - CWP 3077 - Stage 3 with JV dispositions.xlsx
							CWP_3077_S3.0_R1(GHR4)(MB).xlsx
			3078				CDS - CWP 3078 - Stage 3 with JV dispositions.xlsx
							CWP_3078_S3.1_R1(GHR2)(MB) v2.xlsx
			3079				CDS - CWP 3079 - Stage 3 with JV dispositions.xlsx
							CWP_3079_S3.1_R1(GHR2)(MB).xlsx
			3080				CDS - CWP 3080 - Stage 3 with JV dispositions.xlsx
							CWP_3080_S3.2_R1(GHR1)(MB).xlsx
			3083				CDS - CWP 3083.xlsx
							CWP_3083_S3.1_R1(GHR1)(MBR1).xlsx
			3084				CDS - CWP 3084.xlsx
							CWP_3084_S3.1_R1(GHR1)(MBR1).xlsx
			3085				CDS - CWP 3085.xlsx
							CWP_3085_S3.1_R1(GHR4)(MBR1).xlsx
			3086				CDS - CWP 3086.xlsx
							CWP_3086_S3.1_R1(GHR1)(MBR1).xlsx
			3087				CDS - CWP 3087.xlsx
							CWP_3087_S3.2_R1(GHR1)(MB).xlsx
			3092				CDS - CWP 3092.xlsx
							CWP_3092_S3.1_R1(GHR4)(MB).xlsx
			3094				CDS - CWP 3094.xlsx
							CWP_3094_S3.1_R1(GHR1)(MB).xlsx
			3095				CWP- CDS 3095.xlsx
							CWP_3095_S3.0_R1(GHR1)(MB).xlsx
			3096				CDS - CWP 3096.xlsx
							CWP_3096_S3.0_R1(GHR2)(MB).xlsx
			3097				CDS - CWP 3097.xlsx
							CWP_3097_S3.0_R2(GHR3)(MB).xlsx
			3098				CDS - CWP 3098.xlsx
							CWP_3098_S3.0_R1(GHR2)(MB).xlsx
			3099				CDS - CWP 3099.xlsx
							CWP_3099_S3.1_R2(GHR4)(MB).xlsx
			3100				CDS - CWP 3100.xlsx
							CWP_3100_S3.2_R1(GHR1)(MB).xlsx
			3101				CDS - CWP 3101.xlsx
							CWP_3101_S3.0_R2(GHR4)(MB).xlsx
			3102				CDS - CWP 3102.xlsx
							CWP_3102_S3.1_R1(GHR1)(MB).xlsx
			3105				CDS - CWP 3105.xlsx

RFR Class 2 Rev 01 Native File Mapping
Aug-24-15 DRAFT

Legend
: Included in Class 2 Rev 01 Aug 31/15 Report Submission
: To follow in the Sept 18/15 Class 2 Rev 01 Milestone Submission

ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
			2105				CWP_2105_S3.0_R1(GHR3)(MB).xlsx
							CDS - CWP 2105.xlsx
							CWP_2106_S3.0_R1(GHR7)(MBR1).xlsx
			2107				CDS - CWP 2107.xlsx
							CWP_2107_S3.1_R1(GHR3)(MB).xlsx
			2108				CDS - CWP 2108.xlsx
							CWP_2108_S3.0_R2(GHR1)(MB).xlsx
			2109				CDS - CWP 2109.xlsx
							CWP_2109_S3.0_R1(GHR2)(MB).xlsx
			2110				CWP- CDS 2110.xlsx
							CWP_2110_S3.1_R1(GHR2)(MB).xlsx
			2112				CDS - CWP 2112.xlsx
							CWP_2112_S3.1_R1(GHR2)(MB).xlsx
			2113				CDS - CWP 2113.xlsx
							CWP_2113_S3.1_R1(GHR1)(MB).xlsx
			2115				CDS - CWP 2115.xlsx
							CWP_2115_S3.1_R1(GHR2)(MB).xlsx
			2116				CDS - CWP 2116.xlsx
							CWP_2116_S3.1_R1(GHR2)(MB).xlsx
			2119				CDS - CWP 2119 - complete.xlsx
							CWP_2119_S3.0_R1(GHR1)(MB).xlsx
			2120				CDS - CWP 2120 - complete.xlsx
							CWP_2120_S3.0_R1(GHR3)(MB).xlsx
			2121				CDS - CWP 2121.xlsx
							CWP_2121_S3.1_R1(GHR2)(MB).xlsx
			2122				CDS - CWP 2122.xlsx
							CWP_2122_S3.0_R1(GHR1)(MB).xlsx
			2123				CDS - CWP 2123.xlsx
							CWP_2123_S3.0_R1(GHR2)(MB).xlsx
			2124				CDS - CWP 2124.xlsx
							CWP_2124_S3.0_R1(GHR4)(MBR3)-U2.xlsx
			2125				CWP- CDS 2125.xlsx
							CWP_2125_S3.0_R1(GHR3)(MB)-U1,2,3,4.xlsx
			2126				CDS - CWP 2126 - Stage 3 with JV Disposition.xlsx
							CWP_2126_S3.0_R1(GHR1)(MB).xlsx
			2127				CDS - CWP 2127 - Stage 3 with JV Disposition.xlsx
							CWP_2127_S3.0_R1(GHR1)(MB).xlsx
			2128				CDS - CWP 2128 - Stage 3 with JV Disposition.xlsx
							CWP_2128_S3.0_R1(GHR3)(MB).xlsx
			2129				CDS - CWP 2129 - Stage 3 with JV Disposition.xlsx
							CWP_2129_S3.0_R1(GHR3)(MB).xlsx
			2130				CDS - CWP 2130 - Stage 3 with JV Disposition.xlsx
							CWP_2130_S3.1_R1(GHR1)(MBR1).xlsx
			2131				CDS - CWP 2131 - Stage 3 with JV Disposition.xlsx
							CWP_2131_S3.0_R1(GHR3)(MB).xlsx
			2132				CDS - CWP 2132 - Stage 3 with JV Disposition.xlsx
							CWP_2132_S3.0_R1(GHR3)(MB).xlsx
			2133				CDS - CWP 2133 - Stage 3 with JV Disposition.xlsx
							CWP_2133_S3.0_R1(GHR1)(MB).xlsx
			2134				CDS - CWP 2134 - Stage 3 with JV Disposition.xlsx
							CWP_2134_S3.1_R1(GHR3)(MB).xlsx
			2135				CDS - CWP 2135 - JV disposition.xlsx
							CWP_2135_S3.2_R1(GHR1)(MB).xlsx
			2136				CDS - CWP 2136 - JV disposition.xlsx
							CWP_2136_S3.2_R1(GHR1)(MB).xlsx
			2137				CDS - CWP 2137 - Stage 3 with JV Disposition.xlsx
							CWP_2137_S3.0_R1(GHR1)(MB).xlsx
			2138				CDS - CWP 2138 - Stage 3 with JV Disposition.xlsx
							CWP_2138_S3.0_R1(GHR1)(MB).xlsx
			2141				CDS - CWP 2141 - TO OPG.xlsx
							CWP_2141_S3.0_R1(GHR6)(MB).xlsx
			2142				CDS - CWP 2142 - Top 30 Comments - JV Copy (Jan 22 2015).xlsx
							CWP_2142_S5.3_R1(GHR4)(MB).xlsx
			2143				CDS - CWP 2143 - TO OPG.xlsx
							CWP_2143_S3.1_R1(GHR6)(MB).xlsx
			2144				CDS - CWP 2144 - TO OPG.xlsx
							CWP_2144_S3.4_R1(GHR3)(MBR2).xlsx
			2145				CDS - CWP 2145 - TO OPG (04.14.15).xlsx
							CDS - CWP 2145 - TO OPG.xlsx
							CWP_2145_S3.1_R1(GHR3)(MBR2).xlsx
			2146				CDS - CWP 2146 - TO OPG.xlsx
							CWP_2146_S3.1_R1(GHR3)(MB).xlsx
			2147				CDS - CWP 2147 - TO OPG.xlsx
							CWP_2147_S3.0_R1(GHR2)(MBR1).xlsx
			2148				CDS - CWP 2148 - TO OPG.xlsx
							CWP_2148_S3.1_R1(GHR3)(MB).xlsx
			2149				CDS - CWP 2149 - TO OPG.xlsx
							CWP_2149_S3.2_R1(GHR1)(MB).xlsx
			2150				CDS - CWP 2150 - TO OPG.xlsx
							CWP_2150_S3.1_R1(GHR4)(MBR1).xlsx
			2161				CDS - CWP 2161 - Stage 3 with JV Disposition.xlsx
							CWP_2161_S3.0_R1(GHR1)(MB).xlsx
			2164				CDS - CWP 2164 - TO JV.xlsx
							CWP_2164_S3.0_R1(GHR6)(MB).xlsx
			2166				CDS - CWP 2166 -TO JV.xlsx
							CWP_2166_S3.2_R1(GHR6)(MB).xlsx
			2167				CDS - CWP 2167 - TO JV.xlsx
							CWP_2167_S3.0_R1(GHR6)(MB).xlsx
			2168				CDS - CWP 2168 -TO JV.xlsx
							CWP_2168_S3.0_R1(GHR6)(MB)-U2.xlsx
			2169				CWP_2169_S3.0_R1(GHR7)(MB).xlsx
							CWP_2169_S3.0_R1(GHR7)(MB).xlsx
			2171				CDS - CWP 2171 - TO JV.xlsx
							CWP_2171_S3.0_R1(GHR3)(MB).xlsx
			2172				CDS - CWP 2172 - TO JV.xlsx
							CWP_2172_S3.A_R1(GHR6)(MB).xlsx
			2173				CDS - CWP 2173 - TO OPG.xlsx
							CWP_2173_S3.2_R1(GHR1)(MBR1)(CD1).xlsx
			2175				CDS - CWP 2175 -TO JV.xlsx
							CWP_2175_S3.1_R1(GHR7)(MB).xlsx
			2176				CDS - CWP 2176- TO JV.xlsx
							CWP_2176_S3.0_R1(GHR7)(MB).xlsx
			2177				CDS - CWP 2177 - TO JV.xlsx
							CWP_2177_S3.1_R1(GHR6)(MBR1).xlsx
			2178				CDS - CWP 2178 - TO JV.xlsx
							CWP_2178_S3.0_R1(GHR6)(MB).xlsx
			2179				CDS - CWP 2179 - TO OPG.xlsx
							CWP_2179_S3.1_R1(GHR7)(MBR1).xlsx
			2180				CDS - CWP 2180 - TO JV.xlsx
							CWP_2180_S3.1_R1(GHR3)(MBR1)-U2.xlsx
			2181				CDS - CWP 2181 - TO JV.xlsx
							CWP_2181_S3.0_R1(GHR1)(MB).xlsx
			2182				CDS - CWP 2182 - TO JV.xlsx
							CWP_2182_S3.1_R1(GHR1)(MB).xlsx
			2183				CDS - CWP 2183 - TO JV.xlsx
							CWP_2183_S3.0_R1(GHR1)(MBR1)-U2.xlsx
			2185				CDS - CWP 2185 - Stage 3 with JV Disposition.xlsx
							CWP_2185_S3.0_R1(GHR2)(MB).xlsx
			2186				CDS - CWP 2186 - Stage 3 with JV Disposition.xlsx
							CWP_2186_S3.0_R1(GHR2)(MB).xlsx
			2187				CDS - CWP 2187 - JV dispositions.xls
							CWP_2187_S3.2_R1(GHR1)(MB).xlsx
			2188				CDS - CWP 2188 -JV disposition.xlsx
							CWP_2188_S3.2_R1(GHR1)(MB).xlsx
			2189				CDS - CWP 2189 - TO OPG.xlsx
							CWP_2189_S3.0_R1(GHR3)(MB).xlsx
			2191				CDS - CWP 2191 - Stage 3 with JV Dispositions.xlsx
							CWP_2191_S3.0_R1(GHR3)(MB).xlsx
			2192				CDS - CWP 2192 - Stage 3 with JV Disposition.xlsx
							CWP_2192_S3.2_R1(GHR1)(MB).xlsx
			2193				CDS - CWP 2193 - Stage 3 with JV Disposition.xlsx
							CWP_2193_S3.2_R1(GHR1)(MB).xlsx
			2194				CDS - CWP 2194 - Stage 3 with JV Disposition.xlsx
							CWP_2194_S3.0_R1(GHR4)(MBR1).xlsx
			2195				CDS - CWP 2195 - Stage 3 with JV Disposition.xlsx
							CWP_2195_S3.1_R1(GHR3)(MBR1).xlsx
			2196				CDS - CWP 2196 - TO OPG.xlsx
							CWP_2196_S3.2_R1(GHR2)(MBR1).xlsx
			2197				CDS - CWP 2197 - TO OPG.xlsx
							CWP_2197_S3.2_R1(GHR1)(MBR1).xlsx
			2198				CDS - CWP 2198 - Stage 3 with JV Disposition.xlsx
							CWP_2198_S3.0_R1(GHR2)(MB).xlsx
			2199				CDS - CWP 2199 - Stage 3 with JV Disposition.xlsx
							CWP_2199_S3.0_R1(GHR7)(MB).xlsx
			2201				CDS - CWP 2201 - TO OPG.xlsx
							CWP_2201_S3.0_R1(GHR2)(MB).xlsx
			2202				CDS - CWP 2202.xlsx
							CWP_2202_S3.0_R1(GHR2)(MB) (3).xlsx
			2203				CDS - CWP 2203.xlsx
							CWP_2203_S3.0_R1(GHR2)(MB).xlsx
			2205				CDS - CWP 2205 - Stage 3 with JV dispositions.xlsx
							CWP_2205_S3.1_R1(GHR2)(MB).xlsx
			2206				CWP_2206_S3.1_R1(GHR2)(MB).xlsx
							CDS - CWP 2206 - Stage 3 with JV dispositions.xlsx
			2207				CWP_2207_S3.1_R1(GHR1)(MB).xlsx
							CDS - CWP 2207 - Stage 3 with JV dispositions.xlsx
			2208				CDS - CWP 2208 - Stage 3 with JV dispositions.xlsx
							CWP_2208_S3.1_R1(GHR1)(MB).xlsx
			2209				CDS - CWP 2209.xlsx
							CWP_2209_S3.0_R1(GHR1)(MB).xlsx
			2210				CDS - CWP 2210.xlsx
							CWP_2210_S3.0_R1(GHR2)(MB).xlsx
			2211				CDS - CWP 2211.xlsx
							CWP_2211_S3.0_R1(GHR1)(MB).xlsx
			2212				CDS - CWP 2212 -2213 Stage 3 with JV Dispositions.xlsx

RFR Class 2 Rev 01 Native File Mapping
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ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
							CWP_2212_S3.0_R1(GHR1)(MB).xlsx
			2213				CWP_2213_S3.0_R1(GHR1)(MB).xlsx
							CDS - CWP 2212 -2213 Stage 3 with JV Dispositions.xlsx
			2214				CDS - CWP 2214 -2244 Stage 3 with JV Dispositions.xlsx
							CWP_2214_S3.0_R1(GHR1)(MB).xlsx
			2215				CDS - CWP 2215-2216-2217-2218 - Stage 3 with JV DispositionR1.xlsx
							CWP_2215_S3.0_R1(GHR1)(MB).xlsx
			2216				CDS - CWP 2215-2216-2217-2218 - Stage 3 with JV DispositionR1.xlsx
							CWP_2216_S3.0_R1(GHR1)(MB).xlsx
			2217				CDS - CWP 2215-2216-2217-2218 - Stage 3 with JV DispositionR1.xlsx
							CWP_2217_S3.0_R1(GHR1)(MB).xlsx
			2218				CDS - CWP 2215-2216-2217-2218 - Stage 3 with JV DispositionR1.xlsx
							CWP_2218_S3.0_R1(GHR1)(MB).xlsx
			2219				CDS - CWP 2219 - Stage 3 with JV dispositions.xlsx
							CWP_2219_S3.0_R2(GHR3)(MB).xlsx
			2220				CDS - CWP 2220 - Stage 3 with JV dispositions.xlsx
							CWP_2220_S3.0_R2(GHR3)(MB).xlsx
			2221				CDS - CWP 2221 - JV disposition.xlsx
							CWP_2221_S3.2_R2(GHR2)(MB).xlsx
			2222				CDS - CWP 2222 - JV disposition.xlsx
							CWP_2222_S3.3_R1(GHR1)(MB).xlsx
			2223				CDS - CWP 2223 - Stage 3 with JV Disposition.xlsx
							CWP_2223_S3.0_R1(GHR1)(MB).xlsx
			2224				CDS - CWP 2224 - Stage 3 with JV Disposition.xlsx
							CWP_2224_S3.0_R1(GHR1)(MB).xlsx
			2227				CDS - CWP 2227 - TO JV.xlsx
							CWP_2227_S3.0_R1(GHR1)(MB).xlsx
			2229				CDS - CWP 2229.xlsx
							CWP_2229_S3.1_R1(GHR3)(MB).xlsx
			2230				CDS - CWP 2230.xlsx
							CWP_2230_S3.1_R1(GHR2)(MB).xlsx
			2231				CDS - CWP 2231 - Stage 3 with JV dispositions.xlsx
							CWP_2231_S3.0_R1(GHR2)(MB).xlsx
			2232				CDS - CWP 2232 - Stage 3 with JV dispositions.xlsx
							CWP_2232_S3.0_R1(GHR3)(MB).xlsx
			2235				CDS - CWP 2235.xlsx
							CWP_2235_S3.0_R1(GHR1)(MB).xlsx
			2236				CDS - CWP 2236.xlsx
							CWP_2236_S3.0_R1(GHR2)(MB).xlsx
			2237				CDS - CWP 2237.xlsx
							CWP_2237_S3.0_R1(GHR1)(MB).xlsx
			2238				CDS - CWP 2238 to 2241 (PCD 13).xlsx
							CWP_2238_S3.1_R1(GHR1)(MB).xlsx
			2239				CWP_2239_S3.1_R1(GHR1)(MB).xlsx
							CDS - CWP 2238 to 2241 (PCD 13).xlsx
			2240				CWP_2240_S3.1_R1(GHR1)(MB).xlsx
							CDS - CWP 2238 to 2241 (PCD 13).xlsx
			2241				CWP_2241_S3.1_R1(GHR1)(MB).xlsx
							CDS - CWP 2238 to 2241 (PCD 13).xlsx
			2242				CDS - CWP 2242 - Stage 3 with JV dispositions.xlsx
							CWP_2242_S3.0_R1(GHR2)(MB).xlsx
			2243				CDS - CWP 2243 - Stage 3 with JV dispositions.xlsx
							CWP_2243_S3.1_R1(GHR2)(MB).xlsx
			2244				CWP_2244_S3.0_R1(GHR2)(MB).xlsx
							CDS - CWP 2214 -2244 Stage 3 with JV Dispositions.xlsx
			2245				CDS - CWP 2245 - TO OPG.xlsx
							CWP_2245_S3.1_R1(GHR1)(MB).xlsx
			2246				CDS - CWP 2246 - Stage 3 with JV Dispositions.xlsx
							CWP_2246_S3.0_R1(GHR1)(MB).xlsx
			2247				CWP_2247_S3.0_R1(GHR1)(MB).xlsx
			2249				CWP_2249_S3.0_R1(GHR2)(MB).xlsx
	Appendix H						509407-0000-00000-60IM-0025 R00 Integrated Series Execution Plan Window 1.docx
							509407-0000-00000-60IM-0025 R00 Integrated Series Execution Plan Window 1.pdf
							Integrated Series Execution Plan Window 2 509407-0000-00000-60IM-0026 R00.docx
							Integrated Series Execution Plan Window 2 509407-0000-00000-60IM-0026 R00.pdf
							Integrated Series Execution Plan Window 3 509407-0000-00000-60IM-0027 R00.docx
							Integrated Series Execution Plan Window 3 509407-0000-00000-60IM-0027 R00.pdf
							Integrated Series Execution Plan Window 4 509407-0000-00000-60IM-0028 R00.docx
							Integrated Series Execution Plan Window 4 509407-0000-00000-60IM-0028 R00.pdf
							Integrated Series Execution Plan Window 5 509407-0000-00000-60IM-0029 R00.docx
							Integrated Series Execution Plan Window 5 509407-0000-00000-60IM-0029 R00.pdf
							Integrated Series Execution Plan Window 6 509407-0000-00000-60IM-0030 R00.docx
							Integrated Series Execution Plan Window 6 509407-0000-00000-60IM-0030 R00.pdf
							Integrated Series Execution Plan Window 7 509407-0000-00000-60IM-0031 R00.docx
							Integrated Series Execution Plan Window 7 509407-0000-00000-60IM-0031 R00.pdf
							Integrated Series Execution Plan Window 8 509407-0000-00000-60IM-0032 R00.docx
							Integrated Series Execution Plan Window 8 509407-0000-00000-60IM-0032 R00.pdf
		LOE					TS_LOE_R10 ZS (GH) - 1/2.xlsx
							TS_LOE_R5_Totals.pdf
		W1					ISEP Window 1 Estimate - Consolidated.xlsx
							ISEP_W1_R1 ZS (GH).xlsx
							ISEP_W1_R0(GH)(MB)_Totals.pdf
		W2					ISEP Window 2 Estimate - Consolidated.xlsx
							ISEP_W2_R1 ZS (GH).xlsx
							Isep_W2_R0(GH)(MB)_Totals.pdf
		W3					ISEP_W3_R5 ZS (GH)(MB).xlsx
							Isep_W3_R4(GH)(MB)_Totals.pdf
		W4					ISEP_W4_R4 ZS.xlsx
							ISEP_W4_R2(GHR1)(MB)_Totals.pdf
		W5					ISEP Window 5 Estimate - R2 Consolidated.xlsx
							ISEP_W5_R3 ZS (GH)(MB).xlsx
							Isep_W5_R2(GH)(MB)_Totals.pdf
		W6					Isep_W6_R3 ZS.xlsx
							Isep_W6_R1(GH)(MB)_Total.pdf
		W7					ISEP_W7_R2 ZS (GH).xlsx
							ISEP_W7_R1(GH)(MB)_Totals.pdf
		W8					ISEP Window 8 Estimate - R0 Consolidate.xlsx
							ISEP_EW_Timberline_Data.xlsx
							ISEP_W8_R1 ZS (GH)(MB).xlsx
							ISEP_W8_R0(GH)(MB)_Totals.pdf
	Appendix I						
	Appendix J						
	EPSCA 2015-2016 - 4 x 10's Base						Appendix C - EPSCA Blended Rate Summary 2015 - 2016 - 4 x 10's Base.pdf
							Appendix D - EPSCA Blended Rates (Boilermaker JM) 2015 - 2016.pdf
							Appendix E - Class 3 to Class 2 EPSCA Labour Rate Variance.pdf
							EPSCA Blended Rate Summary 2015 - 2016 - 4 x 10's Base 2014 - 2015.xlsx
							EPSCA Blended Rate Summary 2015 - 2016 - 4 x 10's Base.xlsx
							EPSCA Blended Rates (BM, Carp, EL, Ins OPJ) 2015 - 2016.xlsx
							EPSCA Blended Rates (Boilermaker) 2015 - 2016.xlsx
							EPSCA Blended Rates (Carpenter) 2015 - 2016.xlsx
							EPSCA Blended Rates (Electrician) 2015 - 2016.xlsx
							EPSCA Blended Rates (Insulator) 2015 - 2016.xlsx
							EPSCA Blended Rates (Ironworker) 2015 - 2016.xlsx
							EPSCA Blended Rates (LW, Lab, MW, PF GF) 2015 - 2016.xlsx
							EPSCA Blended Rates (Labourer) 2015 - 2016.xlsx
							EPSCA Blended Rates (Millwright) 2015 - 2016.xlsx
							EPSCA Blended Rates (OP, Paint, Team, SM GFJ) 2015 - 2016.xlsx
							EPSCA Blended Rates (Operator) 2015 - 2016.xlsx
							EPSCA Blended Rates (Painter) 2015 - 2016.xlsx
							EPSCA Blended Rates (Pipefitter) 2015 - 2016.xlsx
							EPSCA Blended Rates (Sheet Metal) 2015 - 2016.xlsx
							EPSCA Blended Rates (Teamster) 2015 - 2016.xlsx
							EPSCA Class 2 Estimate Rates 2015 - 2016 (R00).xlsx
							EPSCA Class 2 Estimate Rates 2015 - 2016 (R01).xlsx
							EPSCA Class 2 Estimate Rates 2015 - 2016 (R02).xlsx
							EPSCA Class 2 Estimate Rates 2015 - 2016 (R03).xlsx
							EPSCA Class 2 Estimate Rates 2015 - 2016 (R04).pdf
							EPSCA Class 2 Estimate Rates 2015 - 2016 (R04).xlsx
							EPSCA Class 2 Estimate Rates 2015 - 2016 (R05).xlsx
	TimberlineData						ENG_Timberline_Data_R0.xlsx
							Master_Timberline_Data.xlsx
							Onboarding_Timberline_Data_R0.xlsx
							PMT_CWP_Writing_Timberline_Data_R3.xlsx
							PMT_GA_Timberline_Data_R1.xlsx
							PMT_Rate_Calculator_R7.xlsm
							Series_Data_Dump.xlsx
							Train_Consumables_Timberline_Dump.xlsx
							DFL_Timberline_Rates_R2.pdf
							DFL_Timberline_Rates_R2.xlsx
							MFL_Timberline_Rates.pdf
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							Timberline_CWP_Resource_Rollup_R1.pdf
							Timberline_CWP_Resource_Rollup_R1.xlsx
							Timberline_CWP_Writing_Resource_Rollup.pdf
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							Timberline_LOE_Resource_Rollup.pdf
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RFR Class 2 Rev 01 Native File Mapping
Aug-24-15 DRAFT

Legend
: Included in Class 2 Rev 01 Aug 31/15 Report Submission
: To follow in the Sept 18/15 Class 2 Rev 01 Milestone Submission

ROOT FILE	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	SUB FOLDER	DOCUMENT
							Timberline_Onboarding_Resource_Rollup.pdf Timberline_Onboarding_Resource_Rollup.xlsx Timberline_PMT_Resource_Rollup.pdf Timberline_PMT_Resource_Rollup.xlsx Timberline_Tooling_Resource_Rollup_.pdf Timberline_Tooling_Resource_Rollup_.xlsx

SUPREME COURT OF CANADA

CITATION: Ontario (Energy Board) *v.* Ontario Power Generation Inc., 2015 SCC 44

DATE: 20150925
DOCKET: 35506

BETWEEN:

Ontario Energy Board
Appellant
and
Ontario Power Generation Inc., Power Workers' Union, Canadian Union of Public Employees, Local 1000 and Society of Energy Professionals
Respondents
- and -
Ontario Education Services Corporation
Intervener

CORAM: McLachlin C.J. and Abella, Rothstein, Cromwell, Moldaver, Karakatsanis and Gascon JJ.

REASONS FOR JUDGMENT: (paras. 1 to 121) Rothstein J. (McLachlin C.J. and Cromwell, Moldaver, Karakatsanis and Gascon JJ. concurring)

DISSENTING REASONS: (paras. 122 to 161) Abella J.

NOTE: This document is subject to editorial revision before its reproduction in final form in the *Canada Supreme Court Reports*.

ONT. (ENERGY BOARD) *v.* ONT. POWER GENERATION

Ontario Energy Board *Appellant*

v.

**Ontario Power Generation Inc.,
Power Workers' Union, Canadian Union
of Public Employees, Local 1000 and
Society of Energy Professionals** *Respondents*

and

Ontario Education Services Corporation *Intervener*

Indexed as: Ontario (Energy Board) *v.* Ontario Power Generation Inc.

2015 SCC 44

File No.: 35506.

2014: December 3; 2015: September 25.

Present: McLachlin C.J. and Abella, Rothstein, Cromwell, Moldaver, Karakatsanis and Gascon JJ.

ON APPEAL FROM THE COURT OF APPEAL FOR ONTARIO

Public utilities — Electricity — Rate-setting decision by utilities regulator — Utility seeking to recover incurred or committed compensation costs in utility rates set by Ontario Energy Board — Whether Board bound to apply particular prudence test in evaluating utility costs — Whether Board's decision to disallow $145 million in labour compensation costs related to utility's nuclear operations reasonable — Ontario Energy Board, 1998, S.O. 1998, c. 15, Sch. B, ss. 78.1(5)(6).

Administrative law — Boards and tribunals — Appeals — Standing — Whether Ontario Energy Board acted improperly in pursuing appeal and in arguing in favour of reasonableness of its own decision — Whether Board attempted to use appeal to "bootstrap" its original decision by making additional arguments on appeal.

In Ontario, utility rates are regulated through a process by which a utility seeks approval from the Ontario Energy Board for costs the utility has incurred or expects to incur in a specified period of time. Where the Board approves of the costs, they are incorporated into utility rates such that the utility receives payment amounts to cover the approved expenditures. The Board disallowed certain payment amounts applied for by Ontario Power Generation ("OPG") as part of its rate application covering the 2011-2012 operating period. Specifically, the Board disallowed $145 million in labour compensation costs related to OPG's nuclear operations on the grounds that OPG's labour costs were out of step with those of comparable entities in

the regulated power generation industry. A majority of the Ontario Divisional Court dismissed OPG's appeal and upheld the decision of the Board. The Court of Appeal set aside the decisions of the Divisional Court and the Board and remitted the matter to the Board for redetermination in accordance with its reasons.

The crux of OPG's argument here is that the Board is legally required to compensate OPG for all of its prudently committed or incurred costs. OPG asserts that prudence in this context has a particular methodological meaning that requires the Board to assess the reasonableness of OPG's decision to incur or commit to costs at the time the decisions to incur or commit to the costs were made and that OPG ought to benefit from a presumption of prudence. The Board on the other hand argues that a particular prudence test methodology is not compelled by law, and that in any case the costs disallowed here were not committed nuclear compensation costs, but are better characterized as forecast costs.

OPG also raises concerns regarding the Board's role in acting as a party on appeal from its own decision, arguing that the Board's aggressive and adversarial defence of its decision was improper, and the Board attempted to use the appeal to bootstrap its original decision by making additional arguments on appeal. The Board argues that the structure of utilities regulation in Ontario makes it necessary and important for it to argue the merits of its decision on appeal.

Held (Abella J. dissenting): The appeal should be allowed. The decision of the Court of Appeal is set aside and the decision of the Board is reinstated.

Per McLachlin C.J. and **Rothstein**, Cromwell, Moldaver, Karakatsanis and Gascon JJ.: The first issue is the appropriateness of the Board's participation in the appeal. The concerns with regard to tribunal participation on appeal from the tribunal's own decision should not be read to establish a categorical ban. A discretionary approach provides the best means of ensuring that the principles of finality and impartiality are respected without sacrificing the ability of reviewing courts to hear useful and important information and analysis. Because of their expertise and familiarity with the relevant administrative scheme, tribunals may in many cases be well positioned to help the reviewing court reach a just outcome. Further, some cases may arise in which there is simply no other party to stand in opposition to the party challenging the tribunal decision. In a situation where no other well-informed party stands opposed, the presence of a tribunal as an adversarial party may help the court ensure it has heard the best of both sides of a dispute. The following factors are relevant in informing the court's exercise of its discretion: statutory provisions addressing the structure, processes and role of the particular tribunal and the mandate of the tribunal, that is, whether the function of the tribunal is to adjudicate individual conflicts between parties or whether it serves a policy-making, regulatory or investigative role, or acts on behalf of the public interest. The importance of fairness, real and perceived, weighs more heavily against tribunal standing where the tribunal served an adjudicatory function in the proceeding. Tribunal standing is a matter to be determined by the court conducting the first-instance review in accordance with the principled exercise of that court's discretion. In exercising its discretion, the court is required to balance the need for

fully informed adjudication against the importance of maintaining tribunal impartiality.

Consideration of these factors in the context of this case leads to the conclusion that it was not improper for the Board to participate in arguing in favour of the reasonableness of its decision on appeal. The Board was the only respondent in the initial review of its decision. It had no alternative but to step in if the decision was to be defended on the merits. Also, the Board was exercising a regulatory role by setting just and reasonable payment amounts to a utility. In this case, the Board's participation in the instant appeal was not improper.

The issue of tribunal "bootstrapping" is closely related to the question of when it is proper for a tribunal to act as a party on appeal or judicial review of its decision. The standing issue concerns the types of argument a tribunal may make, while the bootstrapping issue concerns the content of those arguments. A tribunal engages in bootstrapping where it seeks to supplement what would otherwise be a deficient decision with new arguments on appeal. A tribunal may not defend its decision on a ground that it did not rely on in the decision under review. The principle of finality dictates that once a tribunal has decided the issues before it and provided reasons for its decision, absent a power to vary its decision or rehear the matter, it cannot use judicial review as a chance to amend, vary, qualify or supplement its reasons. While a permissive stance towards new arguments by tribunals on appeal serves the interests of justice insofar as it ensures that a reviewing court is presented

with the strongest arguments in favour of both sides, to permit bootstrapping may undermine the importance of reasoned, well-written original decisions. In this case, the Board did not impermissibly step beyond the bounds of its original decision in its arguments before the Court. The arguments raised by the Board on appeal do not amount to impermissible bootstrapping.

The merits issue concerns whether the appropriate methodology was followed by the Board in its disallowance of $145 million in labour compensation costs sought by OPG. The just-and-reasonable approach to recovery of the cost of services provided by a utility captures the essential balance at the heart of utilities regulation: to encourage investment in a robust utility infrastructure and to protect consumer interests, utilities must be allowed, over the long run, to earn their cost of capital, no more, no less. In order to ensure the balance between utilities' and consumers' interests is struck, just and reasonable rates must be those that ensure consumers are paying what the Board expects it to cost to efficiently provide the services they receive, taking account of both operating and capital costs. In that way, consumers may be assured that, overall, they are paying no more than what is necessary for the service they receive, and utilities may be assured of an opportunity to earn a fair return for providing those services.

The *Ontario Energy Board Act, 1998* does not prescribe the methodology the Board must use to weigh utility and consumer interests when deciding what constitutes just and reasonable payment amounts to the utility. However, the *Ontario*

Energy Board Act, 1998 places the burden on the applicant utility to establish that payments amounts approved by the Board are just and reasonable. It would thus seem inconsistent with the statutory scheme to presume that utility decisions to incur costs were prudent. The Board has broad discretion to determine the methods it may use to examine costs — but it cannot shift the burden of proof contrary to the statutory scheme.

The issue is whether the Board was bound to use a no hindsight, presumption of prudence test to determine whether labour compensation costs were just and reasonable. The prudent investment test, or prudence review, is a valid and widely accepted tool that regulators may use when assessing whether payments to a utility would be just and reasonable. However, there is no support in the statutory scheme for the notion that the Board should be required as a matter of law, under the *Ontario Energy Board Act, 1998* to apply the prudence test such that the mere decision not to apply it when considering committed costs would render its decision on payment amounts unreasonable. Where a statute requires only that the regulator set "just and reasonable" payments, as the *Ontario Energy Board Act, 1998* does in Ontario, the regulator may make use of a variety of analytical tools in assessing the justness and reasonableness of a utility's proposed payment amounts. This is particularly so where, as here, the regulator has been given express discretion over the methodology to be used in setting payment amounts.

Where the regulator has discretion over its methodological approach, understanding whether the costs at issue are "forecast" or "committed" may be helpful in reviewing the reasonableness of a regulator's choice of methodology. Here, the labour compensation costs which led to the $145 million disallowance are best understood as partly committed costs and partly costs subject to management discretion. They are partly committed because they resulted from collective agreements entered into between OPG and two of its unions, and partly subject to management discretion because OPG retained some flexibility to manage total staffing levels in light of, among other things, projected attrition of the workforce. It is not reasonable to treat these costs as entirely forecast. However, the Board was not bound to apply a particular prudence test in evaluating these costs. It is not necessarily unreasonable, in light of the particular regulatory structure established by the *Ontario Energy Board Act, 1998*, for the Board to evaluate committed costs using a method other than a no-hindsight prudence review. Applying a presumption of prudence would have conflicted with the burden of proof in the *Ontario Energy Board Act, 1998* and would therefore not have been reasonable. The question of whether it was reasonable to assess a particular cost using hindsight should turn instead on the circumstances of that cost.

In this case, the nature of the disputed costs and the environment in which they arose provide a sufficient basis to find that the Board did not act unreasonably in not applying the prudent investment test in determining whether it would be just and reasonable to compensate OPG for these costs and disallowing. Since the costs at

issue are operating costs, there is little danger that a disallowance of these costs will have a chilling effect on OPG's willingness to incur operating costs in the future, because costs of the type disallowed here are an inescapable element of operating a utility. Further, the costs at issue arise in the context of an ongoing repeat-player relationship between OPG and its employees. Such a context supports the reasonableness of a regulator's decision to weigh all evidence it finds relevant in striking a just and reasonable balance between the utility and consumers, rather than confining itself to a no-hindsight approach. There is no dispute that collective agreements are "immutable" between employees and the utility. However, if the legislature had intended for costs under collective agreements to also be inevitably imposed on consumers, it would not have seen fit to grant the Board oversight of utility compensation costs. The Board's decision in no way purports to force OPG to break its contractual commitments to unionized employees. It was not unreasonable for the Board to adopt a mixed approach that did not rely on quantifying the exact share of compensation costs that fell into the forecast and committed categories. Such an approach represents an exercise of the Board's methodological discretion in addressing a challenging issue where these costs did not fit easily into one category or the other.

The Board's disallowance may have adversely impacted OPG's ability to earn its cost of capital in the short run. Nevertheless, the disallowance was intended to send a clear signal that OPG must take responsibility for improving its performance. Such a signal may, in the short run, provide the necessary impetus for OPG to bring

its compensation costs in line with what, in the Board's opinion, consumers should justly expect to pay for an efficiently provided service. Sending such a signal is consistent with the Board's market proxy role and its objectives under s. 1 of the *Ontario Energy Board Act, 1998*.

Per **Abella** J. (dissenting): The Board's decision was unreasonable because the Board failed to apply the methodology set out for itself for evaluating just and reasonable payment amounts. It both ignored the legally binding nature of the collective agreements between Ontario Power Generation and the unions and failed to distinguish between committed compensation costs and those that were reducible.

The Board stated in its reasons that it would use two kinds of review in order to determine just and reasonable payment amounts. As to "forecast costs", that is, those over which a utility retains discretion and can still be reduced or avoided, the Board explained that it would review such costs using a wide range of evidence, and that the onus would be on the utility to demonstrate that its forecast costs were reasonable. A different approach, however, would be applied to those costs the company could not "take action to reduce". These costs, sometimes called "committed costs", represent binding commitments that leave a utility with no discretion about whether to make the payment. The Board explained that it would evaluate these costs using a "prudence review". The application of a prudence review does not shield these costs from scrutiny, but it does include a presumption that the costs were prudently incurred.

Rather than apply the methodology it set out for itself, however, the Board assessed *all* compensation costs in Ontario Power Generation's collective agreements as adjustable forecast costs, without determining whether any of them were costs for which there is no opportunity for the company to take action to reduce. The Board's failure to separately assess the compensation costs committed as a result of the collective agreements from other compensation costs, ignored not only its own methodological template, but labour law as well.

The compensation costs for approximately 90 per cent of Ontario Power Generation's regulated workforce were established through legally binding collective agreements which obligated the utility to pay fixed levels of compensation, regulated staffing levels, and provided unionized employees with employment security. The obligations contained in these collective agreements were immutable and legally binding commitments. The agreements therefore did not just leave the utility with limited flexibility regarding overall compensation or staffing levels, they made it *illegal* for the utility to alter the compensation and staffing levels of 90 per cent of its regulated workforce in a manner that was inconsistent with its commitments under the agreements.

The Board, however, applying the methodology it said it would use for the utility's forecast costs, put the onus on Ontario Power Generation to prove the reasonableness of all its compensation costs and concluded that it had failed to provide compelling evidence or documentation or analysis to justify compensation

levels. Had the Board used the approach it said it would use for costs the company had no opportunity to reduce, it would have used an after-the-fact prudence review, with a rebuttable presumption that the utility's expenditures were reasonable.

It may well be that Ontario Power Generation has the ability to manage some staffing levels through attrition or other mechanisms that did not breach the utility's commitments under its collective agreements, and that these costs may therefore properly be characterized as forecast costs. But no factual findings were made by the Board about the extent of any such flexibility. There is in fact no evidence in the record, nor any evidence cited in the Board's decision, setting out what proportion of Ontario Power Generation's compensation costs were fixed and what proportion remained subject to the utility's discretion. Given that collective agreements are legally binding, it was unreasonable for the Board to assume that Ontario Power Generation could reduce the costs fixed by these contracts in the absence of any evidence to that effect.

Selecting a test which is more likely to confirm the Board's assumption that collectively-bargained costs are excessive, misconceives the point of the exercise, namely, to determine whether those costs were in fact excessive. Blaming collective bargaining for what are *assumed* to be excessive costs, imposes the appearance of an ideologically-driven conclusion on what is intended to be a principled methodology based on a distinction between committed and forecast costs, not between costs which are collectively bargained and those which are not. While the Board has wide

discretion to fix payment amounts that are just and reasonable and, subject to certain limitations, to establish the methodology used to determine such amounts, once the Board establishes a methodology, it is, at the very least, required to faithfully apply it.

Absent methodological clarity and predictability, Ontario Power Generation would be unable to know how to determine what expenditures and investments to make and how to present them to the Board for review. Wandering sporadically from approach to approach, or failing to apply the methodology it declares itself to be following, creates uncertainty and leads, inevitably, to needlessly wasting public time and resources in constantly having to anticipate and respond to moving regulatory targets. Whether or not one can fault the Board for failing to use a particular methodology, what the Board can unquestionably be analytically faulted for, is evaluating all compensation costs fixed by collective agreements as being amenable to adjustment. Treating these compensation costs as reducible was unreasonable.

The appeal should accordingly be dismissed, the Board's decision set aside, and the matter remitted to the Board for reconsideration.

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By Rothstein J.

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N.B.R. (2d) 93; *Chandler v. Alberta Association of Architects*, [1989] 2 S.C.R. 848; *Dunsmuir v. New Brunswick*, 2008 SCC 9, [2008] 1 S.C.R. 190; *Alberta (Information and Privacy Commissioner) v. Alberta Teachers' Association*, 2011 SCC 61, [2011] 3 S.C.R. 654; *Tervita Corp. v. Canada (Commissioner of Competition)*, 2015 SCC 3, [2015] 1 S.C.R. 161; *Bell Canada v. Bell Aliant Regional Communications*, 2009 SCC 40, [2009] 2 S.C.R. 764; *Re General Increase in Freight Rates* (1954), 76 C.R.T.C. 12; *ATCO Gas and Pipelines Ltd. v. Alberta (Energy and Utilities Board)*, 2006 SCC 4, [2006] 1 S.C.R. 140; *State of Missouri ex rel. Southwestern Bell Telephone Co. v. Public Service Commission of Missouri*, 262 U.S. 276 (1923); *Duquesne Light Co. v. Barasch*, 488 U.S. 299 (1989); *U. S. West Communications, Inc. v. Public Service Commission of Utah*, 901 P.2d 270 (1995); *British Columbia Electric Railway Co. v. Public Utilities Commission of British Columbia*, [1960] S.C.R. 837; *Nova Scotia Power Inc., Re*, 2005 NSUARB 27; *Nova Scotia Power Inc. (Re)*, 2012 NSUARB 227.

By Abella J. (dissenting)

Verizon Communications Inc. v. Federal Communications Commission, 535 U.S. 467 (2002); *Northwestern Utilities Ltd. v. City of Edmonton*, [1929] S.C.R. 186; *State of Missouri ex rel. Southwestern Bell Telephone Co. v. Public Service Commission of Missouri*, 262 U.S. 276 (1923); *Enersource Hydro Mississauga Inc. (Re)*, 2012 LNONOEB 373 (QL); *Enbridge Gas Distribution Inc. (Re)*, 2002 LNONOEB 4 (QL); *Enbridge Gas Distribution Inc. v. Ontario Energy Board* (2006),

210 O.A.C. 4; *Ontario Power Generation v. Society of Energy Professionals*, [2011] O.L.A.A. No. 117 (QL); *TransCanada Pipelines Ltd. v. National Energy Board*, 2004 FCA 149, 319 N.R. 171.

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APPEAL from a judgment of the Ontario Court of Appeal (Rosenberg, Goudge and Blair JJ.A.), 2013 ONCA 359, 116 O.R. (3d) 793, 365 D.L.R. (4th) 247, 307 O.A.C. 109, [2013] O.J. No. 3917 (QL), 2013 CarswellOnt 9792 (WL Can.), setting aside a decision of the Divisional Court (Aitken, Swinton and Hoy JJ.), 2012 ONSC 729, 109 O.R. (3d) 576, 347 D.L.R. (4th) 355, [2012] O.J. No. 862 (QL), 2012 CarswellOnt 2710 (WL Can.), and setting aside a decision of the Ontario Energy Board, EB-2010-0008, March 10, 2011 (online: http://www.ontarioenergyboard.ca/oeb/_ Documents/Decisions/dec_reasons_OPG_Payment_20110310.pdf), 2011 LNONOEB 57 (QL), 2011 CarswellOnt 3723 (WL Can.). Appeal allowed, Abella J. dissenting.

Glenn Zacher, *Patrick Duffy* and *James Wilson*, for the appellant.

John B. Laskin, *Crawford Smith*, *Myriam Seers* and *Carlton Mathias*, for the respondent Ontario Power Generation Inc.

Richard P. Stephenson and *Emily Lawrence*, for the respondent the Power Workers' Union, Canadian Union of Public Employees, Local 1000.

Paul J. J. Cavalluzzo and *Amanda Darrach*, for the respondent the Society of Energy Professionals.

Mark Rubenstein, for the intervener.

The judgment of McLachlin C.J. and Rothstein, Cromwell, Moldaver, Karakatsanis and Gascon JJ.was delivered by

ROTHSTEIN J. —

[1] In Ontario, utility rates are regulated through a process by which a utility seeks approval from the Ontario Energy Board ("Board") for costs the utility has incurred or expects to incur in a specified period of time. Where the Board approves of costs, they are incorporated into utility rates such that the utility receives payment amounts to cover the approved expenditures. This case concerns the decision of the Board to disallow certain payment amounts applied for by Ontario Power Generation Inc. ("OPG") as part of its rate application covering the 2011-2012 operating period. Specifically, the Board disallowed $145 million in labour compensation costs related

to OPG's nuclear operations on the grounds that OPG's labour costs were out of step with those of comparable entities in the regulated power generation industry.

[2] OPG appealed the Board's decision to the Ontario Divisional Court. A majority of the court dismissed the appeal and upheld the decision of the Board. OPG then appealed that decision to the Ontario Court of Appeal, which set aside the decisions of the Divisional Court and the Board and remitted the matter to the Board for redetermination in accordance with its reasons. The Board now appeals to this Court.

[3] OPG asserts that the Board's decision to disallow these labour compensation costs was unreasonable. The crux of OPG's argument is that the Board is legally required to compensate OPG for all of its prudently committed or incurred costs. OPG asserts that prudence in this context has a particular methodological meaning that requires the Board to assess the reasonableness of OPG's decisions to incur or commit to costs at the time the decisions to incur or commit to the costs were made and that OPG ought to benefit from a presumption of prudence. Because the Board did not employ this prudence methodology, OPG argues that its decision was unreasonable.

[4] The Board argues that a particular "prudence test" methodology is not compelled by law, and that in any case the costs disallowed here were not "committed" nuclear compensation costs, but are better characterized as forecast costs.

[5] OPG also raises concerns regarding the Board's role in acting as a party on appeal from its own decision. OPG argues that in this case, the Board's aggressive and adversarial defence of its original decision was improper, and that the Board attempted to use the appeal to "bootstrap" its original decision by making additional arguments on appeal.

[6] The Board asserts that the scope of its authority to argue on appeal was settled when it was granted full party rights in connection with the granting of leave by this Court. Alternatively, the Board argues that the structure of utilities regulation in Ontario makes it necessary and important for it to argue the merits of its decisions on appeal.

[7] In my opinion, the labour compensation costs which led to the $145 million disallowance are best understood as partly committed costs and partly costs subject to management discretion. They are partly committed because they resulted from collective agreements entered into between OPG and two of its unions, and partly subject to management discretion because OPG retained some flexibility to manage total staffing levels in light of, among other things, projected attrition of the workforce. It is not reasonable to treat these costs as entirely forecast. However, I do not agree with OPG that the Board was bound to apply a particular prudence test in evaluating these costs. The *Ontario Energy Board Act, 1998*, S.O. 1998, c. 15, Sch. B, and associated regulations give the Board broad latitude to determine the methodology it uses in assessing utility costs, subject to the Board's ultimate duty to

ensure that payment amounts it orders be just and reasonable to both the utility and consumers.

[8] In this case, the nature of the disputed costs and the environment in which they arose provide a sufficient basis to find that the Board did not act unreasonably in disallowing the costs.

[9] Regarding the Board's role on appeal, I do not find that the Board acted improperly in arguing the merits of this case, nor do I find that the arguments raised on appeal amount to impermissible "bootstrapping".

[10] Accordingly, I would allow the appeal, set aside the decision of the Court of Appeal, and reinstate the decision of the Board.

I. Regulatory Framework

[11] The *Ontario Energy Board Act, 1998* establishes the Board as a regulatory body with authority to oversee, among other things, electricity generation in the province of Ontario. Section 1 sets out the objectives of the Board in regulating electricity, which include:

> **1.** (1) . . .
>
> 1. To protect the interests of consumers with respect to prices and the adequacy, reliability and quality of electricity service.

> 2. To promote economic efficiency and cost effectiveness in the generation, transmission, distribution, sale and demand management of electricity and to facilitate the maintenance of a financially viable electricity industry.

Accordingly, the Board must ensure that it regulates with an eye to balancing both consumer interests and the efficiency and financial viability of the electricity industry. The Board's role has also been described as that of a "market proxy": 2012 ONSC 729, 109 O.R. (3d) 576, at para. 54; 2013 ONCA 359, 116 O.R. (3d) 793, at para. 38. In this sense, the Board's role is to emulate as best as possible the forces to which a utility would be subject in a competitive landscape: *Toronto Hydro-Electric System Ltd. v. Ontario (Energy Board)*, 2010 ONCA 284, 99 O.R. (3d) 481, at para. 48.

[12] One of the Board's most powerful tools to achieve its objectives is its authority to fix the amount of payments utilities receive in exchange for the provision of service. Section 78.1(5) of the *Ontario Energy Board Act, 1998* provides in relevant part:

> (5) The Board may fix such other payment amounts as it finds to be just and reasonable,
>
> (a) on an application for an order under this section, if the Board is not satisfied that the amount applied for is just and reasonable; . . .

[13] Section 78.1(6) provides: ". . . the burden of proof is on the applicant in an application made under this section".

[14] As I read these provisions, the utility applies for payment amounts for a future period (called the "test period"). The Board will accept the payment amounts applied for unless the Board is not satisfied that amounts are just and reasonable. Where the Board is not satisfied, s. 78.1(5) empowers it to fix other payment amounts which it finds to be just and reasonable.

[15] This Court has had the occasion to consider the meaning of similar statutory language in *Northwestern Utilities Ltd. v. City of Edmonton*, [1929] S.C.R. 186. In that case, the Court held that "fair and reasonable" rates were those "which, under the circumstances, would be fair to the consumer on the one hand, and which, on the other hand, would secure to the company a fair return for the capital invested" (pp. 192-93).

[16] This means that the utility must, over the long run, be given the opportunity to recover, through the rates it is permitted to charge, its operating and capital costs ("capital costs" in this sense refers to all costs associated with the utility's invested capital). This case is concerned primarily with operating costs. If recovery of operating costs is not permitted, the utility will not earn its cost of capital, which represents the amount investors require by way of a return on their investment in order to justify an investment in the utility. The required return is one that is equivalent to what they could earn from an investment of comparable risk. Over the long run, unless a regulated utility is allowed to earn its cost of capital, further investment will be discouraged and it will be unable to expand its operations or even

maintain existing ones. This will harm not only its shareholders, but also its customers: *TransCanada Pipelines Ltd. v. National Energy Board*, 2004 FCA 149, 319 N.R. 171.

[17] This of course does not mean that the Board must accept every cost that is submitted by the utility, nor does it mean that the rate of return to equity investors is guaranteed. In the short run, return on equity may vary, for example if electricity consumption by the utility's customers is higher or lower than predicted. Similarly, a disallowance of any operating costs to which the utility has committed itself will negatively impact the return to equity investors. I do not intend to enter into a detailed analysis of how the cost of equity capital should be treated by utility regulators, but merely to observe that any disallowance of costs to which a utility has committed itself has an effect on equity investor returns. This effect must be carefully considered in light of the long-run necessity that utilities be able to attract investors and retain earnings in order to survive and operate efficiently and effectively, in accordance with the statutory objectives of the Board in regulating electricity in Ontario.

[18] As noted above, the burden is on the utility to satisfy the Board that the payment amounts it applies for are just and reasonable. If it fails to do so, the Board may disallow the portion of the application that it finds is not for amounts that are just and reasonable.

[19] Where applied-for operating costs are disallowed, the utility, if it is able to do so, may forego the expenditure of such costs. Where the expenditure cannot be

foregone, the shareholders of the utility will have to absorb the reduction in the form of receiving less than their anticipated rate of return on their investment, i.e. the utility's cost of equity capital. In such circumstances it will be the management of the utility that will be responsible in the future for bringing its costs into line with what the Board considers just and reasonable.

[20] In order to ensure that the balance between utilities' and consumers' interests is struck, just and reasonable rates must be those that ensure consumers are paying what the Board expects it to cost to efficiently provide the services they receive, taking account of both operating and capital costs. In that way, consumers may be assured that, overall, they are paying no more than what is necessary for the service they receive, and utilities may be assured of an opportunity to earn a fair return for providing those services.

II. Facts

[21] OPG is Ontario's largest energy generator, and is subject to rate regulation by the Board. OPG came into being in 1999 as one of the successor corporations to Ontario Hydro. It operates Board-regulated nuclear and hydroelectric facilities that generate approximately half of Ontario's electricity. Its sole shareholder is the Province of Ontario.

[22] It employs approximately 10,000 people in connection with its regulated facilities, 95 percent of whom work in its nuclear business. Approximately 90 percent

of its employees in its regulated businesses are unionized, with approximately two thirds of unionized employees represented by the Power Workers' Union, Canadian Union of Public Employees, Local 1000 ("PWU"), and one third represented by the Society of Energy Professionals ("Society").

[23] Since early in its existence as an independent utility, OPG has been aware of the importance of improving its corporate performance. As part of a general effort to improve its business, OPG undertook efforts to benchmark its nuclear performance against comparable power plants around the world. In a memorandum of agreement ("MOA") with the Province of Ontario dated August 17, 2005, OPG committed to the following:

> OPG will seek continuous improvement in its nuclear generation business and internal services. OPG will benchmark its performance in these areas against CANDU nuclear plants worldwide as well as against the top quartile of private and publicly-owned nuclear electricity generators in North America. OPG's top operational priority will be to improve the operation of its existing nuclear fleet.
>
> (A.R., vol. III, at p. 215)

[24] As part of OPG's first-ever rate application with the Board in 2007, for a test period covering the years 2008 and 2009, OPG sought approval for a $6.4 billion "revenue requirement"; this term refers to "the total revenue that is required by the company to pay all of its allowable expenses and also to recover all costs associated with its invested capital": L. Reid and J. Todd, "New Developments in Rate Design for Electricity Distributors", in G. Kaiser and B. Heggie, eds., *Energy Law and Policy*

(2011), 519, at p. 521. This constituted an increase of $1 billion over the revenue requirement that it had sought and was granted under the regulatory scheme in place prior to the Board's assumption of regulatory authority over OPG: EB-2007-0905, Decision with Reasons, November 3, 2008 (the "Board 2008-2009 Decision") (online), at pp. 5-6).

[25] The Board found that OPG was not meeting the nuclear performance expectations of its sole shareholder and that it had done little to conduct benchmarking of its performance against that of its peers, despite its commitment to do so dating back to 2005. Indeed, the only evidence of benchmarking that OPG submitted as part of its rate application was a 2006 report from Navigant Consulting, Inc. (the "Navigant Report"), which found that OPG was overstaffed by 12 percent in comparison to its peers. The Board found that OPG had not acted on the recommendations of the Navigant Report and had not commissioned subsequent benchmarking studies to assess its performance (Board 2008-2009 Decision, at pp. 27 and 30). The Board also found that operating costs at OPG's Pickering nuclear facilities were "far above industry averages" (p. 29). The Board thus disallowed $35 million of OPG's proposed revenue requirement and directed OPG to prepare benchmarking studies for use in future applications (p. 31).

[26] In explaining the importance of benchmarking, the Board stated: "The reason why the MOA emphasized benchmarking was because such studies can and do

shine a light on inefficiencies and lack of productivity improvement" (Board 2008-2009 Decision, at p. 30).

[27] On May 5, 2010, shortly before OPG was set to file its second rate application, which is the subject of this appeal, the Ontario Minister of Energy and Infrastructure wrote to the President and CEO of OPG to ensure that OPG would demonstrate in its upcoming rate application "concerted efforts to identify cost saving opportunities and focus [its] forthcoming rate application on those items that are essential to the safe and reliable operation of [its] existing assets and projects already under development" (A.R., vol. IV, at p. 38).

[28] On May 26, 2010, OPG filed its payment amounts application for the 2011-2012 test period. As part of its evidence before the Board, OPG submitted two reports by ScottMadden Inc., a general management consulting firm specializing in benchmarking and business planning for nuclear facilities. The Phase 1 report compared OPG's nuclear operational and financial performance against that of external peers using industry performance metrics. The Phase 2 final report discussed performance improvement targets with the intent of improving OPG's nuclear business. OPG collaborated with ScottMadden on the Phase 1 and 2 reports, which were released on July 2, 2009 and September 11, 2009, respectively.

[29] OPG's rate application pertained to a test period beginning on January 1, 2011 and ending on December 31, 2012. OPG sought approval of a $6.9 billion revenue requirement, which represented an increase of 6.2 percent over OPG's then-

current revenue based on the preceding year's approved utility rates. Of the $6.9 billion revenue requirement sought by OPG, $2.8 billion pertained to compensation costs, of which approximately $2.4 billion concerned OPG's nuclear business.

[30] A substantial portion of OPG's wage and compensation expenses were fixed by OPG's collective agreements with the unions, PWU and the Society. At the time of its application, OPG was party to a collective agreement with PWU, effective from April 2009 through March 2012, while its collective agreement with the Society expired on December 31, 2010. These collective agreements provided annual wage increases between 2 percent and 3 percent. OPG forecast an additional 1 percent increase for step progressions and promotions of unionized staff. Following the Board's hearing in this case, an interest arbitrator ordered a new collective agreement between OPG and the Society, effective February 3, 2011. This collective agreement provided wage increases that varied between 1 percent and 3 percent.

III. Judicial History

A. *Ontario Energy Board: EB-2010-0008, Decision With Reasons, March 10, 2011 (the "Board Decision") (Online)*

[31] In its decision concerning OPG's rate application for the 2011-2012 test period, the Board stated that it enjoyed broad discretion pursuant to Ontario Regulation 53/05 (*Payments Under Section 78.1 of the Act*) and s. 78.1 of the *Ontario Energy Board Act, 1998* to "adopt the mechanisms it judges appropriate in setting just

and reasonable rates" (p. 18). The Board recognized that different tests could apply depending on whether its analysis concerned the recovery of forecast costs or an after-the-fact review of costs already incurred. In this rate application, it was appropriate to take into consideration all evidence that the Board deemed relevant to assess the reasonableness of OPG's revenue requirement.

[32] The Board rejected OPG's proposed revenue requirement of $6.9 billion, reducing it by $145 million over the test period "to send a clear signal that OPG must take responsibility for improving its performance" (p. 86). Key to its disallowance was the Board's finding that OPG was overstaffed and that its compensation levels were excessive.

[33] Regarding the number of staff, the Board pointed out that a benchmarking study commissioned by OPG itself, the ScottMadden Phase 2 final report, suggested that certain staff positions could be reduced or eliminated altogether. The Board suggested that OPG could review its organizational structure and reassign or eliminate positions in the coming years, as 20 percent to 25 percent of its staff were set to retire between 2010 and 2014 and it was possible to make greater use of external contractors. Regarding compensation, the Board found that OPG had not submitted compelling evidence justifying the benchmarking of its salaries of non-management employees to the 75th percentile of a survey of industry salaries conducted by Towers Perrin. Instead, the Board considered the proper benchmark to be the 50th percentile, the same percentile against which OPG benchmarks

management compensation. In determining the appropriate disallowance, the Board acknowledged that OPG may not have been able to achieve the full $145 million in savings for the test period through the reduction of compensation levels alone because of its collective agreements with the unions.

B. *Ontario Superior Court of Justice, Divisional Court: 2012 ONSC 729, 109 O.R. (3d) 576*

[34] OPG appealed the Board Decision on the basis that it was unreasonable and that the reasons provided were inadequate. OPG argued that the Board should have conducted a prudent investment test — that is, it should have restricted its review of compensation costs to a consideration of whether the collective agreements that prescribed the compensation costs were prudent at the time they were entered into. OPG also argued that the Board should have presumed that the costs were prudent.

[35] The panel of three Divisional Court judges was split. Justice Hoy (as she then was), for the majority, found the Board Decision reasonable because management had the ability to reduce total compensation costs in the future within the framework of the collective agreement. Applying a strict prudent investment test would not permit the Board to fulfill its statutory objective of promoting cost effectiveness in the generation of electricity. It was particularly important for the Board to exercise its authority to set just and reasonable rates given the "double monopoly" dynamic at play:

> The collective agreements were concluded between a regulated monopoly, which passes costs on to consumers, not a competitive enterprise, and two unions which account for approximately 90 per cent of the employees and amount to a near, second monopoly, based on terms inherited from Ontario Hydro and in face of the reality that running a nuclear operation without the employees would be extremely difficult. [para. 54]

[36] Justice Aitken dissented, finding that,

> to the extent that [nuclear compensation] costs were predetermined, in the sense that they were locked in as a result of collective agreements entered prior to the date of the application and the test period, OPG only had to prove their prudence or reasonableness based on the circumstances that were known or that reasonably could have been anticipated at the time the decision to enter those collective agreements was made. [para. 83]

She would have held that the Board's failure to undertake a separate and explicit prudence review for the committed portion of nuclear compensation costs, coupled with its consideration of hindsight factors in assessing the reasonableness of these costs, rendered the Board Decision unreasonable.

C. *Ontario Court of Appeal: 2013 ONCA 359, 116 O.R. (3d) 793*

[37] The Ontario Court of Appeal reversed the Divisional Court's decision and remitted the case to the Board. The court drew a distinction between forecast costs and committed costs, with committed costs being those that the utility "is committed to pay in [the test period]" and that "cannot be managed or reduced by the utility in that time frame, usually because of contractual obligations" (para. 29). Although costs

may not require actual payment until the future, as in this case, costs that have been "contractually incurred to be paid over the time frame are nonetheless committed even though they have not yet been paid" (para. 29). When reviewing such costs, the court held that the Board must undertake a prudence review as described in *Enbridge Gas Distribution Inc. v. Ontario Energy Board* (2006), 210 O.A.C. 4 (paras. 15-16). By failing to follow this jurisprudence and by requiring that OPG "manage costs that, by law, it cannot manage", the Board acted unreasonably (para. 37).

IV. Issues

[38] The Board raises two issues on appeal:

1. What is the appropriate standard of review?

2. Was the Board's decision to disallow $145 million of OPG's revenue requirement reasonable?

[39] Before this Court, OPG has argued that the Board stepped beyond the appropriate role of a tribunal in an appeal from its own decision, which raises the following additional issue:

3. Did the Board act impermissibly in pursuing its appeal in this case?

V. Analysis

[40] It is logical to begin by considering the appropriateness of the Board's participation in the appeal. I will next consider the appropriate standard of review, and then the merits issue of whether the Board's decision in this case was reasonable.

A. *The Appropriate Role of the Board in This Appeal*

(1) Tribunal Standing

[41] In *Northwestern Utilities Ltd. v. City of Edmonton*, [1979] 1 S.C.R. 684 ("*Northwestern Utilities*"), per Estey J., this Court first discussed how an administrative decision-maker's participation in the appeal or review of its own decisions may give rise to concerns over tribunal impartiality. Estey J. noted that "active and even aggressive participation can have no other effect than to discredit the impartiality of an administrative tribunal either in the case where the matter is referred back to it, or in future proceedings involving similar interests and issues or the same parties" (p. 709). He further observed that tribunals already receive an opportunity to make their views clear in their original decisions: ". . . it abuses one's notion of propriety to countenance its participation as a full-fledged litigant in this Court" (p. 709).

[42] The Court in *Northwestern Utilities* ultimately held that the Alberta Public Utilities Board — which, like the Ontario Energy Board, had a statutory right

to be heard on judicial appeal (see *Ontario Energy Board Act, 1998*, s. 33(3)) — was limited in the scope of the submissions it could make. Specifically, Estey J. observed that

> [i]t has been the policy in this Court to limit the role of an administrative tribunal whose decision is at issue before the Court, even where the right to appear is given by statute, to an explanatory role with reference to the record before the Board and to the making of representations relating to jurisdiction. [p. 709]

[43] This Court further considered the issue of agency standing in *CAIMAW v. Paccar of Canada Ltd.*, [1989] 2 S.C.R. 983, which involved judicial review of a British Columbia Labour Relations Board decision. Though a majority of the judges hearing the case did not endorse a particular approach to the issue, La Forest J., Dickson C.J. concurring, accepted that a tribunal had standing to explain the record and advance its view of the appropriate standard of review and, additionally, to argue that its decision was reasonable.

[44] This finding was supported by the need to make sure the Court's decision on review of the tribunal's decision was fully informed. La Forest J. cited *B.C.G.E.U. v. Indust. Rel. Council* (1988), 26 B.C.L.R. (2d) 145 (C.A.), at p. 153, for the proposition that the tribunal is the party best equipped to draw the Court's attention to

> those considerations, rooted in the specialized jurisdiction or expertise of the tribunal, which may render reasonable what would otherwise appear unreasonable to someone not versed in the intricacies of the specialized area.

(*Paccar*, at p. 1016)

La Forest J. found, however, that the tribunal could not go so far as to argue that its decision was correct (p. 1017). Though La Forest J. did not command a majority, L'Heureux-Dubé J. also commented on tribunal standing in her dissent, and agreed with the substance of La Forest J.'s analysis (p. 1026).

[45] Trial and appellate courts have struggled to reconcile this Court's statements in *Northwestern Utilities* and *Paccar*. Indeed, while this Court has never expressly overturned *Northwestern Utilities*, on some occasions, it has permitted tribunals to participate as full parties without comment: see, e.g., *McLean v. British Columbia (Securities Commission)*, 2013 SCC 67, [2013] 3 S.C.R. 895; *Ellis-Don Ltd. v. Ontario (Labour Relations Board)*, 2001 SCC 4, [2001] 1 S.C.R. 221; *Tremblay v. Quebec (Commission des affaires sociales)*, [1992] 1 S.C.R. 952; see also *Ontario (Children's Lawyer) v. Ontario (Information and Privacy Commissioner)* (2005), 75 O.R. (3d) 309 (C.A.) ("*Goodis*"), at para. 24.

[46] A number of appellate decisions have grappled with this issue and "for the most part now display a more relaxed attitude in allowing tribunals to participate in judicial review proceedings or statutory appeals in which their decisions were subject to attack": D. Mullan, "Administrative Law and Energy Regulation", in Kaiser and Heggie, 35, at p. 51. A review of three appellate decisions suffices to establish the rationale behind this shift.

[47] In *Goodis*, the Children's Lawyer urged the court to refuse or limit the standing of the Information and Privacy Commissioner, whose decision was under review. The Ontario Court of Appeal declined to apply any formal, fixed rule that would limit the tribunal to certain categories of submissions and instead adopted a contextual, discretionary approach: *Goodis*, at paras. 32-34. The court found no principled basis for the categorical approach, and observed that such an approach may lead to undesirable consequences:

> For example, a categorical rule denying standing if the attack asserts a denial of natural justice could deprive the court of vital submissions if the attack is based on alleged deficiencies in the structure or operation of the tribunal, since these are submissions that the tribunal is uniquely placed to make. Similarly, a rule that would permit a tribunal standing to defend its decision against the standard of reasonableness but not against one of correctness, would allow unnecessary and prevent useful argument. Because the best argument that a decision is reasonable may be that it is correct, a rule based on this distinction seems tenuously founded at best as Robertson J.A. said in *United Brotherhood of Carpenters and Joiners of America, Local 1386 v. Bransen Construction Ltd.*, [2002] N.B.J. No. 114, 249 N.B.R. (2d) 93 (C.A.); at para. 32.
>
> (*Goodis*, at para. 34)

[48] The court held that *Northwestern Utilities* and *Paccar* should be read as the source of "fundamental considerations" that should guide the court's exercise of discretion in the context of the case: *Goodis*, at para. 35. The two most important considerations, drawn from those cases, were the "importance of having a fully informed adjudication of the issues before the court" (para. 37), and "the importance of maintaining tribunal impartiality": para. 38. The court should limit tribunal participation if it will undermine future confidence in its objectivity. The court

identified a list of factors, discussed further below, that may aid in determining whether and to what extent the tribunal should be permitted to make submissions: paras. 36-38.

[49] In *Canada (Attorney General) v. Quadrini*, 2010 FCA 246, [2012] 2 F.C.R. 3, Stratas J.A. identified two common law restrictions that, in his view, restricted the scope of a tribunal's participation on appeal from its own decision: finality and impartiality. Finality, the principle whereby a tribunal may not speak on a matter again once it has decided upon it and provided reasons for its decision, is discussed in greater detail below, as it is more directly related to concerns surrounding "bootstrapping" rather than agency standing itself.

[50] The principle of impartiality is implicated by tribunal argument on appeal, because decisions may in some cases be remitted to the tribunal for further consideration. Stratas J.A. found that "[s]ubmissions by the tribunal in a judicial review proceeding that descend too far, too intensely, or too aggressively into the merits of the matter before the tribunal may disable the tribunal from conducting an impartial redetermination of the merits later": *Quadrini*, at para. 16. However, he ultimately found that these principles did not mandate "hard and fast rules", and endorsed the discretionary approach set out by the Ontario Court of Appeal in *Goodis*: *Quadrini*, at paras. 19-20.

[51] A third example of recent judicial consideration of this issue may be found in *Leon's Furniture Ltd. v. Information and Privacy Commissioner (Alta.)*,

2011 ABCA 94, 502 A.R. 110. In this case, Leon's Furniture challenged the Commissioner's standing to make submissions on the merits of the appeal (para. 16). The Alberta Court of Appeal, too, adopted the position that the law should respond to the fundamental concerns raised in *Northwestern Utilities* but should nonetheless approach the question of tribunal standing with discretion, to be exercised in view of relevant contextual considerations: paras. 28-29.

[52] The considerations set forth by this Court in *Northwestern Utilities* reflect fundamental concerns with regard to tribunal participation on appeal from the tribunal's own decision. However, these concerns should not be read to establish a categorical ban on tribunal participation on appeal. A discretionary approach, as discussed by the courts in *Goodis*, *Leon's Furniture*, and *Quadrini*, provides the best means of ensuring that the principles of finality and impartiality are respected without sacrificing the ability of reviewing courts to hear useful and important information and analysis: see N. Semple, "The Case for Tribunal Standing in Canada" (2007), 20 *C.J.A.L.P.* 305; L. A. Jacobs and T. S. Kuttner, "Discovering What Tribunals Do: Tribunal Standing Before the Courts" (2002), 81 *Can. Bar Rev.* 616; F. A. V. Falzon, "Tribunal Standing on Judicial Review" (2008), 21 *C.J.A.L.P.* 21.

[53] Several considerations argue in favour of a discretionary approach. Notably, because of their expertise and familiarity with the relevant administrative scheme, tribunals may in many cases be well positioned to help the reviewing court reach a just outcome. For example, a tribunal may be able to explain how one

interpretation of a statutory provision might impact other provisions within the regulatory scheme, or to the factual and legal realities of the specialized field in which they work. Submissions of this type may be harder for other parties to present.

[54] Some cases may arise in which there is simply no other party to stand in opposition to the party challenging the tribunal decision. Our judicial review processes are designed to function best when both sides of a dispute are argued vigorously before the reviewing court. In a situation where no other well-informed party stands opposed, the presence of a tribunal as an adversarial party may help the court ensure it has heard the best of both sides of a dispute.

[55] Canadian tribunals occupy many different roles in the various contexts in which they operate. This variation means that concerns regarding tribunal partiality may be more or less salient depending on the case at issue and the tribunal's structure and statutory mandate. As such, statutory provisions addressing the structure, processes and role of the particular tribunal are key aspects of the analysis.

[56] The mandate of the Board, and similarly situated regulatory tribunals, sets them apart from those tribunals whose function it is to adjudicate individual conflicts between two or more parties. For tribunals tasked with this latter responsibility, "the importance of fairness, real and perceived, weighs more heavily" against tribunal standing: *Henthorne v. British Columbia Ferry Services Inc.*, 2011 BCCA 476, 344 D.L.R. (4th) 292, at para. 42.

[57] I am thus of the opinion that tribunal standing is a matter to be determined by the court conducting the first-instance review in accordance with the principled exercise of that court's discretion. In exercising its discretion, the court is required to balance the need for fully informed adjudication against the importance of maintaining tribunal impartiality.

[58] In this case, as an initial matter, the *Ontario Energy Board Act, 1998* expressly provides that "[t]he Board is entitled to be heard by counsel upon the argument of an appeal" to the Divisional Court: s. 33(3). This provision neither expressly grants the Board standing to argue the merits of the decision on appeal, nor does it expressly limit the Board to jurisdictional or standard-of-review arguments as was the case for the relevant statutory provision in *Quadrini*: see para. 2.

[59] In accordance with the foregoing discussion of tribunal standing, where the statute does not clearly resolve the issue, the reviewing court must rely on its discretion to define the tribunal's role on appeal. While not exhaustive, I would find the following factors, identified by the courts and academic commentators cited above, are relevant in informing the court's exercise of this discretion:

(1) If an appeal or review were to be otherwise unopposed, a reviewing court may benefit by exercising its discretion to grant tribunal standing.

(2) If there are other parties available to oppose an appeal or review, and those parties have the necessary knowledge and expertise to fully make and respond

to arguments on appeal or review, tribunal standing may be less important in ensuring just outcomes.

(3) Whether the tribunal adjudicates individual conflicts between two adversarial parties, or whether it instead serves a policy-making, regulatory or investigative role, or acts on behalf of the public interest, bears on the degree to which impartiality concerns are raised. Such concerns may weigh more heavily where the tribunal served an adjudicatory function in the proceeding that is the subject of the appeal, while a proceeding in which the tribunal adopts a more regulatory role may not raise such concerns.

[60] Consideration of these factors in the context of this case leads me to conclude that it was not improper for the Board to participate in arguing in favour of the reasonableness of its decision on appeal. First, the Board was the only respondent in the initial review of its decision. Thus, it had no alternative but to step in if the decision was to be defended on the merits. Unlike some other provinces, Ontario has no designated utility consumer advocate, which left the Board — tasked by statute with acting to safeguard the public interest — with few alternatives but to participate as a party.

[61] Second, the Board is tasked with regulating the activities of utilities, including those in the electricity market. Its regulatory mandate is broad. Among its many roles: it licenses market participants, approves the development of new

transmission and distribution facilities, and authorizes rates to be charged to consumers. In this case, the Board was exercising a regulatory role by setting just and reasonable payment amounts to a utility. This is unlike situations in which a tribunal may adjudicate disputes between two parties, in which case the interests of impartiality may weigh more heavily against full party standing.

[62] The nature of utilities regulation further argues in favour of full party status for the Board here, as concerns about the appearance of partiality are muted in this context. As noted by Doherty J.A., "[l]ike all regulated bodies, I am sure Enbridge wins some and loses some before the [Board]. I am confident that Enbridge fully understands the role of the regulator and appreciates that each application is decided on its own merits by the [Board]": *Enbridge*, at para. 28. Accordingly, I do not find that the Board's participation in the instant appeal was improper. It remains to consider whether the content of the Board's arguments was appropriate.

(2) Bootstrapping

[63] The issue of tribunal "bootstrapping" is closely related to the question of when it is proper for a tribunal to act as a party on appeal or judicial review of its decision. The standing issue concerns what types of argument a tribunal may make, i.e. jurisdictional or merits arguments, while the bootstrapping issue concerns the content of those arguments.

[64] As the term has been understood by the courts who have considered it in the context of tribunal standing, a tribunal engages in bootstrapping where it seeks to supplement what would otherwise be a deficient decision with new arguments on appeal: see, e.g., *United Brotherhood of Carpenters and Joiners of America, Local 1386 v. Bransen Construction Ltd.*, 2002 NBCA 27, 249 N.B.R. (2d) 93. Put differently, it has been stated that a tribunal may not "defen[d] its decision on a ground that it did not rely on in the decision under review": *Goodis*, at para. 42.

[65] The principle of finality dictates that once a tribunal has decided the issues before it and provided reasons for its decision, "absent a power to vary its decision or rehear the matter, it has spoken finally on the matter and its job is done": *Quadrini*, at para. 16, citing *Chandler v. Alberta Association of Architects*, [1989] 2 S.C.R. 848. Under this principle, the court found that tribunals could not use judicial review as a chance to "amend, vary, qualify or supplement its reasons": *Quadrini*, at para. 16. In *Leon's Furniture*, Slatter J.A. reasoned that a tribunal could "offer interpretations of its reasons or conclusion, [but] cannot attempt to reconfigure those reasons, add arguments not previously given, or make submissions about matters of fact not already engaged by the record": para. 29.

[66] By contrast, in *Goodis*, Goudge J.A. found on behalf of a unanimous court that while the Commissioner had relied on an argument not expressly set out in her original decision, this argument was available for the Commissioner to make on appeal. Though he recognized that "[t]he importance of reasoned decision making

may be undermined if, when attacked in court, a tribunal can simply offer different, better, or even contrary reasons to support its decision" (para. 42), Goudge J.A. ultimately found that the Commissioner was permitted to raise a new argument on judicial review. The new argument presented was "not inconsistent with the reason offered in the decision. Indeed it could be said to be implicit in it": para. 55. "It was therefore proper for the Commissioner to be permitted to raise this argument before the Divisional Court and equally proper for the court to decide on that basis": para. 58.

[67] There is merit in both positions on the issue of bootstrapping. On the one hand, a permissive stance toward new arguments by tribunals on appeal serves the interests of justice insofar as it ensures that a reviewing court is presented with the strongest arguments in favour of both sides: Semple, at p. 315. This remains true even if those arguments were not included in the tribunal's original reasons. On the other hand, to permit bootstrapping may undermine the importance of reasoned, well-written original decisions. There is also the possibility that a tribunal, surprising the parties with new arguments in an appeal or judicial review after its initial decision, may lead the parties to see the process as unfair. This may be particularly true where a tribunal is tasked with adjudicating matters between two private litigants, as the introduction of new arguments by the tribunal on appeal may give the appearance that it is "ganging up" on one party. As discussed, however, it may be less appropriate in general for a tribunal sitting in this type of role to participate as a party on appeal.

[68] I am not persuaded that the introduction of arguments by a tribunal on appeal that interpret or were implicit but not expressly articulated in its original decision offends the principle of finality. Similarly, it does not offend finality to permit a tribunal to explain its established policies and practices to the reviewing court, even if those were not described in the reasons under review. Tribunals need not repeat explanations of such practices in every decision merely to guard against charges of bootstrapping should they be called upon to explain them on appeal or review. A tribunal may also respond to arguments raised by a counterparty. A tribunal raising arguments of these types on review of its decision does so in order to uphold the initial decision; it is not reopening the case and issuing a new or modified decision. The result of the original decision remains the same even if a tribunal seeks to uphold that effect by providing an interpretation of it or on grounds implicit in the original decision.

[69] I am not, however, of the opinion that tribunals should have the unfettered ability to raise entirely new arguments on judicial review. To do so may raise concerns about the appearance of unfairness and the need for tribunal decisions to be well reasoned in the first instance. I would find that the proper balancing of these interests against the reviewing courts' interests in hearing the strongest possible arguments in favour of each side of a dispute is struck when tribunals do retain the ability to offer interpretations of their reasons or conclusions and to make arguments implicit within their original reasons: see *Leon's Furniture*, at para. 29; *Goodis*, at para. 55.

[70] In this case, I do not find that the Board impermissibly stepped beyond the bounds of its original decision in its arguments before this Court. In its reply factum, the Board pointed out — correctly, in my view — that its submissions before this Court simply highlight what is apparent on the face of the record, or respond to arguments raised by the respondents.

[71] I would, however, urge the Board, and tribunal parties in general, to be cognizant of the tone they adopt on review of their decisions. As Goudge J.A. noted in *Goodis*:

> … if an administrative tribunal seeks to make submissions on a judicial review of its decision, it [should] pay careful attention to the tone with which it does so. Although this is not a discrete basis upon which its standing might be limited, there is no doubt that the tone of the proposed submissions provides the background for the determination of that issue. A tribunal that seeks to resist a judicial review application will be of assistance to the court to the degree its submissions are characterized by the helpful elucidation of the issues, informed by its specialized position, rather than by the aggressive partisanship of an adversary. [para. 61]

[72] In this case, the Board generally acted in such a way as to present helpful argument in an adversarial but respectful manner. However, I would sound a note of caution about the Board's assertion that the imposition of the prudent investment test "would in all likelihood not change the result" if the decision were remitted for reconsideration (A.F., at para. 99). This type of statement may, if carried too far, raise concerns about the principle of impartiality such that a court would be justified in exercising its discretion to limit tribunal standing so as to safeguard this principle.

B. *Standard of Review*

[73] The parties do not dispute that reasonableness is the appropriate standard of review for the Board's actions in applying its expertise to set rates and approve payment amounts under the *Ontario Energy Board Act, 1998*. I agree. In addition, to the extent that the resolution of this appeal turns on the interpretation of the *Ontario Energy Board Act*, *1998,* the Board's home statute, a standard of reasonableness presumptively applies: *Dunsmuir v. New Brunswick*, 2008 SCC 9, [2008] 1 S.C.R. 190, at para. 54; *Alberta (Information and Privacy Commissioner) v. Alberta Teachers' Association*, 2011 SCC 61, [2011] 3 S.C.R. 654, at para. 30; *Tervita Corp. v. Canada (Commissioner of Competition)*, 2015 SCC 3, [2015] 1 S.C.R. 161, at para. 35. Nothing in this case suggests the presumption should be rebutted.

[74] This appeal involves two distinct uses of the term "reasonable". One concerns the standard of review: on appeal, this Court is charged with evaluating the "justification, transparency and intelligibility" of the Board's reasoning, and "whether the decision falls within a range of possible, acceptable outcomes which are defensible in respect of the facts and law" (*Dunsmuir*, at para. 47). The other is statutory: the Board's rate-setting powers are to be used to ensure that, in its view, a just and reasonable balance is struck between utility and consumer interests. These reasons will attempt to keep the two uses of the term distinct.

C. *Choice of Methodology Under the Ontario Energy Board Act, 1998*

[75] The question of whether the Board's decision to disallow recovery of certain costs was reasonable turns on how that decision relates to the Board's statutory and regulatory powers to approve payments to utilities and to have these payments reflected in the rates paid by consumers. The Board's general rate- and payment-setting powers are described above under the "Regulatory Framework" heading.

[76] The just-and-reasonable approach to recovery of the cost of services provided by a utility captures the essential balance at the heart of utilities regulation: to encourage investment in a robust utility infrastructure and to protect consumer interests, utilities must be allowed, over the long run, to earn their cost of capital, no more, no less.

[77] The *Ontario Energy Board Act, 1998* does not, however, either in s. 78.1 or elsewhere, prescribe the methodology the Board must use to weigh utility and consumer interests when deciding what constitutes just and reasonable payment amounts to the utility. Indeed, s. 6(1) of O. Reg. 53/05 expressly permits the Board, subject to certain exceptions set out in s. 6(2), to "establish the form, <u>methodology</u>, assumptions and calculations used in making an order that determines payment amounts for the purpose of section 78.1 of the Act".

[78] As a contrasting example, s. 6(2) 4.1 of O. Reg. 53/05 establishes a specific methodology for use when the Board reviews "costs incurred and firm financial commitments made in the course of planning and preparation for the

development of proposed new nuclear generation facilities". When reviewing such costs, the Board must be satisfied that "the costs were prudently incurred" and that "the financial commitments were prudently made": s. 6(2)4.1. The provision thus establishes a specific context in which the Board's analysis is focused on the prudence of the decision to incur or commit to certain costs. The absence of such language in the more general s. 6(1) provides further reason to read the regulation as providing broad methodological discretion to the Board in making orders for payment amounts where the specific provisions of s. 6(2) do not apply.

[79] Regarding whether a presumption of prudence must be applied to OPG's decisions to incur costs, neither the *Ontario Energy Board Act, 1998* nor O. Reg. 53/05 expressly establishes such a presumption. Indeed, the *Ontario Energy Board Act, 1998* places the burden on the applicant utility to establish that payment amounts approved by the Board are just and reasonable: s. 78.1(6) and (7). It would thus seem inconsistent with the statutory scheme to presume that utility decisions to incur costs were prudent.

[80] Justice Abella concludes that the Board's review of OPG's costs should have consisted of "an after-the-fact prudence review, with a rebuttable presumption that the utility's expenditures were reasonable": para. 150. Such an approach is contrary to the statutory scheme. While the Board has considerable methodological discretion, it does not have the freedom to displace the burden of proof established by s. 78.1(6) of the *Ontario Energy Board Act, 1998* ". . . the burden of proof is on the

applicant in an application made under this section". Of course, this does not imply that the applicant must systematically prove that every single cost is just and reasonable. The Board has broad discretion to determine the methods it may use to examine costs — it just cannot shift the burden of proof contrary to the statutory scheme.

[81] In judicially reviewing a decision of the Board to allow or disallow payments to a utility, the court's role is to assess whether the Board reasonably determined that a certain payment amount was "just and reasonable" for both the utility and the consumers. Such an approach is consistent with this Court's rate-setting jurisprudence in other regulatory domains in which the regulator is given methodological discretion, where it has been observed that "[t]he obligation to act is a question of law, but the choice of the method to be adopted is a question of discretion with which, under the statute, no Court of law may interfere": *Bell Canada v. Bell Aliant Regional Communications*, 2009 SCC 40, [2009] 2 S.C.R. 764, at para. 40 (concerning telecommunication rate-setting), quoting *Re General Increase in Freight Rates* (1954), 76 C.R.T.C. 12 (S.C.C.), at p. 13 (concerning railway freight rates). Of course, today this statement must be understood to permit intervention by a court where the exercise of discretion rendered a decision unreasonable. Accordingly, it remains to determine whether the Board's analytical approach to disallowing the costs at issue in this case rendered the Board's decision unreasonable under the "just and reasonable" standard.

D. *Characterization of Costs at Issue*

[82] Forecast costs are costs which the utility has not yet paid, and over which the utility still retains discretion as to whether the disbursement will be made. A disallowance of such costs presents a utility with a choice: it may change its plans and avoid the disallowed costs, or it may incur the costs regardless of the disallowance with the knowledge that the costs will ultimately be borne by the utility's shareholders rather than its ratepayers. By contrast, committed costs are those for which, if a regulatory board disallows recovery of the costs in approved payments, the utility and its shareholders will have no choice but to bear the burden of those costs themselves. This result may occur because the utility has already spent the funds, or because the utility entered into a binding commitment or was subject to other legal obligations that leave it with no discretion as to whether to make the payment in the future.

[83] There is disagreement between the parties as to how the costs disallowed by the Board in this matter should be characterized. The Board asserts that compensation costs for the test period are forecast insofar as they have not yet been disbursed, while OPG asserts that the costs should be characterized as committed, because OPG is under a contractual obligation to pay those amounts when they become due. This disagreement is important because a "no hind-sight" prudence review, which is discussed in detail below, has developed in the context of "committed" costs. Indeed, it makes no sense to apply such a test where a utility still

retains discretion over whether the costs will ultimately be incurred; the decision to commit the utility to such costs has not yet been made. Accordingly, where the regulator has discretion over its methodological approach, understanding whether the costs at issue are "forecast" or "committed" may be helpful in reviewing the reasonableness of a regulator's choice of methodology.

[84] In this case, at least some of the compensation costs that the Board found to be excessive were driven by collective agreements to which OPG had committed before the application at issue, and which established compensation costs that were, in aggregate, above the 75th percentile for comparable positions at other utilities. The collective agreements left OPG with limited flexibility regarding overall compensation rates or staffing levels — OPG was required to abide by wage and staffing levels established by collective agreements, and retained flexibility only over terms outside the bounds of those agreements — and thus those portions of OPG's compensation rates and staffing levels that were dictated by the terms of the collective agreements were committed costs.

[85] However, the Board found that OPG's compensation costs for the test period were not entirely driven by the collective agreements, and thus were not entirely committed, because OPG retained some flexibility to manage total staffing levels in light of projected attrition of a mature workforce. The Board Decision did not, however, include detailed forecasts regarding exactly how much of the $145 million in disallowed compensation costs could be recovered through natural

reduction in employee numbers or other adjustments, and how much would necessarily be borne by the utility and its shareholder. Accordingly, the disallowed costs at issue must be understood as being at least partially committed. It is unreasonable to characterize them as entirely forecast in view of the constraints placed on OPG by the collective agreements.

[86] Having established that the disallowed costs are at least partially committed, it is necessary to consider whether the Board acted reasonably in not applying a no-hindsight prudent investment test in assessing those costs. Accordingly, I now turn to the jurisprudential history and methodological details of the prudent investment test.

E. *The Prudent Investment Test*

[87] In order to assess whether the Board's methodology was reasonable in this case, it is necessary to provide some background on the prudent investment test (sometimes referred to as "prudence review" or the "prudence test") in order to identify its origins, place it in context, and explore how it has been understood by utilities, regulators, and legislators.

(1) American Jurisprudence

[88] American jurisprudence has played a significant role in the history of the prudent investment test in utilities regulation. In discussing this history, I would first

reiterate this Court's observation that "[w]hile the American jurisprudence and texts in this area should be considered with caution given that Canada and the United States have very different political and constitutional-legal regimes, they do shed some light on the issue": *ATCO Gas and Pipelines Ltd. v. Alberta (Energy and Utilities Board)*, 2006 SCC 4, [2006] 1 S.C.R. 140, at para. 54.

[89] The origins of the prudent investment test in the context of utilities regulation may be traced to Justice Brandeis of the Supreme Court of the United States, who wrote a concurring opinion in 1923 to observe that utilities should receive deference in seeking to recover "investments which, under ordinary circumstances, would be deemed reasonable": *State of Missouri ex rel. Southwestern Bell Telephone Co. v. Public Service Commission of Missouri*, 262 U.S. 276 (1923), at p. 289, fn.1.

[90] In the decades that followed, American utility regulators tasked with reviewing past-incurred utility costs generally employed one of two standards: the "used and useful" test or the "prudent investment" test (J. Kahn, "Keep *Hope* Alive: Updating the Prudent Investment Standard for Allocating Nuclear Plant Cancellation Costs" (2010), 22 *Fordham Envtl. L. Rev*. 43, at p. 49). These tests took different approaches to determining what costs could justly and reasonably be passed on to ratepayers. The used and useful test allowed utilities to earn returns only on those investments that were actually used and useful to the utility's operations, on the principle that ratepayers should not be compelled to pay for investments that do not benefit them.

[91] By contrast, the prudent investment test followed Justice Brandeis's preferred approach by allowing for recovery of costs provided they were not imprudent based on what was known at the time the investment or expense was incurred: Kahn, at pp. 49-50. Though it may seem problematic from the perspective of consumer interests to adopt the prudent investment test — a test that allows for payments related to investments that may not be used or useful — it gives regulators a tool to soften the potentially harsh effects of the used and useful test, which may place onerous burdens on utilities. Disallowing recovery of the cost of failed investments that appeared reasonable at the time, for example, may imperil the financial health of utilities, and may chill the incentive to make such investments in the first place. This effect may then have negative implications for consumers, whose long-run interests will be best served by a dynamically efficient and viable electricity industry. Thus, the prudent investment test may be employed by regulators to strike the appropriate balance between consumer and utility interests: see Kahn, at pp. 53-54.

[92] The states differed in their approaches to setting the statutory foundation for utility regulation. Regulators in some states were free to apply the prudent investment test, while other states enacted statutory provisions disallowing compensation in respect of capital investments that were not "used and useful in service to the public": *Duquesne Light Co. v. Barasch*, 488 U.S. 299 (1989), at p. 302. Notably, when asked in *Duquesne* to consider whether "just and reasonable" payments to utilities required, as a constitutional matter, that the prudent investment

test be applied to past-incurred costs, the U.S. Supreme Court held that "[t]he designation of a single theory of ratemaking as a constitutional requirement would unnecessarily foreclose alternatives which could benefit both consumers and investors": p. 316.

[93] American courts have also recognized that there may exist some contexts in which certain features of the prudent investment test may be less justifiable. For example, the Supreme Court of Utah considered whether a presumption of reasonableness was justified when reviewing costs passed to a utility by an unregulated affiliate entity, and concluded that it was not appropriate:

> . . . we do not think an affiliate expense should carry a presumption of reasonableness. While the pressures of a competitive market might allow us to assume, in the absence of a showing to the contrary, that nonaffiliate expenses are reasonable, the same cannot be said of affiliate expenses not incurred in an arm's length transaction.
>
> (*U.S. West Communications, Inc. v. Public Service Commission of Utah*, 901 P.2d 270 (Utah 1995), p. 274)

[94] Treatment of the prudent investment test in American jurisprudence thus indicates that the test has been employed as a tool that may be useful in arriving at just and reasonable outcomes, rather than a mandatory feature of utilities regulation that must be applied regardless of whether there is statutory language to that effect.

(2) <u>Canadian Jurisprudence</u>

[95] Following its emergence in American jurisprudence, several Canadian utility regulators and courts have also considered the role of prudence review and, in some cases, applied a form of the prudent investment test. I provide a review of some of these cases here not in an attempt to exhaustively catalogue all uses of the test, but rather to set out the way in which the test has been invoked in various contexts.

[96] In *British Columbia Electric Railway Co. v. Public Utilities Commission of British Columbia*, [1960] S.C.R. 837, Martland J. observed that the statute at issue in that case directed that the regulator, in fixing rates,

> (a) . . . shall consider all matters which it deems proper as affecting the rate: [and]
>
> (b) . . . shall have due regard, among other things, to the protection of the public from rates that are excessive as being more than a fair and reasonable charge for services of the nature and quality furnished by the public utility; and to giving to the public utility a fair and reasonable return upon the appraised value of the property of the public utility used, or prudently and reasonably acquired, to enable the public utility to furnish the service. [p. 852]
>
> (Quoting *Public Utilities Act*, R.S.B.C. 1948, s. 16(1)(*b*) (repealed S.B.C. 1973, c. 29, s. 187).)

The consequence of this statutory language, Martland J. held, was that the regulator, "when dealing with a rate case, has unlimited discretion as to the matters which it may consider as affecting the rate, but that it must, when actually setting the rate, meet the two requirements specifically mentioned in clause (*b*)": at p. 856. That is, the regulator, under this statute, must ensure that the public pays only fair and

reasonable charges, and that the utility secures a fair and reasonable return upon its property used *or prudently and reasonably acquired*. This express statutory protection for the recovery of prudently made property acquisition costs thus provides an example of statutory language under which this Court found a non-discretionary obligation to provide a fair return to utilities for capital expenditures that were either used or prudently acquired.

[97] In 2005, the Nova Scotia Utility and Review Board ("NSUARB") considered and adopted a definition of the prudent investment test articulated by the Illinois Commerce Commission:

> . . . prudence is that standard of care which a reasonable person would be expected to exercise under the same circumstances encountered by utility management at the time decisions had to be made. . . . Hindsight is not applied in assessing prudence. . . . A utility's decision is prudent if it was within the range of decisions reasonable persons might have made. . . . The prudence standard recognizes that reasonable persons can have honest differences of opinion without one or the other necessarily being imprudent.
>
> (*Nova Scotia Power Inc, Re*, 2005 NSUARB 27 ("*Nova Scotia Power 2005*"), at para. 84 (CanLII))

The NSUARB then wrote that "[f]ollowing a review of the cases, the Board finds that the definition of imprudence as set out by the Illinois Commerce Commission is a reasonable test to be applied in Nova Scotia": para. 90. The NSUARB then considered, among other things, whether the utility's recent fuel procurement strategy had been prudent, and found that it had not: para. 94. It did not, however, indicate that it believed itself to be compelled to apply the prudent investment test.

[98] The NSUARB reaffirmed its endorsement of the prudent investment test in 2012: *Re Nova Scotia Power Inc. (Re)*, 2012 NSUARB 227 ("*Nova Scotia Power 2012*"), at paras. 143-46 (CanLII). In that case, the utility whose submissions were under review "confirmed that from its perspective this is the test the Board should apply": para. 146. The NSUARB then applied the prudence test in evaluating whether several of the utility's operational decisions were prudent, and found that some were not: para. 188.

[99] In 2006, the Ontario Court of Appeal considered the meaning of the prudent investment test in *Enbridge*. This case is of particular interest for two reasons. First, the Ontario Court of Appeal endorsed in its reasons a specific formulation of the prudent investment test framework:

> – Decisions made by the utility's management should generally be presumed to be prudent unless challenged on reasonable grounds.
>
> – To be prudent, a decision must have been reasonable under the circumstances that were known or ought to have been known to the utility at the time the decision was made.
>
> – Hindsight should not be used in determining prudence, although consideration of the outcome of the decision may legitimately be used to overcome the presumption of prudence.
>
> – Prudence must be determined in a retrospective factual inquiry, in that the evidence must be concerned with the time the decision was made and must be based on facts about the elements that could or did enter into the decision at the time. [para. 10]

[100] Second, the Court of Appeal in *Enbridge* made certain statements that suggest that the prudent investment test was a necessary approach to reviewing committed costs. Specifically, it noted that in deciding whether Enbridge's requested rate increase was just and reasonable,

> the [Board] was required to balance the competing interests of Enbridge and its consumers. That balancing process is achieved by the application of what is known in the utility rate regulation field as the "prudence" test. Enbridge was entitled to recover its costs by way of a rate increase only if those costs were "prudently" incurred. [para. 8]

The Court of Appeal also noted that the Board had applied the "proper test": para. 18. These statements tend to suggest that the Court of Appeal was of the opinion that prudence review is an inherent and necessary part of ensuring just and reasonable payments.

[101] However, the question of whether the prudence test was a required feature of just-and-reasonable analysis in this context was not squarely before the Court of Appeal in *Enbridge*. Rather, the parties in that case "were in substantial agreement on the general approach the Board should take to reviewing the prudence of a utility's decision" (para. 10), and the question at issue was whether the Board had reasonably applied that agreed-upon approach. In this sense, *Enbridge* is similar to *Nova Scotia Power 2012*: both cases involved the application of prudence analysis in contexts where there was no dispute over whether an alternative methodology could reasonably have been applied.

(3) Conclusion Regarding the Prudent Investment Test

[102] The prudent investment test, or prudence review, is a valid and widely accepted tool that regulators may use when assessing whether payments to a utility would be just and reasonable. While there exists different articulations of prudence review, *Enbridge* presents one express statement of how a regulatory board might structure its review to assess the prudence of utility expenditures at the time they were incurred or committed. A no-hindsight prudence review has most frequently been applied in the context of capital costs, but *Enbridge* and *Nova Scotia Power* (both *2005* and *2012*) provide examples of its application to decisions regarding operating costs as well. I see no reason in principle why a regulatory board should be barred from applying the prudence test to operating costs.

[103] However, I do not find support in the statutory scheme or the relevant jurisprudence for the notion that the Board should be *required* as a matter of law, under the *Ontario Energy Board Act, 1998*, to apply the prudence test as outlined in *Enbridge* such that the mere decision not to apply it when considering committed costs would render its decision on payment amounts unreasonable. Nor is the creation of such an obligation by this Court justified. As discussed above, where a statute requires only that the regulator set "just and reasonable" payments, as the *Ontario Energy Board Act, 1998* does in Ontario, the regulator may make use of a variety of analytical tools in assessing the justness and reasonableness of a utility's proposed payment amounts. This is particularly so where, as here, the regulator has been given

express discretion over the methodology to be used in setting payment amounts: O. Reg. 53/05, s. 6(1).

[104] To summarize, it is not necessarily unreasonable, in light of the particular regulatory structure established by the *Ontario Energy Board Act, 1998*, for the Board to evaluate committed costs using a method other than a no-hindsight prudence review. As noted above, applying a presumption of prudence would have conflicted with the burden of proof in the *Ontario Energy Board Act, 1998* and would therefore not have been reasonable. The question of whether it was reasonable to assess a particular cost using hindsight should turn instead on the circumstances of that cost. I emphasize, however, that this decision should not be read to give regulators *carte blanche* to disallow a utility's committed costs at will. Prudence review of committed costs may in many cases be a sound way of ensuring that utilities are treated fairly and remain able to secure required levels of investment capital. As will be explained, particularly with regard to committed capital costs, prudence review will often provide a reasonable means of striking the balance of fairness between consumers and utilities.

[105] This conclusion regarding the Board's ability to select its methodology rests on the particulars of the statutory scheme under which the Board operates. There exist other statutory schemes in which regulators are expressly required to compensate utilities for certain costs prudently incurred: see *British Columbia*

Electric Railway Co. Under such a framework, the regulator's methodological discretion may be more constrained.

(4) Application to the Board's Decision

[106] In this case, the Board disallowed a total of $145 million in compensation costs associated with OPG's nuclear operations, over two years. As discussed above, these costs are best understood as at least partly committed. In view of the nature of these particular costs and the circumstances in which they became committed, I do not find that the Board acted unreasonably in not applying the prudent investment test in determining whether it would be just and reasonable to compensate OPG for these costs.

[107] First, the costs at issue are operating costs, rather than capital costs. Capital costs, particularly those pertaining to areas such as capacity expansion or upgrades to existing facilities, often entail some amount of risk, and may not always be strictly necessary to the short-term ongoing production of the utility. Nevertheless, such costs may often be a wise investment in the utility's future health and viability. As such, prudence review, including a no-hindsight approach (with or without a presumption of prudence, depending on the applicable statutory context), may play a particularly important role in ensuring that utilities are not discouraged from making the optimal level of investment in the development of their facilities.

[108] Operating costs, like those at issue here, are different in kind from capital costs. There is little danger in this case that a disallowance of these costs will have a chilling effect on OPG's willingness to incur operating costs in the future, because costs of the type disallowed here are an inescapable element of operating a utility. It is true that a decision such as the Board's in this case may have the effect of making OPG more hesitant about committing to relatively high compensation costs, but that was precisely the intended effect of the Board's decision.

[109] Second, the costs at issue arise in the context of an ongoing, "repeat-player" relationship between OPG and its employees. Prudence review has its origins in the examination of decisions to pursue particular investments, such as a decision to invest in capacity expansion; these are often one-time decisions made in view of a particular set of circumstances known or assumed at the time the decision was made.

[110] By contrast, OPG's committed compensation costs arise in the context of an ongoing relationship in which OPG will have to negotiate compensation costs with the same parties in the future. Such a context supports the reasonableness of a regulator's decision to weigh all evidence it finds relevant in striking a just and reasonable balance between the utility and consumers, rather than confining itself to a no-hindsight approach. Prudence review is simply less relevant when the Board's focus is not solely on compensating for past commitments, but on regulating costs to be incurred in the future as well. As will be discussed further, the Board's ultimate disallowance was not targeted exclusively at committed costs, but rather was made

with respect to the total compensation costs it evaluated in aggregate. Though the Board acknowledged that OPG may not have had the discretion to reduce spending by the entire amount of the disallowance, the disallowance was animated by the Board's efforts to get OPG's ongoing compensation costs under control.

[111] Having already given OPG a warning that the Board found its operational costs to be of concern (see Board 2008-2009 Decision, at pp. 28-32), it was not unreasonable for the Board to be more forceful in considering compensation costs to ensure effective regulation of such costs going forward. The Board's statement that its disallowance was intended "to send a clear signal that OPG must take responsibility for improving its performance" (Board Decision, at p. 86) shows that it had the ongoing effects of its disallowance squarely in mind in issuing its decision in this case.

[112] The reasonableness of the Board's decision to disallow $145 million in compensation costs is supported by the Board's recognition of the fact that OPG was bound to a certain extent by the collective agreements in making staffing decisions and setting compensation rates, and its consideration of this factor in setting the total disallowance: Board Decision, at p. 87. The Board's methodological flexibility ensures that its decision need not be "all or nothing". Where appropriate, to the extent that the utility was unable to reduce its costs, the total burden of such costs may be moderated or shared as between the utility's shareholders and the consumers. The Board's moderation in this case shows that, in choosing to disallow costs without

applying a formal no-hindsight prudence review, it remained mindful of the need to ensure that any disallowance was not unfair to OPG and certainly did not impair the viability of the utility.

[113] Justice Abella, in her dissent, acknowledges that the Board has the power under prudence review to disallow committed costs in at least some circumstances: para. 152. However, she speculates that any such disallowance could "imperil the assurance of reliable electricity service": para. 156. A large or indiscriminate disallowance might create such peril, but it is also possible for the Board to do as it did here, and temper its disallowance to recognize the realities facing the utility.

[114] There is no dispute that collective agreements are "immutable" between employees and the utility. However, if the legislature had intended for costs under collective agreements to also be inevitably imposed on consumers, it would not have seen fit to grant the Board oversight of utility compensation costs. The existence both of collective bargaining for utility employees and of the Board's power to fix payment amounts covering compensation costs indicates neither regime can trump the other. The Board cannot interfere with the collective agreement by ordering that a utility break its obligations thereunder, but nor can the collective agreement supersede the Board's duty to ensure a just and reasonable balance between utility and consumer interests.

[115] Justice Abella says that the Board's review of committed costs using hindsight evidence appears to contradict statements made earlier in its decision. The

Board wrote that it would use all relevant evidence in assessing forecast costs but that it would limit itself to a no-hindsight approach in reviewing costs that OPG could not "take action to reduce": Board Decision, at p. 19. In my view, these statements can be read as setting out a reasonable approach for analyzing costs that could reliably be fit into forecast or committed categories. However, not all costs are amenable to such clean categorization by the Board in assessing payment amounts for a test period.

[116] With regard to the compensation costs at issue here, the Board declined to split the total cost disallowance into forecast and committed components in conducting its analysis. As Hoy J. observed, "[g]iven the complexity of OPG's business, and respecting its management's autonomy, [the Board] did not try to quantify precisely the amount by which OPG could reduce its forecast compensation costs within the framework of the existing collective bargaining agreements": Div. Ct. reasons, at para. 53. That is, the Board did not split all compensation costs into either "forecast" or "committed", but analyzed the disallowance of compensation costs as a mix of forecast and committed expenditures over which management retained some, but not total, control.

[117] It was not unreasonable for the Board to proceed on the basis that predicting staff attrition rates is an inherently uncertain exercise, and that it is not equipped to micromanage business decisions within the purview of OPG management. These considerations mean that any attempt to predict the exact degree to which OPG would be able to reduce compensation costs (in other words, what

share of the costs were forecast) would be fraught with uncertainty. Accordingly, it was not unreasonable for the Board to adopt a mixed approach that did not rely on quantifying the exact share of compensation costs that fell into the forecast and committed categories. Such an approach is not inconsistent with the Board's discussion at pp. 18-19, but rather represents an exercise of the Board's methodological discretion in addressing a challenging issue where these costs did not fit easily into the categories discussed in that passage.

[118] Justice Abella emphasizes throughout her reasons that the costs established by the collective agreements were not adjustable. I do not dispute this point. However, to the extent that she relies on the observation that the collective agreements "made it *illegal* for the utility to alter the compensation and staffing levels" of the unionized workforce (para. 149 (emphasis in original)), one might conclude that the Board was in some way trying to interfere with OPG's obligations under its collective agreements. It is important not to lose sight of the fact that the Board decision in no way purports to force OPG to break its contractual commitments to unionized employees.

[119] Finally, her observation that the Canadian Nuclear Safety Commission ("CNSC") "has . . . imposed staffing levels on Ontario Power Generation to ensure safe and reliable operation of its nuclear stations" (para. 127) is irrelevant to the issues raised in this case. While the regime put in place by the CNSC surely imposes operational and staffing restraints on nuclear utilities (see OPG record, at pp. 43-46),

there is nothing in the Board's reasons, and no argument presented before this Court, suggesting that the Board's disallowance will result in a violation of the provisions of the *Nuclear Safety and Control Act,* S.C. 1997, c. 9.

[120] I have noted above that it is essential for a utility to earn its cost of capital in the long run. The Board's disallowance may have adversely impacted OPG's ability to earn its cost of capital in the short run. Nevertheless, the disallowance was intended "to send a clear signal that OPG must take responsibility for improving its performance" (Board Decision, at p. 86). Such a signal may, in the short run, provide the necessary impetus for OPG to bring its compensation costs in line with what, in the Board's opinion, consumers should justly expect to pay for an efficiently provided service. Sending such a signal is consistent with the Board's market proxy role and its objectives under s. 1 of the *Ontario Energy Board Act, 1998*.

VI. Conclusion

[121] I do not find that the Board acted improperly in pursuing this matter on appeal; nor do I find that it acted unreasonably in disallowing the compensation costs at issue. Accordingly, I would allow the appeal, set aside the decision of the Court of Appeal, and reinstate the decision of the Board.

The following are the reasons delivered by

ABELLA J. —

[122] The Ontario Energy Board was established in 1960 to set rates for the sale and storage of natural gas and to approve pipeline construction projects. Over time, its powers and responsibilities evolved. In 1973, the Board became responsible for reviewing and reporting to the Minister of Energy on electricity rates. During this period, Ontario's electricity market was lightly regulated, dominated by the government-owned Ontario Hydro, which owned power generation assets responsible for about 90 per cent of electricity production in the province: Ron W. Clark, Scott A. Stoll and Fred D. Cass, *Ontario Energy Law: Electricity* (2012), at p. 134; *2011 Annual Report* of the Office of the Auditor General of Ontario, at pp. 5 and 67.

[123] A series of legislative measures in the late 1990s were adopted to transform the electricity industry into a market-based one driven by competition. Ontario Hydro was unbundled into five entities. One of them was Ontario Power Generation Inc., which was given responsibility for controlling the power generation assets of the former Ontario Hydro. It was set up as a commercial corporation with one shareholder — the Province of Ontario: Clark, Stoll and Cass, at pp. 5-7 and 134.

[124] As of April 1, 2008, the Board was given the authority by statute to set payments for the electricity generated by a prescribed list of assets held by Ontario Power Generation: *Ontario Energy Board Act, 1998*, S.O. 1998, c. 15, Sch. B., s. 78.1(2); O. Reg. 53/05, *Payments Under Section 78.1 of the Act*, s. 3. Under the legislative scheme, Ontario Power Generation is required to apply to the Board for the approval of "just and reasonable" payment amounts: *Ontario Energy Board Act,*

1998, s. 78.1(5). The Board sets its own methodology to determine what "just and reasonable" payment amounts are, guided by the statutory objectives to maintain a "financially viable electricity industry" and to "protect the interests of consumers with respect to prices and the adequacy, reliability and quality of electricity service": O. Reg. 53/05, s. 6(1); *Ontario Energy Board Act, 1998*, ss. 1(1)1 and 1(1)2.

[125] Ontario Power Generation remains the province's largest electricity generator. It was unionized by the Ontario Hydro Employees' Union (the predecessor to the Power Workers' Union) in the 1950s, and by the Society of Energy Professionals in 1992: Richard P. Chaykowski, *An Assessment of the Industrial Relations Context and Outcomes at OPG* (2013) (online), at s. 6.2. Today, Ontario Power Generation employs approximately 10,000 people in its regulated businesses, 90 per cent of whom are unionized. Two thirds of these unionized employees are represented by the Power Workers' Union, and the rest by the Society of Energy Professionals.

[126] Both the Power Workers' Union and the Society of Energy Professionals had collective agreements with Ontario Hydro before Ontario Power Generation was established. As a successor company to Ontario Hydro, Ontario Power Generation inherited the full range of these labour relations obligations: Ontario *Labour Relations Act, 1995*, S.O. 1995, c. 1, Sch. A, s. 69. Ontario Power Generation's collective agreements with its unions prevent the utility from unilaterally reducing staffing or compensation levels.

[127] The Canadian Nuclear Safety Commission, an independent federal government agency responsible for ensuring compliance with the *Nuclear Safety and Control Act*, S.C. 1997, c. 9, has also imposed staffing levels on Ontario Power Generation to ensure safe and reliable operation of its nuclear stations.

[128] On May 26, 2010, Ontario Power Generation applied to the Board for a total revenue requirement of $6,909.6 million, including $2,783.9 million in compensation costs — wages, benefits, pension servicing, and annual incentives — to cover the period from January 1, 2011 to December 31, 2012: EB-2010-0008, at pp. 8, 49 and 80.

[129] In its decision, the Board explained that it would use "two types of examination" to assess the utility's expenditures. When evaluating forecast costs — costs that the utility has estimated for a future period and which can still be reduced or avoided — the Board said that Ontario Power Generation bears the burden of showing that these costs are reasonable. On the other hand, when the Board would be evaluating costs for which "[t]here is no opportunity for the company to take action to reduce", otherwise known as committed costs, it said that it would undertake "an after-the-fact prudence review . . . conducted in the manner which includes a presumption of prudence", that is, a presumption that the utility's expenditures are reasonable: p. 19.

[130] The Board made no distinction between those compensation costs that were reducible and those that were not. Instead, it subjected all compensation costs to

the kind of assessment it uses for reducible, forecast costs and disallowed $145 million because it concluded that the utility's compensation rates and staffing levels were too high.

[131] On appeal, a majority of the Divisional Court upheld the Board's order. In dissenting reasons, Aitken J. concluded that the Board's decision was unreasonable because it did not apply the proper approach to the compensation costs which were, as a result of legally binding collective agreements, fixed and not adjustable. Instead, the Board "lumped" all compensation costs together and made no distinction between those that were the result of binding contractual obligations and those that were not. As she said:

> First, I consider any limitation on [Ontario Power Generation's] ability to manage nuclear compensation costs on a go-forward basis, due to binding collective agreements in effect prior to the application and the test period, to be costs previously incurred and subject to an after-the-fact, two-step, prudence review. Second, I conclude that, in considering [Ontario Power Generation's] nuclear compensation costs, as set out in its application, the [Board] in its analysis (though not necessarily in its final number) was required to differentiate between such earlier incurred liabilities and other aspects of the nuclear compensation cost package that were truly projected and not predetermined. Third, in my view, the [Board] was required to undergo a prudence review in regard to those aspects of the nuclear compensation package that arose under binding contracts entered prior to the application and the test period. In regard to the balance of factors making up the nuclear compensation package, the [Board] was free to determine, based on all available evidence, whether such factors were reasonable. Fourth, had a prudence review been undertaken, there was evidence upon which the [Board] could reasonably have decided that the presumption of prudence had been rebutted in regard to those cost factors mandated in the collective agreements. Unfortunately, I cannot find anywhere in the Decision of the [Board] where such an analysis was undertaken. The [Board] lumped all nuclear compensation costs together. It dealt with them as if they all emanated from the same type of factors

> and none reflected contractual obligations to which the [Ontario Power Generation] was bound due to a collective agreement entered prior to the application and the test period. Finally, I conclude that, when the [Board] was considering the reasonableness of the nuclear compensation package, it erred in considering evidence that came into existence after the date on which the collective agreements were entered when it assessed the reasonableness of the rates of pay and other binding provisions in the collective agreements. [para. 75]

[132] The Court of Appeal unanimously agreed with Aitken J.'s conclusion, finding that "the compensation costs at issue before the [Board] were committed costs" which should therefore have been assessed using a presumption of prudence. As they both acknowledged, it was open to the Board to find that the presumption had been rebutted in connection with the binding contractual obligations, but the Board acted unreasonably in failing to take the immutable nature of the fixed costs into consideration.

[133] I agree. The compensation costs for approximately 90 per cent of Ontario Power Generation's regulated workforce were established through legally binding collective agreements which obligated the utility to pay fixed levels of compensation, regulated staffing levels, and provided unionized employees with employment security. Ontario Power Generation's compensation costs were therefore overwhelmingly predetermined and could not be adjusted by the utility during the relevant period. These are precisely the type of costs that the Board referred to in its decision as costs for which "[t]here is no opportunity for the company to take action to reduce" and which must be subjected to "a prudence review conducted in the manner which includes a presumption of prudence": p. 19.

[134] In my respectful view, failing to acknowledge the legally binding, non-reducible nature of the cost commitments reflected in the collective agreements and apply the review the Board itself said should apply to such costs, rendered its decision unreasonable.

Analysis

[135] Pursuant to s. 78.1(5) of the *Ontario Energy Board Act, 1998*, upon application from Ontario Power Generation, the Board is required to determine "just and reasonable" payment amounts to the utility. In the utility regulation context, the phrase "just and reasonable" reflects the aim of "navigating the straits" between overcharging a utility's customers and underpaying the utility for the public service it provides: *Verizon Communications Inc. v. Federal Communications Commission*, 535 U.S. 467 (2002), at p. 481; see also *Northwestern Utilities Ltd. v. City of Edmonton*, [1929] S.C.R. 186, at pp. 192-93.

[136] The methodology adopted by the Board to determine "just and reasonable" payments to Ontario Power Generation draws in part on the regulatory concept of "prudence". Prudence is "a legal basis for adjudging the meeting of utilities' public interest obligations, specifically in regard to rate proceedings": Robert E. Burns et al., *The Prudent Investment Test in the 1980s*, report NRRI-84-16, The National Regulatory Research Institute, April 1985, at p. 20. The concept emerged in the early 20th century as a judicial response to the "mind-numbing complexity" of other approaches being used by regulators to determine "just and reasonable"

amounts, and introduced a legal presumption that a regulated utility has acted reasonably: *Verizon Communications*, at p. 482. As Justice Brandeis famously explained in 1923:

> The term prudent investment is not used in a critical sense. There should not be excluded from the finding of the base, investments which, under ordinary circumstances, would be deemed reasonable. The term is applied for the purpose of excluding what might be found to be dishonest or obviously wasteful or imprudent expenditures. Every investment may be assumed to have been made in the exercise of reasonable judgment, unless the contrary is shown. [Emphasis added.]
>
> (*State of Missouri ex rel. Southwestern Bell Telephone Co. v. Public Service Commission of Missouri*, 262 U.S. 276 (1923), at p. 289, fn. 1, per Brandeis J., dissenting).

[137] The presumption of prudence is the starting point for the type of examination the Board calls a "prudence review". In undertaking a prudence review, the Board applies a "well-established set of principles":

- Decisions made by the utility's management should generally be presumed to be prudent unless challenged on reasonable grounds.
- To be prudent, a decision must have been reasonable under the circumstances that were known or ought to have been known to the utility at the time the decision was made.
- Hindsight should not be used in determining prudence, although consideration of the outcome of the decision may legitimately be used to overcome the presumption of prudence.
- Prudence must be determined in a retrospective factual inquiry, in that the evidence must be concerned with the time the decision was made and must be based on facts about the elements that could or did enter into the decision at the time.

> (*Enersource Hydro Mississauga Inc. (Re)*, 2012 LNONOEB 373 (QL), at para. 55, citing *Enbridge Gas Distribution (Re)*, 2002 LNONOEB 4 (QL), at para. 3.12.2).

[138] This form of prudence review, including a presumption of prudence and a ban on hindsight, was endorsed by the Board and by the Ontario Court of Appeal as an appropriate method to determine "just and reasonable" rates in *Enbridge Gas Distribution Inc. (Re)*, at paras. 3.12.1 to 3.12.5, aff'd *Enbridge Gas Distribution Inc. v. Ontario Energy Board* (2006), 210 O.A.C. 4, at paras. 8 and 10-12.

[139] In the case before us, however, the Board decided not to submit all costs to a prudence review. Instead, it stated that it would use two kinds of review. The first would apply to "forecast costs", that is, those over which a utility retains discretion and can still be reduced or avoided. It explained in its reasons that it would review such costs using a wide range of evidence, and that the onus was on the utility to demonstrate that its forecast costs were reasonable:

> When considering forecast costs, the onus is on the company to make its case and to support its claim that the forecast expenditures are reasonable. The company provides a wide spectrum of such evidence, including business cases, trend analysis, benchmarking data, etc. The test is not dishonesty, negligence, or wasteful loss; the test is reasonableness. And in assessing reasonableness, the Board is not constrained to consider only factors pertaining to [Ontario Power Generation]. The Board has the discretion to find forecast costs unreasonable based on the evidence — and that evidence may be related to the cost/benefit analysis, the impact on ratepayers, comparisons with other entities, or other considerations.
>
> The benefit of a forward test period is that the company has the benefit of the Board's decision in advance regarding the recovery of forecast costs. To the extent costs are disallowed, for example, a forward test period provides the company with the opportunity to adjust its plans accordingly. In other words, there is not necessarily any cost borne by

> shareholders (unless the company decides to continue to spend at the higher level in any event). [p. 19]

[140] A different approach, the Board said, would be applied to those costs the company could not "take action to reduce". These costs, sometimes called "committed costs", represent binding commitments that leave a utility with no discretion about whether to make the payment. The Board explained that it evaluates these costs using a "prudence review", which includes a presumption that the costs were prudently incurred:

> Somewhat different considerations will come into play when undertaking an after-the-fact prudence review. In the case of an after-the-fact prudence review, if the Board disallows a cost, it is necessarily borne by the shareholder. There is no opportunity for the company to take action to reduce the cost at that point. For this reason, the Board concludes there is a difference between the two types of examination, with the after-the-fact review being a prudence review conducted in the manner which includes a presumption of prudence. [p. 19]

[141] In *Enersource Hydro Mississauga Inc. (Re)*, for example, the Board concluded that it had to conduct a prudence review when evaluating the costs that Enersource had already incurred:

> This issue concerns expenditures which have largely already been incurred by the company. . . . Given that the issue concerns past expenditures which are now in dispute, the Board must conduct a prudence review. [para. 55]

[142] As the Board said in its reasons, the prudence review makes sense for committed costs because disallowing costs Ontario Power Generation cannot avoid, forces the utility to pay out of pocket for expenses it has already incurred. This could negatively affect Ontario Power Generation's ability to operate, leading the utility to restructure its relationships with the financial community and its service providers, or even lead to bankruptcy: see Burns et al., at pp. 129-65. These outcomes would "increase capital costs and utility rates above the levels that would exist with a limited prudence penalty", forcing Ontario consumers to pay higher electricity bills: Burns et al., at p. vi.

[143] The issue in this appeal therefore centres on the Board assessing *all* compensation costs in Ontario Power Generation's collective agreements as adjustable forecast costs, without determining whether any of them were costs for which "[t]here is no opportunity for the company to take action to reduce". The Board did not actually call them forecast costs, but by saying that "collective agreements may make it difficult to eliminate positions quickly" and that "changes to union contracts . . . will take time" (pp. 85 and 87), the Board was clearly treating them as reducible in theory. Moreover, the fact that it failed to apply the prudence review it said it would apply to non-reducible costs confirms that it saw the collectively bargained commitments as adjustable.

[144] The Board did not explain why it considered compensation costs in collective agreements to be adjustable forecast costs, but the effect of its approach

was to deprive Ontario Power Generation of the benefit of the Board's assessment methodology that treats committed costs differently. In my respectful view, the Board's failure to separately assess the compensation costs committed as a result of the collective agreements from other compensation costs, ignored not only its own methodological template, but labour law as well.

[145] Ontario Power Generation was a party to binding collective agreements with the Power Workers' Union and the Society of Energy Professionals covering most of the relevant period. At the time of the application, it had already entered into a collective agreement with the Power Workers' Union for the period of April 1, 2009 to March 31, 2012.

[146] Its collective agreement with the Society of Energy Professionals, which required resolution by binding mediation-arbitration in the event of contract negotiations disputes, expired on December 31, 2010. As a result of a bargaining impasse, the terms of a new collective agreement for January 1, 2011 to December 31, 2012 were imposed by legally binding arbitration: *Ontario Power Generation v. Society of Energy Professionals*, [2011] O.L.A.A. No. 117 (QL).

[147] The collective agreements with the Power Workers' Union and the Society of Energy Professionals prescribed the compensation rates for staff positions held by represented employees, strictly regulated staff levels at Ontario Power Generation's facilities, and limited the utility's ability to unilaterally reduce its compensation rates and staffing levels. The collective agreement with the Power

Workers' Union, for example, stipulated that there would be no involuntary layoffs during the term of the agreement. Instead, Ontario Power Generation would be required either to relocate surplus staff or offer severance in accordance with rates set out in predetermined agreements between the utility and the union: "Collective Agreement between Ontario Power Generation Inc. and Power Workers' Union", April 1, 2009 to March 31, 2012, at art. 11.

[148] Similarly, Ontario Power Generation's collective agreement with the Society of Energy Professionals severely limited the utility's bargaining power and control over compensation levels. When the contract between Ontario Power Generation and the Society of Energy Professionals expired on December 31, 2010, the utility's bargaining position had been that its sole shareholder, the Province of Ontario, had directed that there be a zero net compensation increase over the next two-year term. The parties could not reach an agreement and the dispute was therefore referred to binding arbitration as required by previous negotiations. The resulting award by Kevin M. Burkett provided mandatory across-the-board wage increases of three per cent on January 1, 2011, two per cent on January 1, 2012, and a further one per cent on April 1, 2012: *Ontario Power Generation v. Society of Energy Professionals*, at paras. 1, 9, and 28.

[149] The obligations contained in these collective agreements were immutable and legally binding commitments: *Labour Relations Act, 1995*, s. 56. As a result, Ontario Power Generation was prohibited from unilaterally reducing the staffing

levels, wages, or benefits of its unionized workforce. These agreements therefore did not just leave the utility "with limited flexibility regarding overall compensation rates or staffing levels", as the majority notes (at para. 84), they made it *illegal* for the utility to alter the compensation and staffing levels of 90 per cent of its regulated workforce in a manner that was inconsistent with its commitments under the agreements.

[150] Instead, the Board, applying the methodology it said it would use for the utility's forecast costs, put the onus on Ontario Power Generation to prove the reasonableness of its costs and concluded that it had failed to provide "compelling evidence" or "documentation or analysis" to justify compensation levels: p. 85. Had the Board used the approach it said it would use for costs the company had "no opportunity . . . to reduce", it would have used an after-the-fact prudence review, with a rebuttable presumption that the utility's expenditures were reasonable.

[151] Applying a prudence review to these compensation costs would hardly, as the majority suggests, "have conflicted with the burden of proof in the *Ontario Energy Board Act, 1998*". To interpret the burden of proof in s. 78.1(6) of the *Ontario Energy Board Act* so strictly would essentially prevent the Board from ever conducting a prudence review, notwithstanding that it has comfortably done so in the past and stated, even in its reasons in this case, that it would review committed costs using an "after-the-fact prudence review" which "includes a presumption of prudence". Under the majority's logic, however, since a prudence review always

involves a presumption of prudence, the Board would not only be limiting its methodological flexibility, it would be in breach of the Act.

[152] The application of a prudence review does not shield the utility's compensation costs from scrutiny. As the Court of Appeal observed, a prudence review

> does not mean that the [Board] is powerless to review the compensation rates for [Ontario Power Generation]'s unionized staff positions or the number of those positions. In a prudence review, the evidence may show that the presumption of prudently incurred costs should be set aside, and that the committed compensation rates and staffing levels were not reasonable; however, the [Board] cannot resort to hindsight, and must consider what was known or ought to have been known at the time. A prudence review allows for such an outcome, and permits the [Board] both to fulfill its statutory mandate and to serve as a market proxy, while maintaining a fair balance between [Ontario Power Generation] and its customers. [para. 38]

[153] The majority's suggestion (at para. 114) that "if the legislature had intended for costs under collective agreements to also be inevitably imposed on consumers, it would not have seen fit to grant the Board oversight of utility compensation costs", is puzzling. The legislature did not intend for *any* costs to be "inevitably" imposed on consumers. What it intended was to give the Board authority to determine just and reasonable payment amounts based on Ontario Power Generation's existing and proposed commitments. Neither collective agreements nor any other contractual obligations were intended to be "inevitably" imposed. They were intended to be inevitably considered in the balance. But it is precisely because

of the unique nature of binding commitments that the Board said it would impose a different kind of review on these costs.

[154] It may well be that Ontario Power Generation has the ability to manage some staffing levels through attrition or other mechanisms that did not breach the utility's commitments under its collective agreements, and that these costs may therefore properly be characterized as forecast costs. But no factual findings were made by the Board about the extent of any such flexibility. There is in fact no evidence in the record, nor any evidence cited in the Board's decision, setting out what proportion of Ontario Power Generation's compensation costs were fixed and what proportion remained subject to the utility's discretion. The Board made virtually no findings of fact regarding the extent to which the utility could reduce its collectively bargained compensation costs. On the contrary, the Board, as Aitken J. noted, "lumped" all compensation costs together, acknowledged that reducing those in the collective agreements would "take time" and "be difficult", and dealt with them as globally adjustable.

[155] Given that collective agreements are legally binding, it was unreasonable for the Board to assume that Ontario Power Generation could reduce the costs fixed by these contracts in the absence of any evidence to that effect. To use the majority's words, these costs are "legal obligations that leave [the utility] with no discretion as to whether to make the payment in the future" (para. 82). According to the Board's

own methodology, costs for which "[t]here is no opportunity for the company to take action to reduce" are entitled to "a presumption of prudence": p. 19.

[156] Disallowing costs that Ontario Power Generation is legally required to pay as a result of its collective agreements, would force the utility and the Province of Ontario, the sole shareholder, to make up the difference elsewhere. This includes the possibility that Ontario Power Generation would be forced to reduce investment in the development of capacity and facilities. And because Ontario Power Generation is Ontario's largest electricity generator, it may not only threaten the "financial viability" of the province's electricity industry, it could also imperil the assurance of reliable electricity service.

[157] The majority nonetheless assumes that the ongoing relationship between Ontario Power Generation and the unions should give the Board greater latitude in disallowing the collectively bargained compensation costs than it would have had if it applied a no-hindsight, presumption-of-prudence analysis. It also accepts the Board's conclusion that Ontario Power Generation's collectively bargained compensation costs may be "excessive", and therefore concludes that the Board was reasonable in choosing to avoid the "prudence" test in order to so find. This approach finds no support even in the methodology the Board set out for itself for evaluating just and reasonable payment amounts.

[158] In my respectful view, selecting a test which is more likely to confirm an assumption that collectively bargained costs are excessive, misconceives the point of

the exercise, namely, to determine whether those costs were in fact excessive. Blaming collective bargaining for what are *assumed* to be excessive costs, imposes, with respect, the appearance of an ideologically driven conclusion on what is intended to be a principled methodology based on a distinction between committed and forecast costs, not between costs which are collectively bargained and those which are not.

[159] I recognize that the Board has wide discretion to fix payment amounts that are "just and reasonable" and, subject to certain limitations, to "establish the . . . methodology" used to determine such amounts: O. Reg. 53/05, s. 6, *Ontario Energy Board Act, 1998*, s. 78.1;. That said, once the Board establishes a methodology to determine what is just and reasonable, it is, at the very least, required to faithfully apply that approach: see *TransCanada Pipelines Ltd. v. National Energy Board* (2004), 319 N.R. 171 (F.C.A.), at paras. 30-32, per Rothstein J.A. This does not mean that collective agreements "supersede" or "trump" the Board's authority to fix payment amounts; it means that once the Board selects a methodology for itself for the exercise of its discretion, it is required to follow it. Absent methodological clarity and predictability, Ontario Power Generation would be left in the dark about how to determine what expenditures and investments to make and how to present them to the Board for review. Wandering sporadically from approach to approach, or failing to apply the methodology it declares itself to be following, creates uncertainty and leads, inevitably, to needlessly wasting public time and resources in constantly having to anticipate and respond to moving regulatory targets.

[160] In disallowing $145 million of the compensation costs sought by Ontario Power Generation on the grounds that the utility could reduce salary and staffing levels, the Board ignored the legally binding nature of the collective agreements and failed to distinguish between committed compensation costs and those that were reducible. Whether or not one can fault the Board for failing to use a particular methodology, what the Board can unquestionably be analytically faulted for, is evaluating all compensation costs fixed by collective agreements as being amenable to adjustment. Treating these compensation costs as reducible was, in my respectful view, unreasonable.

[161] I would accordingly dismiss the appeal, set aside the Board's decision, and, like the Court of Appeal, remit the matter to the Board for reconsideration in accordance with these reasons.

Appeal allowed, ABELLA J. *dissenting.*

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ONTARIO POWER GENERATION

Guideline

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Document Number: NK38-GUID-09701-10023	Usage Classification: Reference
Sheet Number: PC	Revision: R002

Title:
Darlington Refurbishment Functional Management Plan Guide

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NK38-GUID-09701-10023
2015-03-06

Order Number: N/A
Other Reference Number:

Internal Use Only

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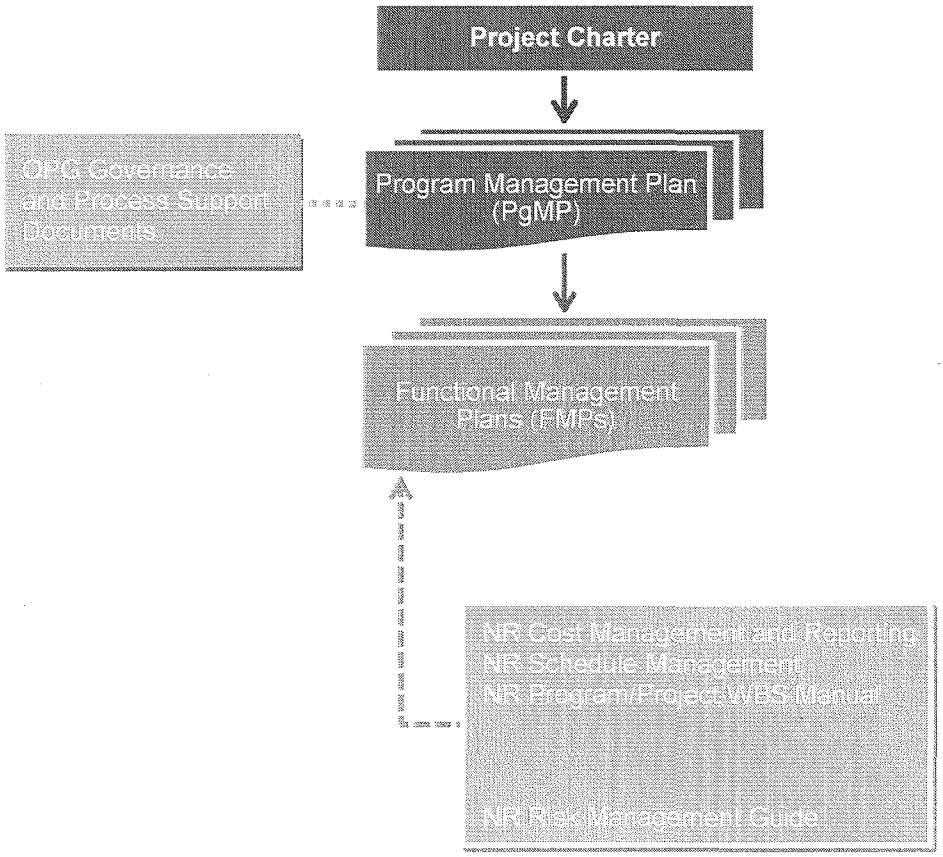
Revision Summary

Revision Number	Date	Comments
D000	2014-05-12	Initial issue.
R001	2014-11-27	Section Removed - SVP NR is responsible for authorising the FMP.
R002	2015-03-05	Comprehensive revision to incorporate clarifications from Self-Assessment and to reflect new Assumptions methodology and Log format.

1.0 BACKGROUND

The Refurbishment Program Management Plan (PgMP) identifies how Nuclear Refurbishment (NR) meets the intent of OPG's Nuclear Management System via the integrated set of roles and accountabilities required to execute the Darlington Refurbishment program. Detailed functional work programs and resource requirements are contained in Functional Management Plans (FMPs).

Figure 1: Document Hierarchy



2.0 PURPOSE

The purpose of this document is to describe the requirements for structure and content for preparation of comprehensive Management Plans for each Function.

The FMP gets its authority from the Darlington Refurbishment PgMP, NK38-NR-PLAN-09701-10001. It describes in detail how the function will execute the requirements outlined in PgMP over the life-cycle of the program.

The FMP identifies the work programs and the resource requirements of each function which are in alignment with the currently approved Funding Release plan. It is the summary of the vital planning information within a function to support program/projects. Fundamentally, the FMP is a management plan encompassing scope, resources, cost, schedule, quality and other relevant parameters to support the NR Program. It is a living document that is revised annually (or as required) to reflect the changes in the role of the functions in meeting program objectives.

3.0 SCOPE

This document defines the requirements, responsibilities and process for preparing Functional Management Plans. FMPs are required for all functions supporting Nuclear Refurbishment (i.e. Engineering, Planning & Controls, Management System Oversight, Operations & Maintenance, Supply Chain, Contract Management, Work Management, Execution Support and Program Support).

For program/project related work, the FMP is prepared to identify the current activity within the function including Strategies, Initiatives and Resource Plans. The FMP will be revised annually, to reflect the changing requirements as NR moves through various phases of the project –Definition, Execution Planning, Execution and Closeout Phases.

Each function will be responsible for keeping its FMP current and aligned with the Funding Release plan. There should be no conflict and minimal overlap between the Program Management Plans, Project Management Plans and Functional Management Plans. Together, the PgMPs, Project Management Plans (PMPs) and FMPs serve as an integrated set of documents that define how NR will meet business objectives.

4.0 FORMAT AND CONTENTS

The FMP defines all the major parameters needed for a functional group to support Nuclear Refurbishment. It provides an overview of what will be done and how it will be accomplished, over the duration of Nuclear Refurbishment.

FMPs are not process support documents and do not need to follow the requirements of NK38-MAN-09701-10006. FMPs will be of document type "PLAN", they will be written on the "Plan" template and the document number will be of the form NK38-PLAN-09701-xxxxx.

FMP's will contain information such as resource requirements and strategies to meet work program requirements. Dollar values and contractor names should not be included. This information will be captured in separate Release Plans which should be reference as required.

FMPs will have a security classification in accordance with OPG-STD-0030 Classification Protection and Release of Information.

The content of the FMP should be sufficiently detailed to give the reader clarity on how the function is supporting NR including what strategies are in place, what initiatives are underway, important milestones and a comprehensive resource plan.

Each FMP will be prepared using the following table of contents: Purpose, Mission, Scope and Responsibilities, Basis & Assumptions, Strategies/Initiatives, Milestones and Key Dates, Major Work Summaries, Risk and Opportunities, Performance Measurement and Reporting, Resource Plan.

Appendix A provides general guidelines and shall be tailored to meet specific function's requirement.

5.0 RESPONSIBILITIES

Author

The Author has overall responsibility for preparing the FMP in accordance with this document. The Author identifies the reviewers and manages the review and approval process. The Author should enlist the assistance subject matter experts as well as peers from other NR functions and projects to write sections of FMP.

The Author is responsible for leading the annual review of the FMP and revisions of the document.

Reviewers

Reviewers are responsible for reviewing sections of the FMP and providing comments per this guideline. Typically, the reviewers include client representatives, other key stakeholders, project managers, and project directors.

Functional Owner

The Functional Owner is the senior manager accountable to the SVP Nuclear Projects for functional deliverables, The Functional Owner is responsible for approving the FMP. This approval signifies that the FMP conforms to the requirements of this document, that due process has been followed in the review of the FMP and disposition of comments, and that the plan reflects the strategies required to support the NR Program.

6.0 REFERENCES

OPG-STD-0030 Classification Protection and Release of Information

DNGSG Refurbishment Project Charter D-PCH-09701-10000

Darlington Refurbishment Program Management Plan (PgMP), NK38-NR-PLAN-09701-10001

Appendix A: FMP Table of Contents and Suggested Content

To be applied as pertinent to the specific function(s)

A.1.0 PURPOSE

States the purpose of the document, the function to which it applies within the NR project and its intended use. Provides a high level summary of the scope of FMP.

A.2.0 MISSION

Identifies the mission of the function to achieve the overall objective of the program as defined in PgMPs.

A.3.0 SCOPE AND RESPONSIBILITIES

Provides a summary of the function's major work program elements by project phase (i.e. Definition, Execution Planning, Execution, and Closeout). This section provides the framework upon which the remainder of the FMP is structured. The summary should provide the reader with a good basis for understanding the life cycle budget flows.

A high level organization chart complete with breakout of major work program responsibilities should be provided.

A.4.0 BASIS AND ASSUMPTIONS

Provides a description of the major basis elements and assumptions that shape the function's work program and life cycle costs, with associated references to the NR Assumption Log entry item numbers for cross-referencing. This section should be revised after any significant changes to the assumption Log.

A.5.0 STRATEGIES / INITIATIVES

Provides a description of the strategies and initiatives which drive the function through various project lifecycle phases and the impact on the function as the program evolves e.g., contracting strategies, process improvement initiatives.

This section should focus on specific initiatives required to enable the execution of the function's work program given the resource profiles in life cycle cost estimates (e.g. software systems, hiring, training).

A.6.0 MILESTONE AND KEY DATES

Summarizes the major project milestones based on the project deliverables and how the function will provide the necessary support. Typically this section contains a table of the functions milestones as derived from the baselined P6 schedule.

A.7.0 MAJOR WORK SUMMARIES

Expanding on the summary provided in Section A3.0, this section defines in detail the function's work program elements at various project phases – definition, execution and close-out. This includes the function's major accountabilities, deliverables, and oversight roles through the definition, execution planning, execution and close-out phases of the program.

A.8.0 RISK AND OPPORTUNITIES

Identifies and characterises the major risks and opportunities by work program element that may potentially affect the project outcome. Associated Risk Register items are cross-referenced.

Opportunities represent potential improvements and efficiencies that the function is, or will be, pursuing in order to benefit project quality, schedule, or cost.

A.9.0 PERFORMANCE MEASUREMENT AND REPORTING

Describes thefunction's 's key performance indicators based on the program's requirements and the criteria on which the function's performance will be measured. Identifies the internal and/or external target stakeholders, frequency of reporting and the mode of communication e.g. e-mails, meetings, SharePoint portal, bulletin board etc.

A.10.0 RESOURCE PLAN

Resource Plan identifies the types of resources (e.g. labour, software, equipment) required to execute the function's work program over the life-cycle of the program. Outlines the general flow of these resources over the program life cycle and the strategies adopted to meet resource requirements.

This section supports the detailed resource plans and estimates provided in release planning, but does not contain numbers of FTEs or dollars (reference release planning estimates where appropriate).

Labour

Define the types of labour required at the job family level (e.g. Design Engineers, Fuel Handling Operators). Specify the resourcing strategy, including Regular, Temporary, Other Business Unit (OBU) and Augmented OPG staff. The Labour Resource Plan for the function describes the composition and structure of the core function team and summarizes the roles and responsibilities and qualifications of the team members. Identifies major changes in resourcing required by project phase, referencing the associated underlying work program basis. References any specific hiring or training strategies required as part of the resource plan

Purchased Services

This includes the managed task services and summarizes the strategy to utilize resources external to OPG, to complete the function's activities. Forecasts the requirement of external specialized resources to meet the function's needs to support refurbishment's demands.

Non-labour Resources

Describe all non-labour resources requirement such as facility, IT systems, computers, LAN access etc. to meet the function's needs in meeting Nuclear Refurbishment's objectives.

ONTARIO POWER GENERATION

Plan

Internal Use Only	
Document Number: NK38-PLAN-09701-10223	Usage Classification: Information
Sheet Number: 0007	Revision: R001

Title:
NUCLEAR REFURBISHMENT OPERATIONS AND MAINTENANCE FUNCTIONAL MANAGEMENT PLAN

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Nuclear Refurbishment Operations And Maintenance Functional Management Plan

NK38-PLAN-09701-10223-0007-R001
2015-08-27

Order Number: N/A
Other Reference Number:

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R001	2015-08-27	Updated Functional Plan to enhance as per present RQE plan. NR Training and NR Conventional Safety have been removed from this FMP to the Execution FMP NK38-PLAN-09701-10223-0013.
R000	2015-03-31	Updated Functional Plan to enhance as per the Guide and Self Assessment RF15-000770 and superseded old FMP NK38-PLAN-09701-10212 with this plan NK38-PLAN-09701-10223-00007.
R001	2014-12-08	Updated Functional PlanNK38-PLAN-09701-10212 to match present organization changes and changes in Project Estimate for 4D. Added Partnership agreements. Corrected references. Updated RISKs to match O&M present scope. Updated Milestone and Key Dates to reflect present status. General doc restructure as per newest template.
R000	2014-06-27	Initial Issue of NK38-PLAN-09701-10212

Records Table

The following Records may be generated by use of this document and shall be registered in the appropriate document management system in accordance with the following table:

Record Created	Associated Form or Template Number	QA Record? Y/N	Filing Information/Retention (AIMS Type/Sub-Type)
None	N/A	N	None

1.0 PURPOSE

This Functional Management Plan (FMP) defines the mission, scope, strategies, and interfaces of the Operations and Maintenance (O&M), Nuclear Refurbishment (NR) Division, as well as the major deliverables and activities. Also includes assumptions and constraints, risks, mitigation plans and the organization and staffing plans. The FMP references and organizes the information in the Program Management Plans, Ownership Transfer Plans (OTP), Service Level Agreements (SLA) and Partnership Agreements (PA).

The Departments within the O&M Division included in this FMP are:

- NR Operations
- NR Maintenance
- NR O&M Programs
- NR Chemistry and Environment
- NR Return to Service
- NR Radiation Protection

2.0 MISSION

Our mission is the successful refurbishment of Darlington Nuclear Station, safely, on time, on budget and 100% of scope completed with minimal impact on the operating units. We will achieve this through effectively planning, preparing and executing all activities to the highest standards of O&M.

2.1 NR O&M Programs Mission

Due to the unique requirements and the large scope of the Darlington Refurbishment there will be a separate O&M Programs team for the refurbishment project to ensure that Structures System and Components (SSC), configurations and status, are documented appropriately for refurbishment execution and return to service.

2.2 NR Maintenance Mission

To ensure that the SSCs are maintained and refurbished to nuclear standards and are returned to the Operations in a condition that will allow them to perform in the top deciles of the industry in terms of safety, reliability and net production.

2.3 NR Operations Mission

The Nuclear Refurbishment Operations and Maintenance organization is to set the standard for Operations for the refurbishment of Darlington CANDU units. Following completion of the Refurbishment Program, all units will be returned to service in a condition that will allow them to operate in the top deciles in the industry in terms of safety, reliability, and net production.

2.4 NR Chemistry and Environment Mission

Through proper oversight and integration, Chemistry and Environment will maintain the integrity of the refurbishment unit's systems and components while effectively managing all environmental aspects during the refurbishment project.

2.5 NR Return to Service Mission

The Return to Service-Nuclear Refurbishment-Operations and Maintenance organization (NR-RTS) mission is to prepare and/or coordinate execution tasks required to return the unit to full power after completion of the refurbishment scope and turnover of systems and equipment from the Project Teams.

2.6 NR Radiation Protection Mission

We will refurbish Darlington units 1-4 over a multi-year period. Due to the unique requirements associated with a refurbishment outage and the large scope of the project, it is recognized that high quality management of Radiation Protection (RP) is

required to ensure that the refurbishment is completed in a safe, quality, and economic manner.

3.0 SCOPE AND RESPONSIBILITIES

The NR O&M Organization will be both a functional and execution type organization. NR O&M will provide functional support to the refurbishment projects and will also have the typical responsibilities of the O&M organizations of the operating plants. NR O&M will have controlling authority for the refurbishment unit(s) and the equipment therein for the duration of the refurbishment. In addition, key projects, such as unit shutdown, Lay-up or Islanding, will be supported by NR O&M.

The Phase 1 Planning Phase for NR O&M is complete. The scope and responsibilities of NR O&M will transition through the remaining two phases of the program as described in 3.1 and 3.2. Functional Support activities will be ongoing as per section 3.3.

3.1 Phase 2 Preparation (Dec 2013 - Oct 2016)

During the Preparation Phase, the NR O&M organization will ensure plans, procedures and trained resources are in place to accept turnover of the units, capable of shutting down the unit, defueling, dewatering and placing the unit in a state that can support refurbishment activities. In addition, plans to support commissioning and Return to Service (RTS) will also be developed. Preparation activities will include:

- Support development of the Level 3 outage execution logic, scheduling integration of project logic and execution planned activities for transfer from IPG and outage.
- Participate in the preparation, review and approval of detailed shutdown and lay up plans including defueling, dewatering and drying of heat transport and moderator systems.
- Establish Terminal/Boundary Points and island requirements and process as per NK38-MAN-09701-10009, “Boundary Point Process Manual”.
- Identify and ensure completion of prerequisite activities for refurbishment of unit, including refurbishment of Fuel Handling infrastructure.
- Assess work to be conducted by NR O&M staff.
- Participate in preparation and review of outage execution schedules and integration into Refurbishment program.
- Implementation of transition and department ownership transfer plans to turnover controlling authority from Operation to Refurbishment and its return.
- Coordinate the preparation, review and approval of commissioning and Return to Service specifications including detailed work plans.

- Assignment of O&M resources to project teams.
- Update and prepare supporting governance as required.
- Implement O&M technical procedure strategy as per NK38-REP-09701-10141 (OPM) and NK38-REP-09701-10139 (Procedures).
- Implement Plant Status Control (PSC) strategy as per NK38-REP-09701-10223.
- Develop new Work Protection Code (WPC) strategy as per N-PROC-MA-0012 including upgrades and improvements to the formatting template and forms.
- Preparation review and approval of plans for Waste Handling.
- Complete integration plans for “Site Integrated Transition Plan”, NK38-PLAN-09701-10215, and “Integrated Workforce Transition Plan”, NK38-NR-PLAN-09701-10003.

3.2 Phase 3 Execution (Oct 2016 – 2026)

During the execution phase, NR O&M will take controlling authority of the units undergoing refurbishment within the Construction Island. The key responsibilities for NR O&M during the refurbishment of the unit include:

- Effective unit turnover and transition are completed to minimize the impact on NR and plant operation.
- Controlling Authority of equipment within the Construction Island.
- Shutdown and lay up of the unit to allow refurbishment activities.
- Scheduling and planning of IPG and cyclical outage tasks into the refurbishment program.
- Support maintenance FIN team during emergent work required to support refurbishment contract partners or unit breakdown type work.
- Oversight of chemistry & environment and radiation protection.
- Monitoring and maintaining laid up equipment as defined in the layup maintenance plans.
- Control of Work Protection and Work Authorization.
- Start-up of the unit including execution of modification commissioning plans, system restart plans, demonstration of Readiness for Service (RFS) and returning the unit to station operations.

- Managing normal waste and waste disposal.
- Ensuring configuration management is maintained in ESMII.
- Ensure O&M manuals and procedures are updated to reflect modifications as per NK38-GUID-09701-10003, “NR O&M Procedure Process”.
- Ensure sufficient qualified staff, are available for unit activities including shutdown and start up.
- Oversee preparation of “Modification Available for Service (MAFS)”, N-PROC-MP-0090, “System Available for Service (SAFS)”, NK38-INS-09701-10005 and “RFS documentation”, NK38-INS-09701-10006.

3.3 O&M Functional support

NR O&M will continue to have project functional support responsibilities. These key responsibilities will:

- Provide O&M expertise to support project execution and completion.
- Provide support to NR projects in terms of assessing, work protection, and documentation requirements.
- Integration of procedures, processes, people and other key activities within NR and with the station as referenced in O&M transition plans:
    - NK38-NR-PLAN-09701-10003, “DR Integrated Workforce Transition Plan”.
    - NK38-PLAN-09701-10215, “DR Site Integrated Transition Plan”.
- Provide and coordinate procedure updates including reviews, validation, verifications and issuance as per NK38-GUID-09701-10003.
- Support integrating project schedules.
- Ensure standards of O&M are maintained.
- Ensure standards of safety (Nuclear, Chemical, Environmental and Radiological) are maintained.

4.0 BASIS AND ASSUMPTIONS

As part of the refurbishment, Operations & Maintenance organization will be established and will require changes to the “Power Reactor Operating License”, PROL 13.00/2015 and further changes to the “Operating Policies and Principles”, NK38-OPP-03600. The following sections include assumptions that have been made during this revision, and may require updating in the future as more information is known.

4.1 Return to Service Assumptions – 335 / 702:

- Planning and scheduling support (CSAs) services will be provided by NR Work Control.
- Specifications, Workplans, reports, and Available for Service (AFS) will be provided by NR Engineering and review will be provided by NR O&M.
- Incorporation of lessons learned and process improvements after completion of the first unit’s refurbishment.
- Sufficient clerical support will be provided to the RTS organization. The Release Quality Estimate (RQE) submission for RTS does not include budget for clerical support staff.

4.2 Operations Assumptions – 336/572:

- Only critical path work will be 20/24hx7d. As a result, during the low activity times of the outage operations Work Control Area (WCA) will not be staffed continuously. The control room execution team will service critical path work.
- Fuel Handling (F/H) support as per the Ops RQE budget will be required to support defueling activities prior to readying the Fueling Machines (F/Ms) for service and during the defuel sequence for approximately 120 days.
- Project Control Center (PCC) will not operate continuously. Full coverage times are currently estimated by Work Management to begin six months into the outage and during the final 9 months including Return to Service of the unit. This estimate has been included as part of the RQE budget.
- A shared services pool to support scope defining work for future units as previously requested will not be required.
- The NR Work Control Execution Team will be the resource pool for reviewing and executing RTS and commissioning work plans.
- Containment boundary will be managed in accordance with the “Containment Boundary Manual”, NK38-DBD-34280-00001.

4.3 Chemistry & Environment Assumptions – 338/599/600/601/602/603/605/606:

- Other Business Unit (OBU) Darlington chemistry laboratory FLM and technicians will be used to support sampling and analysis requirements of station systems and for environmental parameters on a continuous basis.

- During peak resourcing periods (i.e. shutdown and start-up) chemistry laboratory staff may be outsourced to meet project demands.

- The principles of the Environmental Management System (EMS) are explained in CAL 71044, “NR Environmental Awareness”. This CAL is a requirement for Project Managers to ensure they understand their roles, responsibilities and potential liabilities as per the EMS.

- Projects will evaluate the potential environmental impacts at an early stage using the “Environmental Impact Worksheet”, N-FORM-10422.

- Projects will follow and assume the accountabilities as described in “Nuclear Projects Environmental Requirements Guideline”, N-GUID-09701-10013.

- Report environmental activities or events (i.e. waste generated, chemical or radioactive emissions, spills) per regulatory requirements. Reporting will follow the appropriate procedures.

- Lay-up specifications approved by the Chemistry Design Authority are based on industry best practices and included in the “Darlington Refurbishment Chemistry Shutdown and Layup Specifications and Rational”, NK38-SPEC-09701-10032. These specifications have been developed in order to protect equipment from damage caused by poor chemical control (including the impact of foreign materials in the system).

- Operating Experience (OPEX) with the current ion exchange strainers have seen plugging of the screens with particulate matter from the Heat Transport System during normal operation. Back flushing these strainers is a common procedure that is followed to remove the blockages. During hot conditioning of the Heat Transport System all efforts should be made to ensure that particulate matter that is accumulated on these strainers is minimised.

- A procedure for adding hydrazine to the Heat Transport System using the portable hydrazine delivery system is required to ensure the safe addition of Hydrazine.

- Materials used on or in station systems are to be received "Contaminant Free" without any protective surface coatings as per, “Major Components Wipe Down: Cleanliness Requirements and Verification” NK38-REP-09701-10288.

4.4 Maintenance Assumptions – 339/610-611:

- Lessons Learned from the Unit 2 refurbishment will reduce the level of oversight from NR Maintenance of contract partners due to efficiencies gained when repeating same scope of work.
- Fuel Handling (F/H) support reflected in the Maintenance RQE budget will only be required prior to defueling to help with readying the Fueling Machines (F/Ms) for service and during the defuel sequence (approximately 120 days).
- The contractors responsible for installation of designated layup equipment during the Refurbishment Project will also be responsible to install, maintain and restore this equipment (not system) into and out of its layup state.
- Contract partner assigned to perform cyclic maintenance of equipment during refurbishment will also bundle where possible all work scoped for the U2 refurbishment. Unit 2 2016 outage work (D1621), specifically cyclic preventive, corrective and deficient maintenance type work must be scheduled together to reduce costs.

4.5 Radiation Protection Assumptions – 337:

- NR Radiation Protection (RP) Field Section will provide RP support following the Service Protection. NR contractors **will not** be trained to perform RP self protection.
- Critical path RP support will be continuous and non-critical path work will be days based coverage.
- NR RP department will be staffed with full time positions sufficient to provide ALARA, RP Programs and RP field support functions, including BTU Radiation Protection Coordinators and scheduling / assessing functions.
- Fixed RP instruments (not covered under Campus Plan or other infrastructure projects) will be procured by NR RP. Portable RP instruments will be procured utilizing a Service Level Agreement (SLA) with Corporate Health Physics.
- Training facilities and labour will be provided utilizing strategies as agreed upon with OPG NR Training.
- Radiation Protection Coordinator (RPC) resource requirements are based on review of DNRU2 Level 1 schedule and feedback from Joint Venture on their RPC needs. These estimates have been validated by NR RP. RPC labour rates are based on OPG rates. These resource requirements will need to be validated with all the NR Projects (BOP, Islanding, FH, S/L, SG, TG, etc).

4.6 O&M Programs Assumptions 517/518/519/525/609/660

- Budget reduction is anticipated for the refurbishment units following that of Unit 2. The second unit procedure budget estimate is 25% of first unit, and the third and forth unit procedure budget estimate is 10% of the first unit.

- Once the NO's are qualified, the station will release an equivalent number to NR. A minimum of 10 successful ANO's are assumed, with the station releasing qualified ANO's to NR while maintaining station numbers. A minimum of 7 successful SSIT's are assumed, with station releasing qualified SS's while maintaining station numbers.

- Validation of the assumption will be ongoing as TPAR submissions are received. The TPAR monitoring program will be used against the initial estimates to support validation. This is the basis for the current hiring but the assumption should be monitored to track validity and the need for more or less staff support.

- The PSC budget is an oversight budget with only core staff to provide flowsheets and tagging activities. Additional project funding to complete flowsheets and tagging work will be required if more work is identified than that which has been addressed in the assessment completed in Q3-2014

- Assumptions are all FTE’s will be posted in ‘Taleo’ (Web base recruitment program) and all expertise will be drawn in from within OPG. Staff not available from OPG; will be sought after thru Augmented Staff approach. This will result in additional cost.

5.0 STRATEGIES / INITATIVES

Overall, it is assumed the NR O&M department will be separate from the operating units and will assume controlling authority from the operating organization at breaker open of the refurbishment outage. The exception is Fuel Handling O&M work will be performed by Station. NR-OM will have the capability and resources to:

- Defuel, dewater and lay-up the unit to allow refurbishment.
- Support activities of refurbishment.
- Carry out maintenance activities during refurbishment.
- Commission and test modifications
- Restart and return systems to service
- Validate procedures
- Maintain PSC
- Return the unit to service.

It is assumed that the Power Reactor Operating License (PROL) changes will allow the complete isolation of the unit once the unit is defueled and dewatered. It is also assumed that minimum complement requirements will be unchanged although changes in the PROL will be initiated to change the requirements when fuel and heavy water are removed from the core and the unit is isolated from containment.

Detailed white papers and plans are prepared for each functional area in the O&M division, the key assumptions and strategies are:

5.1 Operations

- Authorized personnel are required to monitor unit and be present during major work, commissioning, and system turnover evolutions.
- Shift crew organization to monitor and respond to changing plant conditions
- Dedicated Work Control Area to service high level of activity for each unit under refurbishment.
- Maintain plant configuration management
- Heat Sink management
- Heavy Water management

- Assessing and execution section to provide assessing support and carryout and lead complicated evolutions (e.g. dewater, vacuum dry, refill, commission & start-up).

5.2 Maintenance

- Maintenance department will complete all preventive, corrective, deficient and other maintenance work not assigned to projects in the scope of Cyclic Maintenance Outage (D1621, D1921) using existing station staff in the following areas (MM, CM, Civil M, FIN, and assessing).

- The majority of work will be part of project work and maintenance staff will perform shutdown, start-up commissioning work, support work to project contract partners and emergent breakdown maintenance on unit SSCs and support items (Radiation monitors for staff, security equipment) to support easy access and egress to unit or site.

- We will develop critical internal resources (e.g. instrument and turbine control techs) for transfer of experience when the unit returns to normal operation

- Refurbishment unit Preventative Maintenance program review, accessing and submission of changes to Station PM Oversight Committee.

- Manage refurbishment waste management plan for all waste except reactor components being stored in flasks.

- Overall refurbishment Space Allocation and Transient Materials (SATM) oversight (including shops, lay down area, safe work areas trailers and other additional equipment related to allocation management)

- Maintenance organization will continue to support fleet maintenance initiatives and bring forward any proposed changes required due to refurbishment work execution.

5.3 Operations & Maintenance Common Strategies

- Key individuals will be assigned to each NR project to provide operations and maintenance support for the execution of that specific project.

- The individuals will have necessary support organizations and access to additional resources to meet the project needs

- It is anticipated that there will be a flow of resources from the main O&M organization as project needs vary.

- IPG and outage activities will be integrated into the refurbishment schedule.

5.4 Radiation Protection

- The Nuclear Refurbishment Radiation Protection Department will establish an overall radiation protection policy for the refurbishment project that will define the requirements for OPG staff and all contractors on site.
- All Nuclear Refurbishment work and activities shall be under the requirements and implementing procedures of the existing OPG Radiation Protection Program (N-PROG-RA-0013).
- The Nuclear Refurbishment Radiation Protection Department will provide support and radiological oversight of the NR projects to ensure a high level of radiation safety
- The Nuclear Refurbishment Radiation Protection Department will be staffed with full time positions sufficient to provide ALARA, RP Programs, and RP field support functions, including BTU Radiation Protection Coordinators.
- The OPG NR Radiation Protection Field Section will provide RP support following the Service Protection model of Radiation Protection. The NR contractors will not be trained to perform RP self protection.
- The Nuclear Refurbishment Radiation Protection Department will set challenging RP performance targets, such as collective dose, contamination events, etc, and monitor NR Contractors and OPG performance against these targets

5.5 Chemistry and Environment

- The Chemistry and Environment department will provide support to the refurbishment project and its contractors to ensure the asset is preserved and that the environment is protected.
- The Chemistry and Environment department will monitor, identify, and communicate non-conformances with the contractors and contract administrators to ensure that OPGN policies, procedures, and standards are followed.
- The Chemistry section will be accountable for chemistry control of the unit's systems that will be undergoing refurbishment and will provide support for the commissioning and RTS of that unit.
- The Chemistry section will provide oversight of chemicals being used and brought onsite and ensure that contractors' chemicals and other substances are on the approved supplier list by facilitating the assessments of these chemicals, as required.
- The Environment section will review and provide oversight of contractor work practices and environmental plans to minimize impact to the environment.

- The Environment section will provide support and input for determining waste stream allocation for waste generated as a result of refurbishment activities.
- The Environment section will provide support to assist with emergent issues.
- Chemistry and Environment will continuously improve processes and adopt efficiencies learned from the first unit's refurbishment.

5.6 Operations and Maintenance Programs

Centralized department that will handle:

- Staffing- includes workforce planning, O&M staff movement and controls
- SCR, CAP and Action Tracking function (including CARB, rapid trending, etc) for NR O&M
- Performance Improvements and Learning Organization tools including Human Performance (HU), Operating Experience (OPEX), Self Assessments (SA), etc.)
- Performance monitoring (including metrics and performance indicators) for deliverable such as O&M manuals, flowsheets, PMIDs and SCRs, action tracking and events
- Procedures section (large number of O&M procedure updates from NR modifications) updating operator and maintenance manuals as per N-PROC-AS-0028, "Development, Review and Approval of Technical Procedures".
- O&M procedural controls for systems not in normal operating conditions (e.g. laid-up or islanded systems) in the form of operation procedures and OPMs.
- Plant Status Control and ESM interface, including logs
- Document Change Requests (DCR) have been inputted to affected governance and we are tracking them to completion for reviewed and assessed governance (Specific NR and OPG interface).

5.7 Return to Service

- Start-up commissioning groups will be matrix organizations that have the necessary resources available from engineering, operations, maintenance and projects to take the lead on the development and execution of plans to commission modifications, restart systems and demonstration of unit readiness for service.
- N-COI-00120-00001, "Contractor/Owner Interface Requirements (COIR) for Nuclear", identifies the accountabilities for the contractor for commissioning activities. These accountabilities will be executed with support from NR O&M.

- The “RTS Management Plan”, NK38-NR-PLAN-09701-10001 Sht. 0003, describes the RTS organization. The structure of the RTS organization is based on OPEX from Pickering-A RTS, Point Lepreau Refurbishment, and Bruce Power Refurbishment. It is assumed that qualified individuals will be brought into role.

6.0 MILESTONE AND KEY DATES

This section lists the milestones and key dates in the work scope of NR O&M throughout the Darlington NR Program life cycle.

Milestone ID	Milestone Name	ACCOUNTABLE STRAT 4	MS Tier	Finish
OP-00-1410	Conduct of OPS Review and Approve Governance Changes	MCCORDR	4	14-Oct-15
OP-00-1440	Emergency Preparedness Procedures Issued, Training Requirements identified and Drill Preparation Complete	MCCORDR	5	15-Dec-15
PG-00-1504	Issue Operator Rounds Program REV 0	DANCEM	4	1-Apr-16
OP-00-1510	Final Work Orders Assessing Complete	MCCORDR	4	15-Apr-16
MC-00-1450	Maintenance - U2 CM's & DM's - Non Outage - WO's - Assessing - Complete	VANHORT	3	15-Apr-16
OP-00-1601	OPS - Fully Functional Work control Area with Remote and Wireless Audio/Video Communications network created	MCCORDR	4	29-Apr-16
OP-00-1602	OPS - Fully Functional Work Protection & Authorization Process with Resources assigned, hardware functioning	MCCORDR	4	31-Aug-16
OP-00-1513	Operator FH Training	MCCORDR	4	1-Sep-16
OM-00-1699	O&M Infrastructure in place	VULCANB	4	15-Sep-16
MC-00-1455	Maintenance - U2 PM's - Non Outage - WO's - Assessing - Complete	VANHORT	3	30-Sep-16
OP-00-1523	ANO Training	MCCORDR	4	3-Oct-16
OP-00-1700	Turnover of NR Unit Operating Authority	MCCORDR	4	16-Dec-16
ST-00-1601	All Commissioning and Restart Instructions Complete	STEWARTM	5	30-Dec-16
MC-00-1480	Maintenance - U2 CM's & DM's - Outage - WO's - Assessing - Complete	VANHORT	3	1-Dec-17
ST-00-1701	Unit 2 RTS assessments Complete	STEWARTM	5	4-Dec-17
OP-00-1710	Pre Start Up WANO Review	MCCORDR	4	16-Apr-18
MC-00-1485	Maintenance - U2 PM's - Outage - WO's - Assessing - Complete	VANHORT	3	1-Nov-18
RP-00-1601	Refurbishment ALARA Plans and Work Plans Approved	SCHAEFEJ	4	1-Jun-16

7.0 MAJOR WORK SUMMARYS

#	Major Work Areas Operations and Maintenance	Owner
1	Licensing, PROL and OP&P changes	Manager NR Operations
2	Unit turnover	Manager NR Operations
3	Transition, Ownership Transfer and Program Mgmt Plans	All O&M division
4	Maintenance Strategies for laid up and operating systems	Manager NR Maintenance
5	Develop RTS Logic and schedule	Manager NR RTS
6	Construction Complete Declaration strategies	Manager NR RTS
7	Integration of outage and IPG scheduling into the NR program.	Manager NR Work Mgmt
8	Commissioning and Return to Service strategies	Manager NR RTS
9	Organizational Staffing and resource requirements.	Manager NR Programs
10	Work authorization and work protection	Manager NR Operations
11	Facilities in operations and maintenance staff.	Manager NR Programs
12	Readiness for outage execution	Manager NR Programs
13	Plant Status control and Tagging	Manager NR Programs
14	Documentation to support O&M Execution and Projects	Manager NR Programs
15	O&M Tech Procedure updated as per design Modifications	Manager NR Programs
16	Operational Flowsheets Updated and Issued as per design	Manager NR Programs
17	Execute VBO, D1531, and D1641 outage work as part of Refurbishment Work Preparation	Manager NR Maintenance
18	Plan cyclic maintenance work programs	Manager NR Maintenance
19	Lead-in logic development and sequencing	Manager NR Operations
20	Coordinate the prep, review, and approval of system RTS specs	Manager NR RTS
21	Radiation Protection Plans	Manager NR RP
22	Hire, train, and qualify RP Coordinators to support field work	Manager NR RP

8.0 RISK AND OPPORTUNITIES (AS OF AUG 13, 2015)

8.1 RISKs

ID	Title	Risk Delegate	Risk Response Type	Current Score	Post Score
677	Availability of DN Authorized Staff for Station and Refurb Support	MCCORD Ross - NUCLEARREFUR	Mitigate	10	6
565	Insufficient Qualified Radiation Protection Coordinators (BTU) to support Execution	SCHAEFER Jeff - NUCLEAR	Mitigate	9	6
706	Present ERT mini-COMS plan does not accommodate for and Islanded Unit while meeting adequate response time to emergent events	VAN HORNE Tom -NUCLEARREFUR	Accept	9	2
708	Materials budget for emergent broke-fix maintenance during Shutdown, Layup and Run-up is not included in MTCE budget.	VAN HORNE Tom -NUCLEARREFUR	Monitor	9	9
718	The Cyclic Maintenance budget may not have enough funds (Labour & Materials) to cover Shutdown Maintenance Backlog	VAN HORNE Tom -NUCLEARREFUR	Monitor	9	9
748	Transition/Transfer Plan commitments not met (Ops & Mtce Readiness)	MCCORD Ross - NUCLEARREFUR	Monitor	9	9
564	Large Potential Worker Doses due to Inadequate Internal (Alpha etc.) Hazard Characterization and Management	SCHAEFER Jeff - NUCLEAR	Mitigate	6	4
747	Installation & Commissioning of PSVS project not resourced to meet CNO Milestone	VAN HORNE Tom -NUCLEARREFUR	Monitor	4	4
728	Acute Tritium Release above the station IIL during NR Primary Side Drain and Dry Operation.	DALY Roger - NUCLEARREFUR	Monitor	8	3
555	Project related fire during Execution phase	VAN HORNE Tom -NUCLEARREFUR	Monitor	6	2
676	Inadequate D2O Storage Capacity to Accommodate Station and Refurb Requirements	MCCORD Ross - NUCLEARREFUR	Mitigate	6	1
724	Chemistry Control Procedural Review Risk	DALY Roger - NUCLEARREFUR	Monitor	5	3

597	Reactor Safety Incident Impacts Refurbishment	MCCORD Ross - NUCLEARREFUR	Mitigate	4	2
758	Chemistry Laboratory Support Short of Resources	DALY Roger - NUCLEARREFUR	Monitor	10	3
759	Defuel Cost Could Increase	MCCORD Ross - NUCLEARREFUR	Mitigate	3	3
765	Civil Functions to support Radiation Protection EPC Breakout	Van HORNE Tom - NUCLEARREFUR	Monitor	4	4
767	O&M Procedure Update Program may not have sufficient Funding	Dance Mike - NUCLEARREFUR	Monitor	3	3

8.2 Mitigating Actions Update

ID	Title	Action Owner	Description	Due Date
1484	Mitigating action #2 from risk 597	MCCORD Ross - NUCLEARREFUR	Manage the issues as they arise to prevent them from becoming events: • When there is a nuclear safety issue that warrants “Stop Work”, there is a clear line of authorization to do so. • When there is a “Stop Work” there is a clear line of authorization to resume work. • A systematic approach to problem solving provides a logical method for resolving everyday issues. • Significant Issue Resolution (SIR) process is on standby and used effectively. • EDM and ODM process are used when required. • Management and contractors are engaged and receptive to issues being raised so they can be solved before they become events. • Lines of communication to external oversight bodies, regulatory authorities and contract companies are clear and have been set in advance.	20-Oct-15

1471	Mitigating action #3 from risk 676	MCCORD Ross - NUCLEARREFUR	Mitigation of Risk to Darlington Refurbishment Options to address the risk to Refurbishment include: 1. Review of D2O Storage Project schedule and risks to determine what OPG support may be required to ensure the EPC vendor meets the AFS date-(ongoing by D2O Storage Building project Management team) 2. Within the Refurbishment window, immediate transport of drained moderator and/or PHT D2O to offsite storage (i.e. Pickering) with simultaneous drumming due to limited offsite storage. A significant outage delay may result Note, development of any options has not been completed. 3. Develop an alternative strategy to negate the requirement for a D2O swap and go instead to a complete drain of the moderator followed by 3 fill, recirc, sample and drain cycles totalling 100 Mg light water. This strategy would negate the requirement for the development of swap water but would increase the volume of low currie low isotopic D2O that needs to be handled by the upgrader once the flush is completed. It is unknown at this time what affect this might have on cost and schedule. Meetings and strategy planning are underway with a mid May target to have this alternate strategy presented.	30-Sep-15
2505	Planned inspections for yard drainage inside the PA	DALY Roger - NUCLEARREFUR	Previous OPG and external contractor storm water studies have been reviewed to identify sample locations and key sample parameters. Draft scope for storm sewer cleaning to be used to develop a budget cost estimate for the work has been prepared. This cleaning is a prerequisite activity for the monitoring programme. Draft Project Requirements scope document for the storm sewer cleaning and inspection have been prepared. The next step will be to engage with the contracts management organization to begin the bid process.	11-Dec-15
1481	Mitigating action #12 from risk 677	MCCORD Ross - NUCLEARREFUR	Remediation Plan (Plan B) For refurbishment, key positions are being filled by Darlington previously licensed contract staff. Plan B requires that augmented staff previously licensed at other CANDU stations be used where necessary. Although this strategy is not optimal it partly mitigates the shortfall risk as a larger pool of previously licensed staff is available for use in the refurb planning phase. This strategy may need to be extended into the execution phase of the refurb project. An agreement is in place between the station, training and refurb on the placement of contract staff previously licensed at Darlington to ensure qualified augmented staff is placed as priorities dictate. Preparations are underway to staff the refurb unit with non licensed staff once fuel and D2O has been removed. This could allow the refurb ANO to perform other refurb duties (such as IA) while non licensed staff monitors the unit thus increasing the availability of currently authorized staff for refurb execution.	30-Sep-15

1485	Mitigating action #3 from risk 597	MCCORD Ross - NUCLEARREFUR	Mitigate events when they occur: • When an event occurs, there is training, procedures and practice in handling events, thus the event is handled in a manner that mitigates the severity. • Contracts have been structured to mitigate the risk exposure to OPG. • Lines of communication to external oversight bodies, regulatory authorities and contract companies are clear and have been set in advance.	15-Dec-15
3596	Finalize Moderator Flush Options	DALY Roger - NUCLEARREFUR	Lowering tritium emissions is dependent on the number of light water flushes used after moderator D2O is drained. The decision on how many flushes can be done needs to be finalized. Ops Manager has agreed to lead this meeting for a final decision on this matter.	15-Nov-15
3822	Performing PMT	VAN HORNE Tom - NUCLEARREFUR	Activity: Perform PMT. Issues: If PMT requires system operation, how is the necessary PMT action going to be identified, tracked, scheduled and executed? (If a Passport WO is closed, but PMT remains in vendor schedule, we have a tenuous hold on a test process that's required by Licence.) Action: 1) Review SOW expectations 2) Discuss PMT & PMT tracking at DITL 3) consider mod to SMP to cover more details	15-Nov-15
3599	Ensure Moisture Removal Skids Meet Requirements	DALY Roger - NUCLEARREFUR	Check that moisture removal skids have sufficient capacity to remove the required moisture and water and thereby eliminate as much as reasonable possible the excess tritium inventory. DCAVR scheduled for Aug 31 currently. This will be the final stage for verification to take place.	15-Sep-15
3732	Maintain Flow through VVRS throughout PHT drying.	DALY Roger - NUCLEARREFUR	Flow through VVRS dryers needs to be maintained until PHT drying is complete in order to keep emissions in check. Calculations from the "Joint Venture" credit the dryers to keep emissions under target. However removal efficiency may be lower in real life circumstances than assumed in calculations. VVRS flow must therefore be maintained throughout PHT drying, in order to stay as close to target (1000 Ci/yr) as possible before flows through the dryers are reduced to support other vault work.	8-Dec-15
3600	Spill Kit or Cart	DALY Roger - NUCLEARREFUR	A spill kit or spill cart is required with capability to quickly deal with a heavy water spill in the work area.	31-Dec-15
3601	Fabricate Plastic End Fitting Caps	DALY Roger - NUCLEARREFUR	Fabricate and Install Plastic End Fitting Caps to capture any Tritiated type water that could leak from the end fittings.	31-Dec-15
3753	Finding a Breathing Air Hose	VAN HORNE Tom - NUCLEARREFUR	Activity: Find a breathing air hose Issues: Will we have a "hose in/hose out" rule? (Unknown) Do we have enough hoses? (No) Will we have hose stands outside the vault? (Likely yes) What's the plan for cleaning, testing and returning air hoses? (Part of RP contract) Action: Ensure all breathing air hose management processes are defined and assigned.	15-Feb-16

3820	Testing a Motor/Pump	VAN HORNE Tom - NUCLEARREFUR	Activity: Test run, the motor/pump. Issues: 1) For what motors will we want simple megger testing? For what motors would we perhaps want something more complex (Baker test?) Who decides? What assurance does Operations have when they go to through the breaker that it won't blow up and how is that provided? 2) What tests are we anticipating we need to run when we place a pump back in service? When will we want vibe monitoring, run-out checks etc? When would we want normal Operational checks vs. pump curve verification? Who decides? How is that established? (PMT vs. Commissioning vs. simple operational start-up.) 3) Is this another ""Whose QA manual?"" question? Action: Currently not expecting much vendor involvement. Action - Ops, Mtce, Outage review RTM expectations and verify start-up strategy.	15-Nov-15
1306	Issue Action	STEWART Mike -PICKERING	The Plan actions are part of the Operational Readiness Comprehensive Plan - to be issued closer to BREAKER CLOSED milestone.	30-Jun-16
4929	Vendors Authorization to perform CWP's.	STEWART Mike -PICKERING	Action: Vendors will be producing Comprehensive Work Plans to their own quality processes. OPG has processes that require approved work plans to authorize certain kinds of work. This action is to establish a process for getting authorized to perform work on vendor CWP's or other documents. The intent is, to the extent possible, to use the vendor’s material as the basis for authorization, recognizing that this means that some established review process may be required in order to ensure that work is of authorization quality.	15-Jan-16
5393	Prepare the D2O spill mitigation plan	MCCORD Ross - NUCLEARREFUR	Prepare a decision making matrix which provides the appropriate response strategy in the event of a significant HTS leak while still disconnected from Containment. This strategy will incorporate lessons learned from a review of Pickering OPEX. It will address procedures to be completed with respect to open airlock doors configurations and the impact of those configurations on releases and will assess feasibility of airlock door closure prior to initiation of key evolutions such as PHT D2O fill and PHT hydrostatic testing.	31-Aug-15
5394	Confirm spill strategy alignment with Spills analysis	MCCORD Ross - NUCLEARREFUR	Confirm that the mitigation strategy and the timing for airlock door closure in event of accidents are consistent with the potential release volumes and rates.	15-Oct-15
3811	Chemistry Control Procedural Review Risk	DALY Roger - NUCLEARREFUR	Link Chemistry Control Manual and Chemistry Laboratory Procedures preparation TCD to the milestone in P6 schedule. Coordinate NR Work Plans review with Chemistry Control Manual and Chemistry Laboratory Procedures preparation.	14-Sep-16
5373	Produce NEW BTU RPC in 2015	SCHAEFER Jeff - NUCLEARREFUR	As per the plan for 2015 interview, hire , and train BTU Trades to the level of Green Badge. A key problem will be providing the Yellow Badge "RPC apprentices" with sufficient radioactive work.	15-Dec-15

5119	Functional Review Meeting - Maintenance field oversight	VAN HORNE Tom - NUCLEARREFUR	In consultation with Ken Hobbs, determine if 7 FTEs of Maintenance field oversight can be reduced due to overlap with Execution resources. Submit revised estimate template as required.	30-Sep-15

8.3 Opportunities (Continuous Improvements)

The continuous improvement of the plans and processes is a value established and performed by NR O&M. These are constantly being reviewed and challenged for advantages for cost savings, added value or quality and of course saving time. O&M will do this through oversight of all O&M staff on the Refurbishment Project looking for duplication of efforts, process improvements to reduce time to get required work done, and where needed put in the rigor for quality work overall during the Refurbishment Project of Darlington.

The staffing strategy is strategically set up to reduce resourcing requirements after the first unit is refurbished. Once the level of support is clearly defined and new processes are in place and proven for the first unit, then staffing will be streamlined accordingly for subsequent units.

Here are some other examples of these saving, already implemented and sorted by each department.

8.3.1 O&M Programs (Procedures)

Technical Procedure Process: This could have been completed any of 3 ways. The choices were to create a project team with an NR oversight group, or an Owner Support Service (OSS) type contract with and oversight group or thirdly, do the procedures in house with augmented staff. Both first and second choice had an oversight team. While this increases the rigor of the process it does greatly increase the overall cost. By implementing in house approach, this was weighed with >10 million in savings. This tells us that the augmented staff approach does have refurbishment project best interest in mind when implementing strategies.

8.3.2 Operations

Throughout the design process operations personnel are engaged in reviews with respect to the constructability, operability maintainability and safety (COMS) of the proposed modifications or conceptual designs. Additionally operations inputs into the preparation and maintenance of the execution schedule. The major focus of this input is to continuously improve NR products with respect to cost, value and time.

8.3.3 Maintenance

The initial project of PSVS modifications for NR discovered issues that will be captured for future projects. Of particular note was the need for an Online Wiring SME attached to maintenance to assist with the commissioning of new systems.

8.3.4 Chemistry and Environment

One of the environmental sustainability initiatives is 2500 m3 of bedrock from the D20 Project excavation was moved for re-use to St. Mary's cement company as a resource. This saved the project $ 204 K and serves as a great example of environmental sustainability.

A natural resource (rock) that would normally have been managed as waste was instead re-used in the cement making process. The benefits of this approach are numerous: less transportation costs due to shorter distance travelled, no off-site truck traffic reaping community impacts, less truck emissions (diesel), no tipping fees (cost),off-site land is not being consumed (landfill) and the resource is being used to benefit society (cement).

8.3.5 Radiation Protection

Use of already existing OPG Radiation Protection Program:

Based on industry feedback, and OPEX from previous Nuclear Refurbishments, it was decided early that the OPG Radiation Protection Program would be utilized and implemented for the Nuclear Refurbishment Execution. As the OPG Radiation Protection Program is an established program, with many years of OPEX and Lessons Learned providing strong fundamentals, it eliminated the need to develop and implement a separate RP program for Nuclear Refurbishment execution

8.3.6 Return to Service

Return to Service plans to use existing operating processes, tools, and aids as much as possible during the start-up of a refurbished unit. The advantages of basing the start-up of a unit on a typical outage are:

- Familiarity of existing processes, tools, and aids by operating personnel
- Minimization of training on new processes, tools, and aids
- Reduction of error likely situations by avoiding unnecessary duplication of processes, tools, and aids
- Cost savings by reducing the creation of new infrastructure

9.0 PERFORMANCE MEASUREMENT AND REPORTING

Refer to performance mgmt guide N-GUID-09701-10119.

For metric and reporting this is done by the O&M Programs department who are responsible for all metrics and reports. There will be metrics for each deliverable for each department. They will also create required reports for each department and an overall dashboard of the O&M department as a whole to give a summary of work and issues that O&M can report and give status to all the required parties within refurbishment and our overseers outside of refurbishment. Here are a few specifics:

- Support the NR-Director of Operations and Maintenance (DOM) in the preparation and communication of business planning inputs, dashboards, budgets, and divisional and departmental work programs.
- Support the NR-DOM with the provision of effective corrective action program support to the management of the NR – O&M organization. Effective support for internal and external review bodies as required.
- Ensure the provision of effective Corrective Action Control Group services for NR O&M, including:
    - Root cause analysis services.
    - SCR processing, trending, and reporting.
    - Performance metrics on the overall health of the process.
    - Action tracking processing, trend analysis and follow-up.
    - Investigation of abnormal events.
    - Performance reporting and accounting.
    - Self Assessment (SA) coordination, control and follow-up.
- Participate in or coordinate benchmarking visits and implementation of lessons learned.
- Assess the most significant events (Level 1 and 2 internal events) to ensure the events are evaluated and corrective actions by NR-O&M departments are effective, including:
    - Provide insight on areas of performance strength and opportunities for improvement to the management of NR- O&M organization based on internal assessments.

- Coach Managers and on expectations and behaviours to effectively drive Corrective Action Plan (CAP) as core business.

- Develop, monitor, and maintain metrics for performance improvement programs and processes that enable NR-DOM and the direct reports to effectively monitor and make necessary changes to improve performance and achieve business results.

10.0 RESOURCE PLAN

The transition of units, work programs and staff between the station and refurbishment are planned and controlled by the 'Site Integrated Transition Plan', NK38-PLAN-09701-10215, and 'Integrated Workforce Transition Plan', NK38-NR-PLAN-09701-10003.

10.1 Operations - NR

For operations section organization and staffing plan refer to NK38-PLAN-09701-10113-OPS-01, "Operations – Ownership Transfer Plan" and Partnership agreements NK38-REF-09701-0520345(Ops) and NK38-REF-09701-0520346(FH).

10.2 Maintenance – NR

For maintenance section organization and staffing plan refer to NK38-PLAN-09701-10113-MTC-01, "Maintenance – Ownership Transfer Plan" and Partnership Agreement.

10.3 Operations and Maintenance Programs – NR

The programs department is split into 3 sections which are Procedures, Plant Status Control and Strategies and Staffing.

For the programs department organization and staffing refer to the following ownership transfer plans:

- NK38-PLAN-09701-10113-PGM-01, "O&M Programs Ownership Transfer Plan".
- NK38-NR-PLAN-09701-10003, "Integrated Workforce Transition Plan".

10.4 Return to Service – NR

- For RTS department organization and staffing plan refer to NK38-NR-PLAN-09701-10001 Sht. 0003, "Darlington Refurbishment Return to Service Program Management Plan".

10.5 Radiation Protection - NR

- For Radiation Protection Organization and Staffing Plan refer to NK38-PLAN-09701-10113-RAD-01, "Radiation Protection – Ownership Transfer Plan".

10.6 Chemistry and Environment –NR

- For chemistry and environment department organization and staffing plan refer to NK38-PLAN-09701-10113-CHE-01, “Chemistry and Environment – Ownership Transfer Plan”.

11.0 PURCHASED OR NON PURCHASED SERVICES

Purchased or Non-Purchased services and costs are detailed within each department Ownership Transfer Plans.

Some example of services required or purchased are the following:

- Bulk Laundry Monitors
- ESMII database program update
- ESMII terminals
- Tag Printers
- Full Color Printer dedicated to programs procedure section
- SharePoint TPAR database creation
- Double Screen set up for Technical Writers
- Ground Test Devices
- Electrical Racking Tools
- Work Protection Locks
- Work Protection Tags
- Waste Bag Monitors
- 6-8 storage filing cabinets to store O&M procedure packages.

12.0 REFERENCES

[R-1] NK38-PLAN-09701-10113-OPS-01 – OPERATIONS OWNERSHIP TRANSFER PLAN

[R-2] NK38-PLAN-09701-10113-MTC-01 – MAINTENANCE OWNERSHIP TRANSFER PLAN

[R-3] NK38-PLAN-09701-10113-RAD-01 – RADIATION PROTECTION OWNERSHIP TRANSFER PLAN

[R-4] NK38-PLAN-09701-10113-CHE-01 – CHEMISTRY AND ENVIRONMENT OWNERSHIP TRANSFER PLAN

[R-5] NK38-NR-PLAN-09701-10001-0003 – DARLINGTON REFURBISHMENT RETURN TO SERVICE PROGRAM MANAGEMENT PLAN

[R-6] NK38-REF-09701-0520344 - MAINTENANCE PARTNERSHIP AGREEMENT

[R-7] NK38-REF-09701-0520345 - OPERATIONS PARTNERSHIP AGREEMENT

[R-8] NK38-REF-09701-0520346 - FUEL HANDLING PARTNERSHIP AGREEMENT

[R-9] NK38-MAN-09701-10009 – BOUNDARY POINT PROCESS MANUAL

[R-10] NK38-REP-09701-10141 – WHITE PAPER – DARLINGTON REFURBISHMENT – OPERATIONS MEMO

[R-11] NK38-REP-09701-10139 – WHITE PAPER – DARLINGTON REFURBISHMENT – OPERATIONS AND MAINTENANCE PROCEDURES

[R-12] NK38-GUID-09701-10003 – NUCLEAR REFURBISHMENT O&M PROCEDURE PROCESS

[R-13] N-GUID-09701-10120 – GUIDELINE FOR CONSTRUCTION OVERSIGHT

[R-14] N-PROC-AS-0028 – DEVELOPMENT, REVIEW AND APPROVAL OF TECHNICAL PROCEDURES

[R-15] N-PROC-MA-0012 – WORK PROTECTION

[R-16] N-COI-00120-00001 – CONTRACTOR/OWNER INTERFACE REQUIREMENTS FOR NUCLEAR

[R-17] NK38-NR-PLAN-09701-10003 – DALINGTON REFURBISHMENT INTEGRATED WORKFORCE TRANSITION PLAN

[R-18] NK38-PLAN-09701-10215 – DARLINGTON REFURBISHMENT SITE INTEGRATED TRANSITION PLAN

ONTARIO POWER GENERATION

Plan

Internal Use Only General Business	
Document Number: NK38-PLAN-09701-10223	Usage Classification: N/A
Sheet Number: 0008	Revision: R000

Title:
FUNCTIONAL MANAGEMENT PLAN - PROJECT PLANNING & CONTROLS

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Functional Management Plan - Project Planning & Controls

NK38-PLAN-09701-10223-SHT0008-R000
2015-08-25

Order Number: N/A
Other Reference Number:

Internal Use Only
General Business

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Revision Summary

Revision Number	Date	Comments
R000	2015-08-25	Initial issue.

1.0 PURPOSE

The purpose of this Management Plan is to clearly define the planning assumptions, strategies, structures, roles and responsibilities, and major work programs associated with the provision of the Project Planning & Controls (P&C) functions for the Nuclear Refurbishment (NR).

This Management Plan has been updated to represent the functional estimates being proposed for the Release Quality Estimate (RQE) noting that the organization will transition from the Defintion Phase to the Execution Phase through the end of 2015 and into 2016; and as such, P&C will shift organizational focus from planning and establishing governance, tools, and processes, to monitoring project performance through the use of project controls metrics, reporting, monitoring, and quality assurance. Key roles and the shift is captured in the following table:

Functional Area	Definition Phase "Plan the Plan"	Execution Phase "Work the Plan"
P&C Director Office	• Executive level oversight of P&C Function • Strategic Planning (Business Plan, OEB, Contracts, etc.) • Oversight of Definition Phase and RQE Development • Oversight of P&C Leads • P&C Support for FIP/SIO Projects	• Executive Leadership of P&C Function and NPET • Strategic Planning for Future units • Business Planning and OEB/External Stakeholder support as required • Establish and oversee Execution Phase Project Controls Office • Perform stakeholder management function for Darlington Refurbishment
Scheduling	• Develop Standards and tools • Develop Program Master Schedule and Unit 2 Schedule • Schedule Management of Definition Phase (PV, Milestones)	• Maintain Program Master Schedule • Manage integration of multiple vendor schedules, oversee quality of schedules and adherence to standards • Strong interface with Work Control to manage Unit Schedule against approved baseline • Oversight of key milestones and metrics
Cost Management	• Develop Standards and tools • Manage Scope Process (PSRB) • Develop independent estimates, assess vendor estimates and classify for RQE • Manage Gating Process • Cost Management of Definition Phase including FIP/SIO projects	• Manage project cost system against approved baseline including analysis, earned value, and forecasting. • Administer integrated change control process for all types of change, including scope, cost, schedule, etc. • Perform cost engineering and estimating in support of change control process. • Develop check estimate for subsequent units through validation of actual from previous units and validation of vendor estimates.
Reporting	• Develop Standards and tools • Establish reporting framework • Identify Metrics required for	• Support stakeholder management functions • Develop Execution Phase reports and

Functional Area	Definition Phase "Plan the Plan"	Execution Phase "Work the Plan"
	Execution and establish framework to develop	metrics on a priority basis during Unit 2, and sustain through subsequent units. • Issue and publish all require metrics/reports to all levels (project, unit, program, executive, board, stakeholder) • Maintain data model and integrated reporting database
Risk Management	• Develop Standards and tools • Collect Lessons Learned and monitor implementation in Refurbishment • Initial risk assessment for all projects and bundles; quantify contingency and float and baseline. • Quarterly ROC Meetings.	• Provide project level risk management oversight and analysis including Risk Register (RMO). • Perform monthly Program Level risk review and report to the Risk Oversight Committee • Perform adhoc risk assessments in support of change management • Manage overall contingency and float drawdown against baseline established at RQE

2.0 MISSION

The Project Planning & Controlsmission is to support NR through the establishment and application of project controls at the project, unit, and program level and perform stakeholder management functions through effective project level, executive level, and external project performance reporting.

P&C will deploy efficient and effective standards within the OPG governance and based on industry standards (i.e. PMI, AACE).

The organization will be integrated with project teams, however, also act as an objective assessing organization through reporting and oversight of project controls activities on projects. To do this, P&C will support the project teams on the standard application and use of tools that will collect data in a consistent way and enable traceable and transparent reporting for all metrics, reports, etc. at the required intervals. P&C will also perform selected oversight of vendor and project activities, i.e. quality review of schedules, earned value methods, forecasting techniques, risk management activities.

3.0 SCOPE AND RESPONSIBILITIES

The scope of P&C includes traditional project controls functions including:

- Scope Control
- Planning
- Governance assurance and gating
- Cost Management
- Estimating
- Earned Value Management
- Forecasting
- Reporting and Metrics
- Change Control Management
- Risk Management

The P&C organization also includes funding for IT development (for all functions) and document management clerical support.

The P&C organization also includes certain stakeholder or strategic planning functions executed by the P&C Director and the Program Management Office as required. This includes:

- Decision analysis and support
- Stakeholder Reporting and presentations
- OEB support
- Business Planning Support and interface

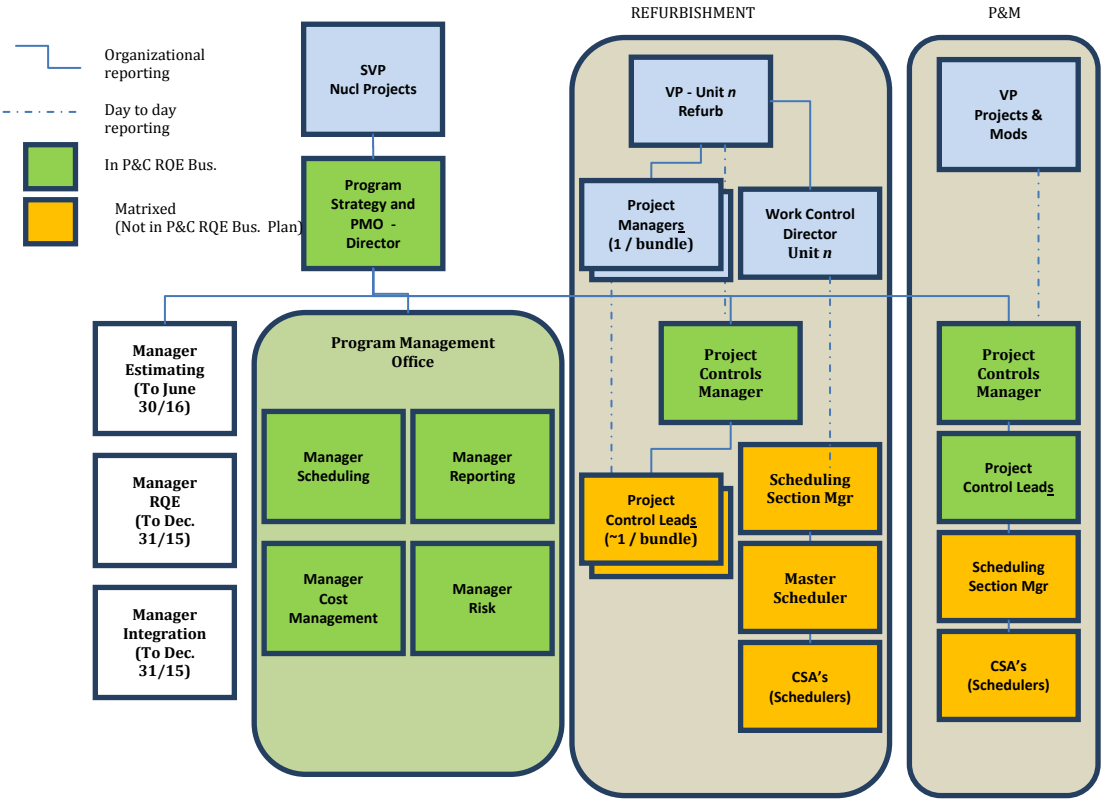
For each of these areas, P&C has developed procedures (including guides, templates, etc.) and tools. P&C will continue to provide direct support and guidance to execute the Refurbishment project through all life cycle phases. For some of the areas noted above, P&C is also responsible for executing day-to-day processes and systems transactions to ensure quality and integrity of NR data is maintained to support decision making and effective Program, Unit, and Project reporting.

P&C will be resourced using the Project Direct (matrixed) model, however, to achieve common standardization, cost efficiencies, and program level oversight, will also resource as Project Indirects and Functional, as summarized on following page.

Project Directs	Project Indirects	Functions
• Project Controls Office • Project Control Integration • Project Controls Lead • Scheduling Support	• Risk Management • Project Reporting and Metrics Management • Cost and Change Management • Governance and Gating •	• Standards • Program Reporting • Program Planning • Strategic Planning and Decision Support

As each project progresses through it's phase of the overall execution plan, Project indrects would be assigned to support that segment, i.e. Defueling is a ~ 113 days in length (approx. 10% of total project duration), additional staff would support this project during this period, and, transition to other projects once this activity is complete. During dual unit periods, project indirects would also be spread across both units to gain some economies of scale.

P&C, in utilizing a strong matrix model, is organized in the following manner in order to execute the full scope of major accountabilities as listed below:



The P&C Group has adopted this organizational concept for several reasons. First, it allows for unambiguous identification of accountability both for project management and for the support of project management. Second, it provides an environment for project managers to exert initiative when solving problems. Third, it promotes efficiency in resource allocation through the tailoring of the independent project delivery teams. And fourth, it facilitates the flow of information needed for prudent portfolio and program management.

4.0 BASIS AND ASSUMPTIONS

The Project Planning & Controls Management Plan has been constructed in accordance with the program planning assumptions contained within the Darlington Refurbishment Program Charter supported by the specific Release 4d Planning Assumptions as documented in AIDA. The Management Plan will be further updated, as required, for alignment with the RQE estimate assumptions Specific assumptions and constraints related to the provision of Refurbishment P&C support include:

- Deployment of P&C resources will be consistent with the NR model:
  - Functional resources required to define, document, administer, and monitor standards, processes, and tools will be maintained in a central functional group
  - Resources deployed to execute expert P&C functions will be matrixed to projects where possible, or allocated as shared service resources where dedicated FTEs is not appropriate.
- Functional support resource levels will vary over the life cycle of Refurbishment in accordance with the following assumptions:
  - Standards, processes, procedures, and roles and accountabilities will be established during the Definition Phase of the program, with resource levels consistent with the maintenance and monitoring of functional infrastructure provided over the remaining phases of the program.
  - Tools shall be established and implemented during the Definition Phase to support the full life cycle requirements of the program. Software tools will be established with the intent that they are stable, sustainable platforms for the life of the program, with only typical maintenance required.
  - Tools are assumed to be integrated, automated, and optimized to the extent possible to support Refurbishment work programs.

- Resourcing strategies will be optimized to provide optimum value to OPG. OPG resources will be utilized consistent with life cycle business requirements and labour agreements where applicable. Contract resources will be utilized to meet short and medium-term needs using contracting models that optimize value-for-money for OPG.

- Formal estimating services to support project scopes of work will be maintained as a separate function, utilizing OPG staff in accordance with the resource table identified in Section 10.4 supplemented by contract staff as required. This organization will be independent until Unit 2 check estimate (mid 2016) at which time it will be consolidated with the Cost Management function.

- Project scheduling services will be provided from the Work Management department within Unit 2 Execution starting in January 2015, with all scheduling matrixed resources to be centralized within the Work Management department. P&C will maintain a small functional capability for the remaining program life cycle.

- The Analyst resources supporting cost management of Program, Functions, and Projects will be centralized in the P&C Cost management department commencing Q3 2015 in order to ensure specific focus on cost monitoring, cost control, and change control (specifically from the cost perspective) during the entire Refurbishment Execution period.

5.0 STRATEGIES / INITIATIVES

During the final year of the Definition Phase leading up to the Release Quality Estimate, several P&C infrastructure initiatives will be completed to enable effective project management and control over the program life cycle.

These initiatives include:

- Scheduling Initiatives: Improvements to the scheduling software, coding, and reporting of P6 data via the Business Intelligence (BI) data warehouse will improve the quality of schedules, integration with vendor schedules and monitoring and reporting capabilities.

- Cost Management: Improved Cost Management software functionality, automated change management, and commitment tracking will be implemented to enable more effective and efficient cost management. Additional improvement and streamlining of Cost Management and Change Management processes will also continue in 2015 to make the processes ready to support the Execution phase.

- Reporting & Metrics: Improvements to Business Intelligence (BI) reporting capability, and integration with the Integrated Database (IDB), will facilitate the implementation of a comprehensive, web/SharePoint-based metrics platform. This will enable Refurbishment to more effectively track performance and proactively manage the program.

- Risk Management and Oversight (RMO): RADAR, AIDA, OPEX, Lessons Learned and Oversight Findings and Plan SharePoint logs will be consolidated into one application called the Risk Management and Oversight (RMO) Tool. The RMO is a web-based software product similar to that of the SCR system. This software will show the interactions of all logs in a dashboard view, simplify use, reduce the inefficiencies in defining and looking for relationships between log items and ultimately benefit the user, owners and teams.

- Estimating Software Platform: Implementation of industry-standard estimating software to support project and program level cost estimates is critical to achieving a comprehensive, quality set of products for the Release quality Estimate (RQE) submission and Check Estimate requirements.

- Governance Consolidation/Simplification: Streamlining of P&C governance and guides, along with the production of a comprehensive “playbook” that integrates P&C process direction at a user level, will improve the organizations ability to effectively and efficiently apply project Planning and Project Controls.

6.0 MILESTONE AND KEY DATES

The following table lists the program level Tier 1-3 Refurbishment Milestones owned by P&C.

Milestone ID	Milestone Name	Finish Date
NR Program Milestone Schedule		**15-Jul-22**
Program Release Dates		**15-Oct-21**
RL010	Rel.3: Preliminary Planning Release	19-Nov-09 A
RL020	Rel.4A: Detailed Planning Release A	17-Nov-11 A
RL025	Rel.4B: Detailed Planning Release B	15-Nov-12 A
RL070	Rel.4C: Detailed Planning Release C	14-Nov-13 A
RL080	Rel.4D: Detailed Planning Release D	13-Nov-14 A
RL030	Rel.5/6/RQE: U2 Outage Release	15-Oct-15
RL040	Rel.7: Unit 3 Outage Release	15-Oct-18
RL050	Rel.8: Unit 1 Outage Release	15-Mar-20
RL060	Rel.9: Unit 4 Outage Release	15-Oct-21
Outage Preparation Key Dates		**15-Jul-22**
Unit Common Outage Prep Key Dates		**22-May-15**
RP010	Program Execution Plan (PEP) Approved	19-Nov-09 A
RP030	Program Integrated Master Schedule Approved	15-Dec-10 A
RP055	2nd Phase Evolution of Outage Sequence	15-Oct-11 A
RP075	PIMS Revision 2016 Start Issued	15-Feb-12 A
OP2005	U2 Level 3 Schedule Developed for Definition Phase	14-Dec-12 A
RP180	Program Health Review Finished	22-May-15
Unit 2 Outage Prep Key Dates		**15-Jul-16**
OP2130	U2 Refurb Pre-Outage Metrics Prepared	02-Apr-15
OP2250	U2 Refurb Outage Execution Metrics Prepared	15-Jul-16
Unit 3 Outage Prep Key Dates		**15-Jul-19**
OP3130	U3 Refurb Pre-Outage Metrics Prepared	15-Oct-17
OP3250	U3 Refurb Outage Execution Metrics Prepared	15-Jul-19
Unit 1 Outage Prep Key Dates		**15-Dec-20**
OP1130	U1 Refurb Pre-Outage Metrics Prepared	15-Mar-19
OP1250	U1 Refurb Outage Execution Metrics Prepared	15-Dec-20
Unit 4 Outage Prep Key Dates		**15-Jul-22**
OP4130	U4 Refurb Pre-Outage Metrics Prepared	15-Oct-20
OP4250	U4 Refurb Outage Execution Metrics Prepared	15-Jul-22

7.0 MAJOR WORK SUMMARIES

7.1 Scope Control

N-MAN-00120-10001-SCOPE, Nuclear Projects Scoping Process, outlines the scope principles and requirements for Nuclear Refurbishment (NR). During the Initiation and Definition Phases, significant effort is dedicated within the project to define and characterize the full scope of the project. The Darlington Scope Request (DSR) is the source document for scoping items. The DSR Database is maintained as a living record of the scope status of the program. The scope of work for the next project phase should be well defined compared to the scope for the balance of the project in future phases. The scoping process, particularly developing and defining the scope, is a continuous process in the project lifecycle.

7.2 Schedule Management

Establishing an accurate and realistic schedule is a critical planning tool for a project. The schedule is the main planning tool used to understand and communicate how a project will be executed and includes the interrelationships and dependencies among project activities and deliverables, and the status of the work. The schedule is critical to properly strategize, plan and prepare for upcoming project work, to determine resource requirements, to understand how work is progressing and to apply corrective actions as required.

N-MAN-00120-10001-SCH, Nuclear Projects Schedule Management, outlines scheduling management principles and requirements for DRP which are applicable to both OPG project teams within the DRP and to contractors whom are performing work. Schedules are to be developed with inputs from all stakeholders and are monitored and updated throughout the project lifecycle. Schedule detail must be developed at an appropriate level to allow the project team to communicate the plan, monitor project progress and as an input into performance metrics in order to make accurate forecasts and to strategize and plan for upcoming work.

Refurbishment uses a multi level schedule structure (L0, L1, L2 and L3) and a standardized Work Breakdown Structure in accordance with best practices. The Program Milestones for Darlington Refurbishment are identified and maintained in the Program Integrated Master Schedule (PIMS). The schedule is maintained regularly and activities are tracked to a baseline. Variances are tracked, reported and mitigating and/or recovery plans developed when required. Critical path to Breaker Open and Breaker Open to Breaker Closed are identified, monitored and reviewed for potential impacts.

The Level 2 Control & Coordination schedule (CCL2) is the level of detail that identifies all program work for all units and all bundles. The work packages, (the lowest level in the WBS structure) are represented in the CCL2 schedule by at least 1 activity and tied to the level 1 milestone schedule. All activities in the CCL2 schedule are logically tied according to the sequence of work based in a roll up of Level 3 activities.

Contractors prepare schedules in accordance with N-MAN-00120-10001-SCH-09, Nuclear Projects Scheduling Requirements from EPC Contractors. Level 3 schedules are integrated and aligned to CCL2 and the PIMS. Vendors will self perform their schedule updates and maintenance with oversight from the OPG Master Scheduler. Vendors will identify OPG obligations in their Level 3.

The integrated Level 3 Schedule provides further breakdown of the work below the work package level and shows all interfaces and shared resources between contractors and OPG. All activities in the level 3 schedules are logically tied according to the sequence of work and summarized to the CCL2 activity level. Level activities are resources loaded. All Level 3 schedules will be in one P6 database managed by OPG. The Integrated Level 3 schedule is documented in the Darlington Refurbishment: Schedule Management Plan for Integrated L3 Execution (N-MAN-00120-10001-SCH-11).

Milestones are baselined in accordance with N-MAN-00120-10001-SCH-06, Nuclear Refurbishment Milestone Definition Framework. The Milestones are grouped by tiers based on the importance to Refurbishment and Stakeholders.

7.3 Cost Management

Cost management includes the processes required for planning, funding, managing, recording, forecasting, and controlling costs at the program and project/function levels within approved budgets.

The Program's cost management process is currently defined in N-MAN-00120-10001-PC, Project Controls, N-MAN-00120-10001 PC-15: Cost Management and Reporting, and N-MAN-00120-10001: Forecasting, with desktops established below the manual level in the areas of cost management and cost forecasting. The Program's Change Management process is currently defined in N-MAN-00120-10001-PC-01, Nuclear Refurbishment Cost and Schedule Change Control. In addition, a draft document N-MAN-00120-10001-PC 12: Change Management was prepared in 2014 to incorporate additional details regarding types of change and corresponding approval authorities and this document is currently used internally by the Cost group in P&C. The associated Change Control Form N-FORM-11252 R002: Nuclear Refurbishment Change Control Form has been issued for use and is currently used for all NR funded Projects. Cost Management and Forecasting and Change Management Manuals and Playbooks are currently under revision and, once issued, this Management Plan will include the updated reference.

Funding process for Refurbishment is governed by OPG Finance governance and requirements. Program level funding is established via Program Releases. Funding for Functions for the current release period is allocated directly to functional groups (both DRP and Centre-led) upon release approval. Funding for Projects is allocated from the program via the Gated Process and the Gate Review Board in accordance with N-MAN-00120-10001-GRB, Nuclear Projects Gated Process.

Estimated funding requirements for the program beyond the current release are documented as unreleased funds at the project and functional levels.

Program releases also establish program level Contingency and Management Reserve.

The program has established and will maintain a systematic and hierarchical Cost Breakdown Structure (CBS) that identifies all the Control Accounts and Work Packages (WP) used by the Program. The CBS mirrors the Program Work Breakdown Structure (WBS) including cost only elements (e.g. Contingency, Interest). A Control Account contains one or more WP's. Budgets for all work are established at the WP level and associated actual costs, earned values and estimates to complete are collected at the WP level to support performance monitoring.

The program life cycle funding, budgets, forecasts and incurred costs are recorded, tracked, and managed within a cost management tool. The tool currently in use is Proliance.

Cost and schedule alignment is maintained via the change control process. Changes to the cost baseline are rigorously identified, categorized, and recorded in Proliance in order to effectively maintain project and program baselines and track cost performance against approved plans and budgets.

Earned Value Management methodology, as defined in N-MAN-00120-10001 SCH-07: Refurbishment Earned Value Management is utilized as the primary architecture for project performance management.

In NR Definition/Planning Phase, nominally up to RQE, the P&C Cost management department continues to be focussed on development and finalisation of processes, standards, and tools to support cost monitoring, cost control, and cost reporting in NR. A "shared service" model is being applied for ensuring that all the cost data for Functions, Projects and Bundles (e.g. Planned Values, Actuals, Forecasts etc.) are recorded and maintained accurately in Proliance and all the Change Control Forms (CCF's) are reviewed and dispositioned through a controlled process. Cost management department also records the allocation of project and Program contingency in Proliance. Up to Release 4D, Cost management department provided all the planning templates required for preparation of Project and Functional estimates, and as well, led the review, consolidation, challenge process, finalization and submission of the release requests for BOD approval. For RQE, a separate group has been created for providing this work (refer to Section 7.8 for its Work Program).

As NR moves to the Execution phase, P&C Cost management department will be further centralised as a service provider to support Project Execution teams in cost recording, cost monitoring, and cost control and P&C Reporting in cost reporting.

In summary, the department will be responsible for:

- Maintaining and/or updating Cost Management & Forecasting and Change Management Manuals, Playbooks, and Roadmaps, as and when required and appropriate.
- Acting as Lead for future changes/upgrades to Proliance or development of an alternate cost management tool.
- Maintaining and/or updating the Proliance (or, other cost management tool) Desktop Guides, as and when required and appropriate.
- Ensuring cost data quality and integrity in Proliance for all work funded by NR.
- Tracking contingency allocations in Proliance for all work funded by NR.
- Ensuring accurate and timely cost data is available for reporting at various levels for internal and external stakeholders.
- Ensuring all Change Control Forms are, reviewed, dispositioned, and integrated in the cost management process and systems (Proliance) in a controlled manner.
- Establishing the Master Project List (MPL) for NR and maintaining the change control of the MPL.

7.4 Estimating

Establishing accurate estimates is critical for the successful planning of Refurbishment.

Cost estimating includes the processes required for estimate planning and development, estimate review, classification, validation and documenting the estimate. The result of the estimating process is a determination of the expected total cost of labour, materials, equipment, professional fees, and other resources required for the execution of a package of work, project, or program.

Detailed guidance on estimating for Darlington Refurbishment is provided in N-MAN-00120-10001-EST-01, Nuclear Refurbishment Cost Estimate. Estimating Standards and practices are based on best practices as defined by the Association for the Advancement of Cost Engineering (AACE). The estimating function is to achieve the highest level of quality estimate to the maturity level of the project definition.

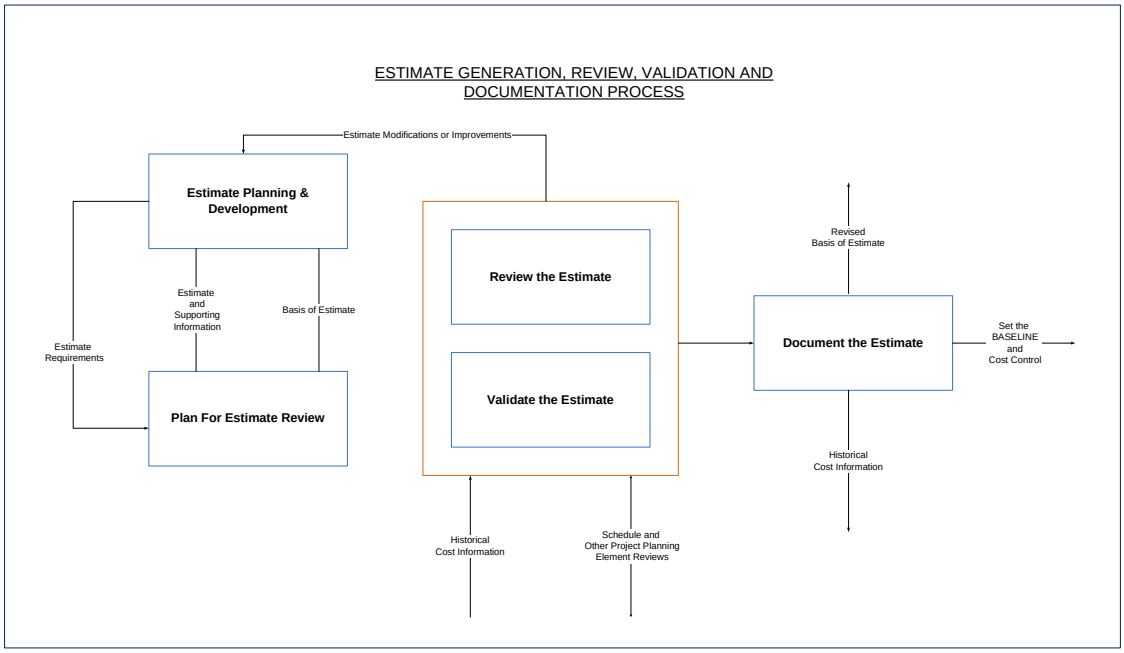


Figure 1: Estimating Process Framework

Within the Darlington Refurbishment Program, estimating activities are performed to support the following:

- Annual business planning for NR program funding requests. Program level cost estimates to formulate the program total life cycle cost in support of release planning and program milestones, including the release quality estimates required for October 2015 and August 2016,
- Facilitate preparation of DRAS and its NPV calculation to support scope progression,
- Facilitate procurement/contracting processes. Internal independent or third party cost estimates to support EPC contract Request for Proposal (RFP) and bid evaluations,
- Internal cost estimates to formulate the project total cost in support of gate reviews needs,
- Support Change Requests during the execution of projects,
- Support to Projects - to complete project re-estimates based on forecasting needs,
- Support to Projects in validating claims and estimating project changes,
- Support to risk quantification and contingency analysis and forecasting; validating or developing estimates on contingency impacts and associated costs,
- Subsequent unit RQE Check Estimates.

7.5 Risk Management

The Risk Management (RM) organization is accountable to create and maintain standards, procedures, tools, and shared services resources to facilitate effective risk management within the Nuclear Refurbishment project. Risk Management facilitates the “Knowledge Management” functionality for NR, specifically the documentation and archiving of major risk influencing items such as operating experience, lessons learned integration, planning assumptions, major decisions, actions, and issues. This documentation of these elements will be executed in the form of project logs in the Risk Management and Oversight (RMO) tool.

Life Cycle Objectives and Deliverables for NR

Definition/Planning Phase:

In the planning phase of the refurbishment project, nominally up to RQE, the RM department is heavily focused on the development of standards and tools for the broader team to apply and use in executing risk management. In parallel with maturing processes, the organization is involved in generating the baseline content of the functional and project level risk registers and project logs and validating the quality of the risks as the program progresses to RQE.

A “shared service” model is employed such that the individual risk owners have access to support directly from the risk organization in executing these duties. The role of the department during planning is one of establishing good risk culture and practices, educating users, and developing metrics to and reports to communicate and escalate risk to support the successful achievements of safety, quality, cost and schedule objectives. Through education and communication, RM ensures that the broader Refurbishment team knows they must risk manage and document planning assumptions and decisions, they know how to do so, and they have the support and ability to apply it consistently.

A critical input to the risk management process is the concept of knowledge management, or rather the processes through which the NR organization seeks out, generates, integrates, and documents operating experience and lessons learned. Additionally, the robust logging of assumptions, decisions, actions, and issues are key attributes that support a mature risk management program and are required to exhibit prudence. The RM department is accountable to ensure the risk manual and tools are up to date to capture these key elements from a risk perspective, i.e. understanding how the life cycle of risk works from inception through realization or retirement. The tool to capture this information, as well as the risks to the Program, will be the Risk Management and Oversight (RMO) tool.

The RM organization also provides a central shared service to the project bundles and functions to calculate contingency in support of the gated approval process. Contingency development instruction is provided and is calculated for functions and

bundles, and the program at large, during program release planning and gate progression.

Throughout the planning phase metrics and reports will be developed in support of NR needs.

Execution Phase:

Much of the same activity identified in the planning phase, as it relates to risk management (i.e. the identification and treatment of risk, the documentation of assumptions and lessons learned in the RMO tool, reporting and metrics, etc.) is carried through the execution phase. Some notable changes in approach from the planning to execution phases include the following:

- The risk and knowledge management group will be involved, to a greater extent, in providing real time risk and impact analysis and dealing with emerging risk items on the NR project itself. Resources provided to look outwardly during the planning phase and the establishment of the manual and the toolset will be involved in a more active shared service model, supplementing the project teams' time constraints around risk management and performing contingency adequacy analyses and risk emerges.

- Oversee the contingency drawdown, and contingency development for supplement gate submission.

Deliverables/Products

The RM organization is responsible to establish and maintain the following products and deliverables:

1) Manuals and guides, where appropriate. The primary risk management document for Nuclear Projects (including Refurbishment) is N-MAN-00120-10001-RISK.

2) Risk Management and Oversight Tool, containing all project logs and risk registers.

3) Risk management metrics and reports, and metrics and reports for other aspects of the RM areas of responsibility, from time to time as required to support the execution of work.

4) Contingency analyses, both project and program level, to support gate progression and release planning.

5) Shared service support to all projects and functions.

6) Internal and external stakeholder interfacing on risk related activity, including and not limited to Enterprise Risk Management, Internal Audit, etc.

7.6 Reporting

An integral part of successful project management is relaying performance information in a reliable, accurate manner. The Reporting organization is accountable to create and maintain the Project and Program reports required to support management decision process for the Nuclear Refurbishment project. This includes the standards, procedures, and tools required to facilitate effective Project and Program reporting within the project.

In alignment with the strategic initiative to streamline Planning & Control governance and guides, the overall approach to Program and Project reporting will be defined in a new guide for Darlington Refurbishment Metrics and Reporting Project Controls (to be developed). This will include the Cost reporting guidance that is currently provided in N-MAN-00120-10001-PC-13, Nuclear Refurbishment Cost Management and Reporting. This Management Plan will be updated to reference the appropriate governance once it is issued.

Reporting Principles

Reporting will follow the same principles for all phases of the program, though the specific metrics and reports may vary to align to the business needs of each phase. Key reporting principles are:

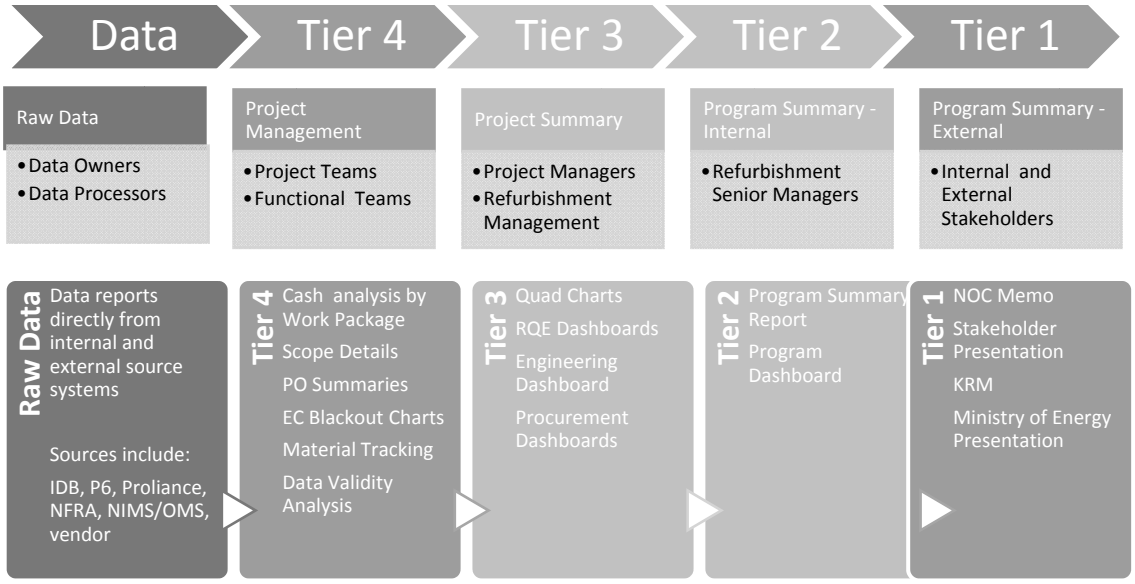
- Provide accurate, reliable, auditable and timely information,
- Assess all phases of the project from definition through to execution,
- Support key Project initiatives including RQE,
- Align with industry best practice
- Provide various tiers of reporting, from detailed project budget analysis to external stakeholder updates

The suite of Nuclear Refurbishment Metrics will be developed on the following principles:

- Single set and site for Refurbishment Metrics that will reside on an electronic platform, with data being extracted from source systems
- Integrated hierarchical set of program/project/function metrics for Refurbishment
- Utilization of Vendor data and metrics directly will be considered to avoid replication within OPG source systems
- Interface with Integrated Database
- Integrated into Reporting Structure
- Metric development and administration effort needs to deliver value for money
- Based on Needs Analysis with input from functions, projects and stakeholders

Nuclear Refurbishment requires a multi-tiered reporting structure as detailed below. The tiers are differentiated by the intended audience, level of detail required, and the metrics reported. The information within the lower tier feeds the reports in the tier above.

Nuclear Refurbishment Reporting Tier Structure



Standard Reports

A set of standard reports are currently produced to communicate program and project performance to suit various stakeholder needs. These reports will be adjusted as required based on the project phase and key program focus areas. Standard reports currently produced include:

(a) Board Update is a high level program status report prepared for the Ontario Power Generation (OPG) Board of Directors (BOD).

(b) Periodic program level performance reports are prepared for senior OPG management audiences (e.g. Nuclear Oversight Committee, Nuclear Executive Committee).

(c) Major Darlington Refurbishment milestones and performance targets are included in corporate, Nuclear, Nuclear Projects, and Darlington Refurbishment level Report Cards produced on a monthly basis by the corporate Finance function.

(d) Program Status Report is prepared monthly for senior Darlington Refurbishment management. This report summarizes safety, schedule, cost, and quality performance at the program level.

(e) Project and Function level Quad Charts are prepared monthly. These reports summarize safety, schedule, cost, and quality performance.

(f) The Controllership Financial & Oversight Report is produced monthly by nuclear finance. This report is a comparison of actual and forecast costs against the approved Business Plan.

(g) Standard monthly Earned Value performance reports at all levels from the program down to Work Packages are produced by the BI reporting tool for use by line managers to support ongoing monitoring and control of work programs and projects.

(h) Joint OPG/Vendor scorecards are produced for all major refurbishment contracts. These scorecards assess performance against the terms and conditions of the contracts.

7.7 Project Controls Integration

The project controls integration is a key role to ensure all project control processes are simplified, integrated and successfully implemented cross all Darlington Nuclear Refurbishment bundles.

The Manager Project Control Integration's key responsibility is to lead a matrix project controls leads team who are embedded within each bundle (project) to provide project management and control leadership to the project team and EPC Vendors, including estimating, scheduling, project planning, cost management / forecasting and reporting, risk management, and change control management. They are responsible to the project manager to perform project planning, controlling, and oversight activities in support of the delivery of successful project outcomes in accordance with the project management / Controls standards, procedures, and instruction.

Program P&C Lead is responsible to develop quality assurance program and perform self assessment in a regular basis for continuous improvements.

In addition, the project integration department is responsible of co-ordinating and providing training to all Cost and Schedule Analysts (CSAs) and project controls leads.

7.8 Release Quality Estimate (RQE) Project

The RQE milestone fulfills a key Corporate Investment Management objective for the Refurbishment Program by providing a business planning decision gate within the overall refurbishment lifecycle schedule such that a due diligence assessment can be performed and justification can be provided for continued expenditure.

The purpose of the RQE Project is to facilitate the strategic asset planning requirements of the formal Program level decision gate known as Milestone RL030. This Milestone reflects the completion of the detailed planning phase and the Release 5 funding request for the execution phase of DNRP.

As such, the RQE Project as a distinct mandate to deliver the RQE milestone for the Darlington Nuclear Refurbishment Program defined in the RL030 Milestone Definition Statement (NK38-REF-09701-RL030). It is managing itself to fulfill this mandate under NK38-NR-PLAN-09701-10004.

The RQE Project Management Plan defines the activities and processes that will be utilized to validate Program "Readiness" and develop the RQE Package in accordance with the RL030 Milestone.

As the program progresses into execution through to closeout, the RQE Project will remain active after RL030's completion date of October 15, 2015 to support the Project Planning & Controls department 2016 "Check Estimate" prior to Unit 2 breaker open. These activities are funded in the current 4D release plan.

8.0 RISK AND OPPORTUNITIES

The following table lists the major risks owned by (and related to) P&C based on data in the Nuclear Refurbishment Risk register as of November 14, 2014. Risk mitigation measures are incorporated in current P&C work programs, with the specific mitigation actions documented and tracked in the Risk Register.

ID	Title	Risk Description
337	Insufficient Level of Confidence in Program Cost Estimate at RQE	The risk is that due to the level of quality of the estimates at RQE, an appropriate level of confidence in the program estimate is not achieved leading to an underestimated contingency funds.
640	Insufficient funds/financing available	The risk is that Refurbishment is technically ready to proceed but delayed due to insufficient funding as a result of financing issues, such as lack of establishment of a letter of credit.
661	Inaccurate performance data causing inappropriate or untimely control of critical program deliverables	The risk is that ineffective and/or inappropriate management decisions are made due to deficient processes, flawed metrics or uncontrolled/unverified source data.
664	Planning & Controls capability shortfalls (number, type, and capability of staff	The risk is that Planning & Controls resources as planned in 4d will not be able to support the planning, monitoring, and oversight of the program and project due to resource and capability shortfalls.
701	Aggregate Refurbishment Cost Estimate Exceeds 10B Target (in 2013$) at RQE	The risk is that the Refurbishment project no longer exhibits a viable business case due increasing EPC and OPG cost estimates to execute the approved scope, resulting in cancellation of the program or a complete reanalaysis of the program scope and execution strategy.
710	EDMS Document Processing Staff Resource Requirements Underestimated	The risk is that the assumption of the quantity of EDMS document processing staff (3 FTE) required is invalidated, creating a requirement to hire temps resulting in cost increases to NR program.
711	IT Infrastructure not in place by early 2015 for program life cycle	The risk is that IT Infrastructure not in place by early 2015 for program life cycle due continuing of changes of IT scope and/or not clear identification of IT requirements results in increasing cost of IT projects and inability of oversight, control work progress, manage cost and quality of reporting.
712	Extend the Refurbishment Program Master Schedule duration	The risk is that the RTS refurbished unit may require stabilization period or buffer imposed by Operations and/or the IESO, which may impact the following planned refurbishment unit. Adding one month buffer between (U2 & U3) and another month between (U1&U4) will increase the Program Master Schedule duration by two months.
719	Ineffective use of project management control processes in NR pre-requisite projects	The risk is that projects and modifications will not effectively apply scoping, scheduling, risk and cost management tools to successfully manage NR pre-requisite projects to meet program requirements.

Risk #664, “Planning & Controls capability shortfalls”, includes the following specific risks posed by the work programs and staffing strategies reflected in this FMP:

1. Scope Management: No dedicated resources are included in the current P&C plan for executing the comprehensive set of ownership functions (including ownership and administration of the DSR database currently executed by the U2 Outage Department).

2. Projects & Modifications (P&M) P&C functional gaps: Refurbishment compensation for current and potential shortcomings in P&M P&C support of Refurbishment projects is not resourced or included in the strategies or work programs reflected in this plan.

3. Vendor Deliverable quality problems may require requiring additional P&C support/resources that are not included in this plan.

4. “Peak Support” capability to address emergent client needs, per the Shared Service model, may be challenged given resource levels reflected in this plan.

5. The impact of the scheduling resource amalgamation strategy on cost management support has not been fully studied or mitigated in this plan. Additional CSA resources may be required to support project cost management.

6. Cost department has not been adequately resourced (in terms of number and capability) in the Definition Phase. It was an embedded group under Project Reporting and was not designed to have specialists required to implement this function in a mega Project environment. Continuing inability to properly resource the Cost department will impact P&C’s ability to provide effective support, from the cost perspective, to the Project Execution and Project Reporting teams in NR Execution phase.

7. Additional costs may be incurred should the IT Infrastructure not be in place by early 2015 as planned.

8. Expanding Execution department roles/resources may place additional demands on P&C (Roles & Responsibilities unclear)

9. Program resourcing strategies currently being implemented to overcome OPG structural staffing impediments may not be sufficiently successful to enable execution of P&C accountabilities and deliverables.

9.0 PERFORMANCE MEASUREMENT AND REPORTING

P&C has adopted industry standard performance measurement practices and metrics in the areas of scope, schedule, cost, and risk management. Major performance measurement elements include:

- Earned Value metrics (including Schedule Performance Index (SPI) and Cost Performance Index (CPI)) used to monitor schedule and cost
- Schedule Health metrics to assess the rigour and integration of program and project schedules
- Tiered milestone monitoring and reporting
- Risk reviews and health reports at project and program levels

Scope, schedule, cost, and risk performance metrics are reviewed regularly at planned program level and project level meetings, including OPG/Vendor forums.

Estimate submissions and development/validation metrics are captured in the IDB (Integrated Data Base) Playbook. Work down curves are reviewed on an ongoing basis.

10.0 RESOURCE PLAN

10.1 Program Strategy and PMO

As the DNR Program enters into the execution phase, the P&C has adopted a structure that ensures continuous and meaningful engagement with both the NR Organization and the Proj's and Mod's Organization. The P&C group will conduct the Program Management Office (PMO) as the single entitity to maintain project management processes, standards and tools, and two Project Control Offices (PCO's) to support project management organizations within NR and Proj's and Mod's (P&M) organizations with best in class resources. The PMO will supports the project teams regularly by maintaining processes and standards, throughout the Program lifecycle. Also, the PMO will meet with OPG Stakeholders, Peergroups, and/or Operation business units to provide periodic Program Status Reviews.

The PMO will be led by MPET member Director of Planning and Project Control, and will consist of the following functions: Cost Management and Estimating, Scheduling, Risk Management and Reporting.

The PCO Refurbishment and PCO P&M will provide both organizations with best in class project controls resources trained and engaged with the PMO processes, tools and standards.

An overall spreadsheet of the P&C resources is attached in Appendix A.

10.2 Schedule Management

Throughout the early Definition Phase of the program, the scheduling function was centralized within the P&C organization, with a Scheduling Manager and staff providing standards, processes, and scheduling support to the Refurbishment departments as they completed the initial program scope development. In this early phase, the standardized Work Breakdown Structure, multi-level scheduling approach, standards and tools were developed and implemented.

Once project teams were established, scheduling resources were matrixed to the projects, with functional scheduling support retained within the central P&C Scheduling department. Once the P&C Lead concept was established and Leads hired and matrixed to each of the project bundles, overall accountability for project schedules was assigned to the P&C Leads. Project scheduling resources (Cost and Schedule Analysts) then took their daily work direction from the P&C Leads.

As the program heads into the final year of Definition Phase to reach Release Quality Estimate (RQE), the scheduling model is evolving toward a focus on initial unit readiness planning. As such, all matrixed project scheduling resources will be amalgamated within the Work Control Department to facilitate the integration of project schedules and the planning of the shutdown and refurbishment of the first unit. These resources will still be matrixed from P&C Scheduling. Functional ownership, as well as scheduling support of the functional organizations, will continue to be retained within P&C.

As the program progresses into execution through to closeout, the scheduling model will remain unchanged, with scheduling resources ramped to meet the needs of first unit execution, then scaled to provide support to the overlapping refurbishment of the subsequent units, and finally ramping down through the completion of the final unit and program closeout.

The P&C Scheduling Department is also accountable for the resourcing and execution of independent scheduling reviews. These reviews will be carried out on a scheduled basis using expert contracted resources.

Department/ Section	Resource	Resource Type	Project Life Cycle Description
Scheduling	Band G Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
Scheduling - Program	MP6 Section Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	Cost and Schedule Analyst	Aug Staff	2 FTE. This resource is planned through the life cycle of

Department/ Section	Resource	Resource Type	Project Life Cycle Description
	University Student	Student	As required to support Full Time Employees
Scheduling-Matrixed Work Management	Band H Section Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	Master Scheduler	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	Master Scheduler	Aug Staff	This resource will adjust based on the project phase on the Unit overlap
	Cost and Schedule Analyst	Full Time Employee	This resource will adjust based on the project phase on the Unit overlap.

Roles and Responsibilities for Cost & Schedule Analyst (CSA)
General Accountabilities:

Provide support to Section Manager through information accumulation, analysis and problem-solving in regard to:

- Nuclear Refurbishment (NR) cost management e.g. cost planning, cost collection, cost monitoring, cost analysis, cost forecasting and cost reporting.
- NR change management e.g. change documentation review and processing.

Roles and Responsibilities for Master Scheduler
General Accountabilities:

Requires a high level of organizational and technical skills and the ability to schedule the construction and refurbishment of large nuclear systems. This position will manage all aspects of the scheduling process using a Primavera P-6 based software system. Additional responsibilities include:

- Maintaining resource loaded schedule with progress reporting and updates.
- Maintain baselines and milestones
- Integrate EPC vendors into one P6 database
- Ensure vendors are following the schedule quality standards
- Interface schedule with Asset Suite 7
- Effectively manage the critical path

Roles and Responsibilities for P6 SPOC
General Accountabilities:

- Single Point of Contact for P6 administration
- Administer all P6 coding
- Administer security roles and access to P6
- Interface with IT on P6 requirements and maintenance
- Administer P6 quality standards and governance

Roles and Responsibilities for Cost and Schedule Analyst
General Accountabilities:

- Schedule all OPG self performing projects
- Update P6 logic and ties with the Work Control Team Leaders
- Work with Vendor planners to ensure that they are following OPG P6 standards
- Identify areas of concern that could affect critical path

10.3 Cost Management and Estimating

Throughout the early Definition Phase of the program, the cost management function was embedded within the P&C Project Reporting department, with a Cost Section Manager and staff providing standards, processes, and cost management support to the Refurbishment departments as they completed the initial program scope development. In this early phase, the standardized Cost Breakdown Structure, change management approach, cost standards and tools were developed and implemented.

The shared service cost support model has been retained throughout the Definition Phase of the program. Once the P&C Lead concept was established and Leads hired and matrixed to each of the project bundles, overall accountability for project cost management was assigned to the P&C Leads, with the P&C cost management section providing Cost and Schedule Analyst resources in support of the P&C Leads on a shared service basis.

As the program heads into the final year of Definition Phase to reach Release Quality Estimate (RQE), the cost management model is evolving toward a centralized approach that will see the NR Program, projects and all functions receiving cost support from the central P&C Cost Management organization. The CSAs in the Cost Management organization will support the P&C leads in executing cost monitoring, cost control, change control and cost reporting of the projects and functions. They will also support NR Senior Management in Program cost monitoring and cost reporting and P&C Reporting organization in cost reporting. The Senior Specialists in the Cost Management organization will share the following accountabilities:

- Process owners for the Cost Management and Change Management processes and lead the future revisions, roll-outs and self-assessments on these processes
- Lead participator from Cost Management group in the change control board
- Lead future upgrades/modifications to the cost management tool
- Lead in cost analytics

As the program progresses into execution through to closeout, further emphasis will be placed on cost management within the project bundles, with additional resources provided to the P&C Cost department, as required. The central core functional and program cost support resourcing will remain stable throughout execution and program closeout.

Throughout the Definition Phase the estimating function provided standards, processes, procedures (including roles and accountabilities), and estimating management support to the Refurbishment departments.

Software tools/estimating website were established and implemented during the Definition Phase to support the full life cycle requirements. Software tools were established with the intent that they are stable, sustainable platforms for the life of the program, with only typical maintenance required.

Estimating support throughout early Definition Phase of the program life cycle was being provided via a managed task contract with an expert project management vendor. OPG provided management direction and oversight of the vendor.

Throughout the Definition Phase of the program, estimates for all refurbishment scopes of work progressed from the Darlington Scope Requests towards progressively more detailed estimates based upon preliminary and basic design outputs.

As the program heads into the final year of Definition Phase to reach Release Quality Estimate (RQE), detailed estimates are developed by the organizations executing the project work based on completion of detailed design outputs and incorporating the detailed work execution plans to achieve the readiness to transition through to the Execution Phase. Estimating is providing oversight, review, and validation of the detailed estimates provided by the executing organizations.

In advance of the first unit, Unit 2, Breaker Open program milestone, a Check Estimate will be performed on the U2 scope to establish cost certainty and continued alignment of the total program cost. The U2 Check Estimate will be a further elaboration of the estimates that were developed in support of the RQE, providing final estimate details based on complete finalization of Unit work.

During the Execution Phase estimating will support the addition of discovery work and the associated cost estimates provided by the executing organizations. Estimating will

also provide support for commercial claims, forensics of cost increases, change requests, and validation of Target Price adjustments.

Also on an ongoing basis for all units estimating will support the activities identified in Section 7.4 (items 1 to 9).As the program progresses from execution through to closeout, cost estimates in support of change control and refinement of estimates based on actual performance data are performed in order that Unit over Unit benefits of learning and optimization is achieved. Resourcing during this phase will be ramped to meet the needs of the first unit execution then scaled to support final estimate reconciliations and unitized sub-gates.

Resource levels will vary over the life cycle of Refurbishment. The current model for estimating support throughout the future program life cycle is being provided via a steady compliment of 4 in-house resources and as required contract/augmented staff utilizing estimating specialists and process owners. OPG provides management direction and oversight of the contract/augmented staff.

The following table represents the summary view of the resources required to execute the work described through the life cycle of the Refurbishment project.

Department/ Section	Resource	Resource Type	Project Life Cycle Description
Cost Management and Estimating	Band G Manager	Full Time Employee (currently Aug Staff)	This resource is planned through the life cycle of Refurbishment.
Cost Management and Estimating	MP6 Section Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	Sr Planning & Reporting Specialist	Full Time Employee	This resource is planned through the life cycle of Refurbishment
Cost Management and Estimating	Cost and Schedule Analyst	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
Cost Management and Estimating	Estimating Support	Augmented/ Contract Staff	Resource levels will vary over the life cycle of Refurbishment on an as needed basis.
Cost Management and Estimating	University Student	Student	As required to support Full Time Employees

Roles and Responsibilities for Manager, Refurbishment Planning & Controls, Cost
General Accountabilities:

Accountable to the Director, Refurbishment Planning and Project Control to provide project control support with a specific focus on cost and change management and to develop, implement, and maintain best practice project management processes to support Nuclear Refurbishment (NR).

Specific Accountabilities:

- Develop, communicate, implement, maintain and enforce the processes, guides and tools necessary to support cost management and change management in NR.
- Manage the operation of the cost management system in NR to provide accurate cost data recording, cost monitoring, and cost control.
- Provide support to the NR Project Planning & ControlsReporting group to ensure accurate cost reports and cost metrics are produced to support project and/or program monitoring and control.
- Provide oversight of the quality of the change control forms and provide support to other accountable managers to facilitate implementation of the change management process.
- Maintain communication with all functional and project managers in NR in order to develop a detailed understanding of the entire program and/or project process and procedures, and progress throughout the phases of the program and/or project.
- Manage resourcing and budgets for NR P&C Cost team.
- Continuously assess and improve performance of the NR Project Planning & ControlsCost department to maximize value added to the achievement of the NR goals and objectives.
- Provide inputs to divisional business plan.

Roles and Responsibilities for Section Manager, Refurbishment Planning & Controls, Cost
General Accountabilities:

Accountable to the Manager, Refurbishment Planning and Control, Cost to provide project cost and change management support and to develop, implement, and maintain best practice project management processes to support Nuclear Refurbishment (NR).

Specific Accountabilities:

- Develop and operationalize implementation of the processes, guides and tools necessary to support cost management and change management in NR. Seek to

continuously improve processes, guides, and tools to align with industry good practices.

- Maintain the quality and integrity of all the cost and related performance data in the NR cost system to provide accurate cost recording, cost monitoring, and cost control data.
- Provide technical expertise and services for maintaining and/or upgrading the cost system in NR.
- Provide ongoing support to the NR Project Planning & ControlsReporting group to ensure accurate cost reports and cost metrics are produced to support project and/or program monitoring and control.
- Lead or participate in cross-functional initiatives based on NR business needs.
- Supervise the work of Cost and Schedule Analysts and Senior Specialists, Project Planning and Project Control in the Cost department. Perform this role in accordance with approved policies, procedures and standards. Provide meaningful input to the business plan and formulation of department work programs and tasks.
- Act as a coach and facilitator to create and sustain a non-threatening, supportive, team environment, actively working with staff to empower them to attain optimal work performance.
- Plan and implement staff development. Identify training requirements of staff, required to perform tasks, ensuring the training is relevant and evaluation measures meaningful.

Roles and Responsibilities for Senior Specialist, Project Planning and Control General Accountabilities:

Provide support to Section Manager and Manager through technical advice and expertise, information accumulation, analysis and problem-solving in regard to:

- Nuclear Refurbishment (NR) cost management e.g. cost planning, cost collection, cost monitoring, cost analysis, cost forecasting and cost reporting.
- NR change management e.g. change documentation review and processing.

Specific Accountabilities:

- Identify and champion the use of best practices for cost management and change management related to the Nuclear Refurbishment (NR) portfolio.
- Lead development, revision, roll-out, and training of cost management and change management processes and procedures in NR. Analyse, evaluate, and recommend process improvements to enhance the efficiency and effectiveness of these processes in NR.

- Be the technical expert (SPOC) for smooth operation of the cost management system in NR. Also, support/lead roll-outs and communications related to the cost management system.
- Provide ongoing support and consultation to Section Manager and Manager in the Cost group in NR Planning & Controls (P&C) with respect to (a) month-end cost reporting, (b) cost analyses work, (c) supporting other NR business units in the execution of cost and change related business processes.
- Provide periodic or limited supervision of Cost and Schedule Analysts for technical aspects of their work. Provide technical direction, check on progress, accuracy of work methods, and results, ensuring adherence to established standards and procedures.
- Contribute to the overall effectiveness and efficiency of the Planning & Controls, Cost section.

Roles and Responsibilities for Cost & Schedule Analyst (CSA)
General Accountabilities:

Provide support to Section Manager through information accumulation, analysis and problem-solving in regard to:

- Nuclear Refurbishment (NR) cost management e.g. cost planning, cost collection, cost monitoring, cost analysis, cost forecasting and cost reporting.
- NR change management e.g. change documentation review and processing.

Specific Accountabilities:

Update, monitor and analyze specified areas of cost performance.

- Maintain Control Budget, Earned Values, Actual Costs, and Forecasts in the cost system. Ensure cost data quality and integrity in the cost system for all work funded by NR.
- Track commitments and forecasts of costs for various NR Functional groups.
- Support the month-end cost reporting and Quad chart processes by assisting client groups and P&C Leads with progress and forecast PIFs, including the review and validation of products submitted for month-end reporting.
- Support Project Planning & ControlsLeads in conducting cost performance review meetings with budget owners.
- At least each month, or as frequent as required by the management team, assist P&C Leads in providing forecast for Year-End and At-Completion estimates. Quarterly, work with client groups to provide project/functional year end forecasts.
- Provide Cost Charts/Tables and analysis to client groups on an as-required basis.

- Support the preparation of the monthly Program level reports by providing cost information (e.g. control budgets, commitments and forecast) and analyses (e.g. performance variance analyses).

Conduct assessment of various requests and deliverables to ensure accurate cost collection and reporting e.g. Work Event requests, Funding requests, Gate PIFs, Change Control Forms, Requests for Purchasing, OBU requests, monthly collection, analysis and reporting of accruals to Finance etc.

Develop or support development of cost management and change management procedures, instructions, guidelines, and desktops.

Establish and maintain Master Project List (MPL) for NR that retains control over six levels of NR Work Breakdown Structure (WBS).

Advise and assist Section Manager with regards to avoiding and resolving cost problems.

As directed by the Section Manager and Manager, review planning and control-related techniques, tools, processes and new technology developments for potential application.

Lead, participate, or support Section Manager, NR Project Planning & ControlsCost in cross-functional initiatives.

10.4 Risk Management and Infrastructure

The following table represents the summary view of the resources required to execute the work described through the life cycle of the Refurbishment project. This summary resource profile is outlined in detail in the release planning spreadsheets for the department that support Release 4D. Reference the Work Breakdown Structure provided in the previous section for detailed information as required.

Department/ Section	Resource	Resource Type	Project Life Cycle Description
Risk Management and Infrastructure	Band G Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
Risk Management and Infrastructure	MP6 Section Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	MP4 Risk Coordinator	Full Time Employee	3 FTE are required through RQE and breaker open on Unit 2. There are 2 required through Unit 2 execution and then 1 FTE

Department/ Section	Resource	Resource Type	Project Life Cycle Description
			through the balance of Refurbishment. The assumption is a significant amount of learning and risk will be experienced leading up to U2 breaker open and through the refurbishment of the first unit.
Knowledge Management	MP6 Section Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	OPEX/LL Coordinator	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
IT Projects Coordination	MP4 CSA	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	IT Projects Coordinator	Contract	This resource is planned through YE 2015.
Document Processing	EDMS Document Processing Clerks	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	EDMS FLMa	Full Time Employee	This resource is planned through the life cycle of Refurbishment.

Roles and Responsibilities for Band G Manager
General Accountabilities:

Strategic direction and oversight of the risk management program for Nuclear Projects.

- Implementation of continuous improvement initiatives and best practices for risk management and contingency development.
- Monitoring of organizational performance and execution of risk management activity, including implementation of corrective actions and communications when opportunities to drive improvements are identified.
- Preparation and approval of program level risk and contingency reports/estimates and delivery of forums (such as the Risk Oversight Committees) to highlight and escalate major risks to the successful execution of Nuclear Projects objectives to the Nuclear Projects Executive Team (NPET).
- Interface point with corporate entities as it relates to Nuclear Projects risks, including Enterprise Risk Management (ERM) and external business unit risk leadership.

Roles and Responsibilities for MP6 Section Manager
General Accountabilities:

- Implementation of risk management strategies.
- Ownership and maintenance of and improvements to risk governance, toolset, and reporting.
- Day to day management of risk management staff. Interfacing and communication regarding all aspects of the risk management program with project and functional management peers.
- Presentation and delivery of continuous improvement initiatives to the Nuclear Projects organization.

Roles and Responsibilities for MP4 Risk Coordinator/ Process Specialist
General Accountabilities:

Centre of Excellence/Shared services support of individual project bundles and functions to implement effective risk management activities, in line with approved governance and standards.

- Performs contingency calculations, risk workshops, and working level support and direction for day to day utilization of risk management governance, standards, practices, tools, reports and strategy.

10.5 Reporting

The resources required to execute the work described through the lifecycle of the Refurbishment project are summarized below. This summary resource profile is outlined in detail in the release planning spreadsheets for the department that support Release 4D.

Department/ Section	Resource	Resource Type	Project Life Cycle Description
Reporting	Band G Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
Reporting	MP6 Section Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	Report Builder	Aug Staff	2 FTE. This resource is planned through the life cycle of
Reporting	Report Writer	Full Time Employee	This resource is planned through the life cycle of Refurbishment.

Department/ Section	Resource	Resource Type	Project Life Cycle Description
Reporting	Data Process Integrity SPOC	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
Reporting	Executive and External Reporting SPOC	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
Intergrated Database Management	MP6 Section Manager	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	IDB Master Administrator	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	IDB Data Integration	Full Time Employee	This resource is planned through the life cycle of Refurbishment.
	CIO Support	Contract	This resource will be drawn upon as required for the lifecyle of refurbishment.

In the Definition Phase, during the development of metrics software, data warehouses, and reporting tools, additional specialized contract resources will be secured to establish and implement these tools as required.

Reporting Roles and Responsibilities:

Manager of Reporting

The Manager of Nuclear Refurbishment Reporting reports to the Director of Planning and Project Control. Manages a team that ensures quality, control and confidentiality where appropriate are maintained regarding cost, schedule and project updates. The manager provides sole source on direction and clarity around Stakeholder required reports to the section manager, report building and writing staff.

Section Manager of Reporting

The section manager of Reporting reports and takes direction from the Manager of Reporting. When the manager is not available will assume responsibilities of the Manager of Reporting. Main duty is to supervise the delivery of high profile management reports utilized at all levels of leadership.

Executive Report Writer

This position supports the Reporting mission by creating, building and editing reports. As an excellent writer this position requires exceptional attention to detail. It is critical

that this position understands the importance of communications, including how to write for a leadership audience. This position will report to the Section Manager of Reporting.

Report Builder Analyst

This position supports the reporting mission by building quality system reports. Builders are self-motivating working in a technical area that report to the Section Manager of Report. This position will examine the unique attributes and concerns in developing reports by using data warehouses, systems and their procedures. This includes creating and maintaining secure systems for recording data and producing relevant documentation that captures the need and how the report will be built.

Data Integrity Administrator

This is position supports the Reporting mission by implementing, managing, and maintaining the IDB databases providing analysis and reports for internal administrative and externally product support. This position will report to the Section Manager of Reporting and work closely with the Report Builders and other staff as needed.

10.6 Project Controls Office - Refurbishment

Resourcing Strategy:

- Matrix Project PC leads are embedded in each bundle to support each project manager and budgeted within the project manager budget.
- Matrix Functional PC leads are embedded in Engineering, OP&M organization to support these organizations and budgeted within the project control integration budget.
- Program PC lead position to perform independent self assessments in a regular basis and budgeted within the project control integration budget.

Roles and Responsibilities for Project Planning and Project Control (PC) Lead General Accountabilities:

The P&C Lead provides project management and controls leadership to the project team and Engineering, Procurement and Construction (EPC) vendor(s), including; estimating, scheduling, project planning, cost management, forecasting and reporting, risk management and change control management.

- Responsible to the project manager, performs project planning, controlling, and oversight activities in support of the delivery of successful project outcomes in accordance with the Project Management and Controls standards, procedures, and instructions.

- Ensures that project plans are effectively developed and performance is effectively monitored against those plans in order to manage project status, issues, risks, and actions being taken, by the Project Team, the Program Management Office, and Project stakeholders.
- Communicates with senior internal stakeholders, with EPC vendor(s), and with external stakeholders, i.e. external oversight.
- Assists the Program Management Office/Project Planning and Project Control Function in establishing standards and ensuring adherence to those standards as it relates to performing project Planning and Project Control activities.

10.7 Project Controls Office – Refurb funded P&M Projects

Resourcing Strategy:

- Matrix Project PC leads are embedded in each bundle to support each project manager and budgeted within the project manager budget.
- Matrix Functional PC leads are embedded in Engineering, OP&M organization to support these organizations and budgeted within the project control integration budget.
- Program PC lead position to perform independent self assessments in a regular basis and budgeted within the project control integration budget.

Roles and Responsibilities for Project Planning and Project Control (PC) Lead General Accountabilities:

The P&C Lead provides project management and controls leadership to the project team and Engineering, Procurement and Construction (EPC) vendor(s), including; estimating, scheduling, project planning, cost management, forecasting and reporting, risk management and change control management.

- Responsible to the project manager, performs project planning, controlling, and oversight activities in support of the delivery of successful project outcomes in accordance with the Project Management and Controls standards, procedures, and instructions.
- Ensures that project plans are effectively developed and performance is effectively monitored against those plans in order to manage project status, issues, risks, and actions being taken, by the Project Team, the Program Management Office, and Project stakeholders.
- Communicates with senior internal stakeholders, with EPC vendor(s), and with external stakeholders, i.e. external oversight.
- Assists the Program Management Office/Project Planning and Project Control Function in establishing standards and ensuring adherence to those standards as it relates to performing project Planning and Project Control activities.

10.8 Legacy Departments

These departments had critical activities during the definition phase, however, have been consolidated for the Execution Phase, or activities will be complete prior to execution.

10.8.1 Release Quality Estimate Project

The RQE Project will be resourced from 2014 until 2016 with a Manager and purchased service labour support; *due to the short term nature of the project*. Additionally, independent 3rd Party Assessments will be conducted using purchased service labour.

The RQE management plan includes details regarding the RQE Project integration and interfaces with various Refurbishment Program Organizations

Additional Roles and Responsibilities related to the development of the RQE Estimate are defined in the RQE Strategy and Progression Guide (NK38-NR-PLAN-09701-10005).

10.8.2 Integration

The RQE Project will be resourced from 2014 until 2016 with a Manager and purchased service labour support; *due to the short term nature of the project*. Additionally, independent 3rd Party Assessments will be conducted using purchased service labour.

The RQE management plan includes details regarding the RQE Project integration and interfaces with various Refurbishment Program Organizations

Additional Roles and Responsibilities related to the development of the RQE Estimate are defined in the RQE Strategy and Progression Guide (NK38-NR-PLAN-09701-10005).

10.8.3 Estimating and Program Scope Management

The RQE Project will be resourced from 2014 until 2016 with a Manager and purchased service labour support; *due to the short term nature of the project*. Additionally, independent 3rd Party Assessments will be conducted using purchased service labour.

The RQE management plan includes details regarding the RQE Project integration and interfaces with various Refurbishment Program Organizations

Additional Roles and Responsibilities related to the development of the RQE Estimate are defined in the RQE Strategy and Progression Guide (NK38-NR-PLAN-09701-10005).

11.0 APPENDICES

RQE - Resource Template - Director Office

Unit #	Project #	Local	Owner	Work Package Description	Resource Type L1	Resource Type L2	Resource Type L3	Resource Type L4 (Job Family)	Unit	Additional Information	Annual Rate incl OT (2015), $K Reference Only	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
U2	73036	00701	Rose, Gary	Interest	Non_Labour	Interest	Interest		$	Interest P&C Consolidated		0.0	0.0									
U2	73036	10101	Rose, Gary	Program Management	Labour	Core	Regular	Band DF	FTE		$208	1.0	1.0	1.0	1.0	0.5						
U2	73036	10101	Rose, Gary	Program Management	Labour	Core	Regular	Band G	FTE	Project Controls Office (Matrixed to VP Execution for Engineering)	$208	0.0	0.0									
U2	73036	10101	Rose, Gary	Program Management	Labour	Core	Regular	ManagAsst	FTE		$80	1.0	1.0	1.0	1.0	0.5						
U2	73036	10102	Rose, Gary	P&C Support	Non_Labour	Contracts	Non_EPC		$			300.0	200.0	200.0	100.0	0.0						
U2	73036	00501	Rose, Gary	Expenses	Non_Labour	Expenses	Business_Expenses		$			74.0	63.0	62.0	60.0	29.5						
U2	73036	10102	Rose, Gary	P&C Support	Non_Labour	Contracts	Non_EPC		$	Scheduling Self Assessment		150.0	150.0	150.0	150.0	37.5						
U3	73037	00701	Rose, Gary	Interest	Non_Labour	Interest	Interest		$	Interest P&C Consolidated		0.0	0.0									
U3	73037	10101	Rose, Gary	Program Management	Labour	Core	Regular	Band DF	FTE		$208	0.0	0.0			0.5	0.5	0.5	0.5			
U3	73037	10101	Rose, Gary	Program Management	Labour	Core	Regular	Band G	FTE		$208	0.0	0.0									
U3	73037	10101	Rose, Gary	Program Management	Labour	Core	Regular	ManagAsst	FTE		$80	0.0	0.0			0.5	0.5	0.5	0.5			
U3	73037	10102	Rose, Gary	P&C Support	Non_Labour	Contracts	Non_EPC		$			0.0	0.0			0.0	0.0	0.0	0.0			
U3	73037	00501	Rose, Gary	Expenses	Non_Labour	Expenses	Business_Expenses		$			0.0	0.0			29.5	29.5	29.0	28.0			
U2	73037	10102	Rose, Gary	P&C Support	Non_Labour	Contracts	Non_EPC		$	Scheduling Self Assessment		0.0	0.0			37.5	37.5					
U4	73038	00701	Rose, Gary	Interest	Non_Labour	Interest	Interest		$	Interest P&C Consolidated		0.0	0.0									
U4	73038	10101	Rose, Gary	Program Management	Labour	Core	Regular	Band DF	FTE		$208	0.0	0.0							0.5	1.0	0.5
U4	73038	10101	Rose, Gary	Program Management	Labour	Core	Regular	Band G	FTE		$208	0.0	0.0									
U4	73038	10101	Rose, Gary	Program Management	Labour	Core	Regular	ManagAsst	FTE		$80	0.0	0.0							0.5	1.0	0.5
U4	73038	10102	Rose, Gary	P&C Support	Non_Labour	Contracts	Non_EPC		$			0.0	0.0							0.0		
U4	73038	00501	Rose, Gary	Expenses	Non_Labour	Expenses	Business_Expenses		$			0.0	0.0							23.5	45.0	15.0
	Subtotal, FTE	21							FTE	21		2	2	2	2	2	2	2	2	2	2	1
	Subtotal, $	$65,405							$	$2,148		524	413	412	310	134	134	58	56	47	45	15

RQE - Resource Template - Project and Mods Support

Unit #	Project #	Local	Owner	Work Package Description	Resource Type L1	Resource Type L2	Resource Type L3	Resource Type L4 (Job Family)	Unit	Additional Information	Annual Rate incl OT (2015), $K Reference Only	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
UD				various					$			0.0	0.0	0.0									
UD	73013	70101	Rose	Project Planning	Labour	Core	Regular	Band G	FTE	Manager	$208	0.0	1.0	0.5									
UD	73013	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	1.0	0.3									
UD	73013	70101	Rose	Project Planning	Labour	Matrix	Regular	AnalystCS	FTE	P&M CSA	$169	0.0	2.0	0.5									
U2	73036	70101	Rose	Project Planning	Labour	Core	Regular	Band G	FTE	Manager	$208	0.0	0.0	0.0									
U2	73036	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U2	73036	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U3	73037	70101	Rose	Project Planning	Labour	Core	Regular	Band G	FTE	Manager	$208	0.0	0.0	0.0									
U3	73037	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U3	73037	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U4	73038	70101	Rose	Project Planning	Labour	Core	Regular	Band G	FTE	Manager	$208	0.0	0.0	0.0									
U4	73038	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U4	73038	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U4	73038	70101	Rose	Project Planning	Labour	Core	Regular	Band G	FTE	Manager	$208	0.0	0.0	0.0									
U4	73038	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U4	73038	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U0	73091	70101	Rose	Project Planning	Labour	Core	Regular	Band G	FTE	Manager	$208	0.0	0.0	0.0									
U0	73091	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
U0	73091	70101	Rose	Project Planning	Labour	Matrix	Regular	SpeclstBus	FTE	P&M PC Lead	$169	0.0	0.0	0.0									
	Insert new line above this row. Add in Cash flow tab the same number of rows.											0	0	0									
	Subtotal, FTE	5							FTE			0	4	1	0	0	0	0	0	0	0	0	0
	Subtotal, $	0							$			0	0	0	0	0	0	0	0	0	0	0	0

RQE - Resource Template - Scheduling

Unit #	Project #	Local	Owner	Work Package Description	Resource Type L1	Resource Type L2	Resource Type L3	Resource Type L4 (Job Family)	Unit	Additional Information	Annual Rate incl OT (2015), $K Reference Only	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
U2	73036	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	SecMgrBus	FTE		$169	1	1	0.0	0.0	0.0						
U2	73036	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	SecMgrBus	FTE	Move 1 to Outage Matrix	$169	1	1	1.0	1.0	0.5						
U2	73036	20201	Mcauley, Derek	Coordination and Control Schedule Development	Labour	Core	Regular	AnalystCS	FTE	Programatic Support	$169	2	2	2.0	2.0	1.0						
U2	73036	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	AnalystCS	FTE	Functional Support- Eng2/Ops&Mtc1/Misc/ Added One More CSA for Eng EWMS 2015-	$169	1	1	0.0	0.0	0.0						
U2	73036	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	Band G	FTE	Manager	$208	1	1	1.0	1.0	0.5						
U2	73036	20102	Mcauley, Derek	Purchase Services Scheduling and Oversight	Non_Labour	Contracts	Non_EPC		$	Scheduling Self Assessment		0	0									
U3	73037	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	SecMgrBus	FTE		$169	0	0			0.0	0.0	0.0	0.0			
U3	73037	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	SecMgrBus	FTE	Move 1 to Outage Matrix	$169	0	0			0.5	0.5	0.5	0.5			
U3	73037	20201	Mcauley, Derek	Coordination and Control Schedule Development	Labour	Core	Regular	AnalystCS	FTE	Programatic Support	$169	0	0			1.0	1.0	1.0	1.0			
U3	73037	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	AnalystCS	FTE	Functional Support- Eng2/Ops&Mtc1	$169	0	0			0.0	0.0	0.0	0.0			
U3	73037	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	Band G	FTE	Manager	$208	0	0			0.5	0.5	0.5	0.5			
U3	73037	20102	Mcauley, Derek	Purchase Services Scheduling and Oversight	Non_Labour	Contracts	Non_EPC		$	Scheduling Self Assessment		0	0									
U1	73035	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	SecMgrBus	FTE		$169	0	0				0.0	0.0	0.0	0.0		
U1	73035	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	SecMgrBus	FTE	Move 1 to Outage Matrix	$169	0	0				0.5	0.5	0.5	0.5		
U1	73035	20201	Mcauley, Derek	Coordination and Control Schedule Development	Labour	Core	Regular	AnalystCS	FTE	Programatic Support	$169	0	0				1.0	1.0	1.0	1.0		
U1	73035	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	AnalystCS	FTE	Functional Support- Eng2/Ops&Mtc1	$169	0	0				0.0	0.0	0.0	0.0		
U1	73035	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	Band G	FTE	Manager	$208	0	0						0.5	0.5		
U1	73035	20102	Mcauley, Derek	Purchase Services Scheduling and Oversight	Non_Labour	Contracts	Non_EPC		$	Scheduling Self Assessment		0	0					0.0	0.0	0.0		
U4	73038	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	SecMgrBus	FTE		$169	0	0							0.0	0.0	0.0
U4	73038	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	SecMgrBus	FTE	Move 1 to Outage Matrix	$169	0	0							0.5	1.0	0.5
U4	73038	20201	Mcauley, Derek	Coordination and Control Schedule Development	Labour	Core	Regular	AnalystCS	FTE	Programatic Support	$169	0	0							1.0	2.0	0.5
U4	73038	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	AnalystCS	FTE	Functional Support- Eng2/Ops&Mtc1	$169	0	0							0.0	0.0	0.0
U4	73038	20101	Mcauley, Derek	Program Level Scheduling and Oversight	Labour	Core	Regular	Band G	FTE	Manager	$208	0	0							0.5	1.0	0.5
Insert new line above this row. Add in Cash flow tab the same number of rows.												0	0									
Subtotal, FTE		43.5							FTE			6	6	4	4	4	4	4	4	4	4	2
Subtotal, $		0							$			0	0	0	0	0	0	0	0	0	0	0

RQE - Resource Template - Reporting

Unit #	Project #	Local	Owner	Work Package Description	Resource Type L1	Resource Type L2	Resource Type L3	Resource Type L4 (Job Family)	Unit	Additional Information	Annual Rate incl OT (2015), $K Reference Only	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
U2	73036	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	Band G	FTE	Program Management - Reporting	$208	1.0	1.0	1.0	1.0	0.5						
U2	73036	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	SecMgrBus	FTE	Section Manager - Reporting	$169	1.0	1.0	1.0	1.0	0.5						
U2	73036	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	SpecistBus	FTE	External Reporting	$169	1.0	1.0	1.0	1.0							
U2	73036	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Aug	SpecistBus	FTE	Internal Project Reporting	$169	2.0	2.0	2.0	2.0	0.5						
U2	73036	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	OBU	OBU	SpecistBus	FTE	Internal Project Reporting - CIO	$169	2.0	2.0	2.0	2.0	0.5						
U2	73036	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	AnalystCS	FTE	Data Integrity SPOC	$169	1.0	1.0	1.0	1.0	0.5						
U2	73036	50101	GREENLAND,Lindsay	Project Status Reporting	Non_Labour	Contracts	Non_EPC		$	IDB Database Management		250.0	500.0	500.0	500.0	125.0						
U2	73036	50101	GREENLAND,Lindsay	Project Status Reporting	Non_Labour	Contracts	Non_EPC		$	Section Manager - IT and Data Management		0.0	0.0	0.0	0.0	0.0						
U3	73037	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	Band G	FTE	Program Management - Reporting	$208	0.0	0.0			0.0	0.0	0.0	0.0			
U3	73037	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	SecMgrBus	FTE	Section Manager - Reporting	$169	0.0	0.0			0.5	0.5	0.5	0.5			
U3	73037	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	SpecistBus	FTE	External Reporting	$169	0.0	0.0			1.0	0.5	0.5	0.5			
U3	73037	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Aug	SpecistBus	FTE	Internal Project Reporting	$169	0.0	0.0			0.5	0.5	0.5	0.5			
U3	73037	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	OBU	OBU	SpecistBus	FTE	Internal Project Reporting - CIO	$169	0.0	0.0			0.5	0.5	0.5	0.5			
U3	73037	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	AnalystCS	FTE	Data Integrity SPOC	$169	0.0	0.0			0.5	0.5	0.5	0.5			
U3	73037	50101	GREENLAND,Lindsay	Project Status Reporting	Non_Labour	Contracts	Non_EPC		$	IDB Database Management		0.0	0.0			125.0	125.0	125.0				
U3	73037	50101	GREENLAND,Lindsay	Project Status Reporting	Non_Labour	Contracts	Non_EPC		$	Section Manager - IT and Data Management		0.0	0.0									
U1	73035	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	Band G	FTE	Program Management - Reporting	$208	0.0	0.0				0.0	0.0	0.0			
U1	73035	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	SecMgrBus	FTE	Section Manager - Reporting	$169	0.0	0.0				0.5	0.5	0.5			
U1	73035	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	SpecistBus	FTE	External Reporting	$169	0.0	0.0				0.5	0.5	0.5			
U1	73035	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Aug	SpecistBus	FTE	Internal Project Reporting	$169	0.0	0.0				0.5	0.5	0.5			
U1	73035	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	OBU	OBU	SpecistBus	FTE	Internal Project Reporting - CIO	$169	0.0	0.0				0.5	0.5	0.5			
U1	73035	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	AnalystCS	FTE	Data Integrity SPOC	$169	0.0	0.0				0.5	0.5	0.5			
U1	73035	50101	GREENLAND,Lindsay	Project Status Reporting	Non_Labour	Contracts	Non_EPC		$	IDB Database Management		0.0	0.0				125.0	125.0	125.0			
U1	73035	50101	GREENLAND,Lindsay	Project Status Reporting	Non_Labour	Contracts	Non_EPC		$	Section Manager - IT and Data Management		0.0	0.0									
U4	73038	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	Band G	FTE	Program Management - Reporting	$208	0.0	0.0							0.0	0.0	0.0
U4	73038	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	SecMgrBus	FTE	Section Manager - Reporting	$169	0.0	0.0							0.5	1.0	1.0
U4	73038	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	SpecistBus	FTE	External Reporting	$169	0.0	0.0							0.5	1.0	0.5
U4	73038	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Aug	SpecistBus	FTE	Internal Project Reporting	$169	0.0	0.0							0.5	1.0	0.5
U4	73038	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	OBU	OBU	SpecistBus	FTE	Internal Project Reporting - CIO	$169	0.0	0.0							0.5	0.5	0.5
U4	73038	50101	GREENLAND,Lindsay	Project Status Reporting	Labour	Core	Regular	AnalystCS	FTE	Data Integrity SPOC	$169	0.0	0.0							0.5	1.0	0.0
U4	73038	50101	GREENLAND,Lindsay	Project Status Reporting	Non_Labour	Contracts	Non_EPC		$	IDB Database Management		0.0	0.0							0.0	0.0	0.0
U4	73038	50101	GREENLAND,Lindsay	Project Status Reporting	Non_Labour	Contracts	Non_EPC		$	Section Manager - IT and Data Management		0.0	0.0									
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	Subtotal, FTE	64							FTE			8	8	8	8	6	5	5	5	5	5	3
	Subtotal, $	$2,625							$			250	500	500	500	250	250	250	125	0	0	0

RQE - Resource Template - Cost Department

Unit #	Project #	Local	Owner	Work Package Description	Resource Type L1	Resource Type L2	Resource Type L3	Resource Type L4 (Job Family)	Unit	Additional Information	Annual Rate incl OT (2015), $K Reference Only	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
U2	73036	30101	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	Band G	FTE	Chatterjee, Deepa	$208	1.00	1.00	1.00	1.00	0.50						
U2	73036	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SMEng	FTE	N Chan + 1 FTE for Estimating	$159	1.50	2.00	2.00	2.00	1.00						
U2	73036	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SrSpecIstBus	FTE	Alberto + 1 FTE Estimating	$169	2.00	2.00	2.00	2.00	1.00						
U2	73036	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	AnalystCS	FTE	J Della Pia, M Courtney, L Schippers, TBD CSA (2 CSAs in 2016 is contingent, to support centralizing cost managament function) + 2 FTE for Estimating	$169	6.00	7.00	7.00	6.00	3.00						
U2	73036	30104	Chatterjee, Deepa	Project Cost Management	Non_Labour	Contracts	Non_EPC		$	Estimating Services		0.00	100.00	100.00	50.00							
U2	73036	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SecMgrBus	FTE	2 PC Leads for Functional Transferred from Integration Department 2016-2026	$169	2.00	2.00	2.00	2.00	1.00						
U3	73037	30101	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	Band G	FTE	Chatterjee, Deepa	$208	0.00	0.00			0.50	0.50	0.50	0.50			
U3	73037	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SMEng	FTE	N Chan	$159	0.00	0.00			1.00	0.50	0.50	0.50			
U3	73037	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SrSpecIstBus	FTE	Alberto + 1 MP5	$169	0.00	0.00			1.00	1.00	1.00	1.00			
U3	73037	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	AnalystCS	FTE	J Della Pia, M Courtney, L Schippers, TBD CSA + 2 FTE for Estimating	$169	0.00	0.00			3.00	3.00	3.00	3.00			
U3	73037	30104	Chatterjee, Deepa	Project Cost Management	Non_Labour	Contracts	Non_EPC		$	Estimating Services		0.00	0.00	50.00	50.00	50.00	50.00					
U3	73037	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SecMgrBus	FTE	2 PC Leads for Functional Transferred from Integration Department 2016-2026	$169	0.00	0.00			1.00	1.00	1.00	1.00			
U1	73035	30101	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	Band G	FTE	Chatterjee, Deepa	$208	0.00	0.00				0.50	0.50	0.50	0.50		
U1	73035	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SMEng	FTE	N Chan	$159	0.00	0.00				0.50	0.50	0.50	0.50		
U1	73035	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SrSpecIstBus	FTE	Alberto + 1 MP5	$169	0.00	0.00				1.00	1.00	1.00	1.00		
U1	73035	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	AnalystCS	FTE	J Della Pia, M Courtney, L Schippers, TBD CSA + 2 FTE for Estimating	$169	0.00	0.00				3.00	3.00	3.00	3.00		
U1	73035	30104	Chatterjee, Deepa	Project Cost Management	Non_Labour	Contracts	Non_EPC		$	Estimating Services		0.00	0.00			50.00	50.00					
U1	73035	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SecMgrBus	FTE	2 PC Leads for Functional Transferred from Integration Department 2016-2026	$169	0.00	0.00				1.00	1.00	1.00	1.00		
U4	73038	30101	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	Band G	FTE	Chatterjee, Deepa	$208	0.00	0.00							0.50	1.00	0.50
U4	73038	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SMEng	FTE	N Chan	$159	0.00	0.00							0.50	1.00	0.50
U4	73038	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SrSpecIstBus	FTE	Alberto + 1 MP5	$169	0.00	0.00							1.00	2.00	1.00
U4	73038	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	AnalystCS	FTE	J Della Pia, M Courtney, L Schippers, TBD CSA + 2 FTE for Estimating	$169	0.00	0.00							3.00	3.00	1.50
U4	73038	30104	Chatterjee, Deepa	Project Cost Management	Non_Labour	Contracts	Non_EPC		$	Estimating Services		0.00	0.00					50.00				
U4	73038	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SecMgrBus	FTE	2 PC Leads for Functional Transferred from Integration Department 2016-2026	$169	0.00	0.00							1.00	2.00	1.00
U0	73072	30101	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	Band G	FTE	Chatterjee, Deepa	$208	0.00	0.00									0.50
U0	73072	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SMEng	FTE	N Chan	$159	0.00	0.00									0.25
U0	73072	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SrSpecIstBus	FTE	Alberto + 1 MP5	$169	0.00	0.00									1.00
U0	73072	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	AnalystCS	FTE	J Della Pia, M Courtney, L Schippers, TBD CSA + 2 FTE for Estimating	$169	0.00	0.00									1.50
U0	73072	30103	Chatterjee, Deepa	Project Cost Management	Labour	Core	Regular	SecMgrBus	FTE	2 PC Leads for Functional Transferred from Integration Department 2016-2026	$169	0.00	0.00									1.00
	Insert new line above this row. Add in Cash flow tab the same number of rows.											0	0									
	Subtotal, FTE	132							FTE			13	14	14	14	13	12	12	12	12	9	9
	Subtotal, $	$600							$			0	100	150	100	100	100	50	0	0	0	0

RQE - Resource Template - Risk and Infra Structure Department

Unit #	Project #	Local	Owner	Work Package Description	Resource Type L1	Resource Type L2	Resource Type L3	Resource Type L4 (Job Family)	Unit	Additional Information	Annual Rate incl OT (2015), SK Reference Only	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
U2	73036	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	Admin	FTE	3 EDMS Clerks	$111	3	3	3.0	1.5							
U2	73036	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	FLMANucIncSVHO	FTE	Angela Webster	$159	1	1	1.0	0.5							
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	Walid	$176	1	1	1.0	0.5							
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Jennifer Lafferty - IT Projects Coordinator	$195	195	0									
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Tarik - IT Projects Coordinator	$195	195	0									
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstBus	FTE	OPEX/LL Coord/SCR Coord (Donna/Valerie) - Position Deleted	$169	0	0									
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Joe - OPEX Function will be managed through MSOJoe	$176	0	0									
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	IT Admistration and Process Support for OPEX/LL (TBD)	$176	0	0									
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	Band G	FTE	Ryan	$208	1	1	1.0	0.5							
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Lisa	$176	1	1	1.0	0.5							
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	NR Project Risk Coordinators - Atef + 1 (NR) - (Removed for all units as per Ryan/Andy	$176	0	0	2.0	1.0							
U2	73036	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	AISC Project Risk Coordinators - 1 (AISC) + 1 (AISC)	$176	0	0									
U2	73036	60202	Smith, Ryan	IT Projects Development	Non_Labour	Contracts	Non_EPC		$	IT Project - EV (Earned Value) Application Modifications		210	0									
U2	73036	60202	Smith, Ryan	IT Projects Development	Non_Labour	Contracts	Non_EPC		$	IT Project - PIF (Proliance Integration File) Modifications		238	0									
U2	73036	60202	Smith, Ryan	IT Projects Development	Non_Labour	Contracts	Non_EPC		$	IT Project - AS7 to P6 Integration Data Volume Capacity Planning		400	0									
U2	73036	60202	Smith, Ryan	IT Projects Development	Non_Labour	Contracts	Non_EPC		$	IT Project - RMO Phase 3		400	0									
U2	73036	60202	Smith, Ryan	IT Projects Development	Non_Labour	Contracts	Non_EPC		$	IT Project - P6 Toolkit		50	0									
U2	73036	60202	Smith, Ryan	IT Projects Development	Non_Labour	Contracts	Non_EPC		$	IT Project - DSR Database Migration		150	0									
U2	73036	60202	Smith, Ryan	IT Projects Development	Non_Labour	Contracts	Non_EPC		$	IT Project - Projects in Conceptual Phase		120	120									
U2	73036	60203	Smith, Ryan	WiFi project	Non_Labour	Contracts	Non_EPC		$	WiFi Projects		5,604	0									
U3	73037	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	Admin	FTE	3 EDMS Clerks	$111	0.00	0.00		1.50	3.00	1.50	1.50				
U3	73037	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	FLMANucIncSVHO	FTE	Angela Webster	$159	0.00	0.00		0.50	1.00	0.50	0.50				
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	Walid	$176	0.00	0.00		0.50	1.00	0.50	0.50				
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Jennifer Lafferty - IT Projects Coordinator	$195	195	0									
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Tarik - IT Projects Coordinator	$195	195	0									
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstBus	FTE	OPEX/LL Coord/SCR Coord (Donna/Valerie)	$169	0.00	0.00									
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Joe - OPEX Function will be managed through MSO	$176	0.00	0.00									
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	IT Admistration and Process Support for OPEX/LL (TBD)	$176	0.00	0.00									
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	Band G	FTE	Ryan	$208	0.00	0.00		0.50	1.00	0.50	0.50				
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Lisa	$176	0.00	0.00		0.50	1.00	0.50	0.50				
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	NR Project Risk Coordinators - Atef + 1 (NR) - (Removed for all units as per Ryan/Andy	$176	0.00	0.00									
U3	73037	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	AISC Project Risk Coordinators - 1 (AISC) + 1 (AISC)	$176	0.00	0.00									
U3	73037	60203	Smith, Ryan	WiFi project	Non_Labour	Contracts	Non_EPC		$	WiFi Projects		0	0									
U4	73038	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	Admin	FTE	3 EDMS Clerks	$111	0.00	0.00				1.50	1.50	1.50	1.50		
U4	73038	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	FLMANucIncSVHO	FTE	Angela Webster	$159	0.00	0.00				0.50	0.50	0.50	0.50		
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	Walid	$176	0.00	0.00				0.50	0.50	0.50	0.50		
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Jennifer Lafferty - IT Projects Coordinator	$195	0	0									

RQE - Resource Template - Risk and Infra Structure Department

U1	73051	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Tarik - IT Project Coordinator	$195	0	0										
U1	73052	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpeclstBus	FTE	OPEX/LL Coord/SCR Coord (Donna/Valerie)	$169	0.00	0.00										
U1	73053	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Joe	$176	0.00	0.00										
U1	73054	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	IT Administration and Process Support for OPEX/LL (TBD)	$176	0.00	0.00										
U1	73055	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	Band G	FTE	Ryan	$208	0.00	0.00				0.50	0.50	0.50	0.50			
U1	73056	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Lisa	$176	0.00	0.00				0.50	0.50	0.50	0.50			
U1	73057	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	NR Project Risk Coordinators - Atef + 1 (NR)	$176	0.00	0.00										
U1	73058	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	AISC Project Risk Coordinators - 1 (AISC) + 1 (AISC)	$176	0.00	0.00										
U4	73038	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	Admin	FTE	3 EDMS Clerks	$111	0.00	0.00							1.50	1.50	3.00	
U4	73038	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	FLMANucIncSVHO	FTE	Angela Webster	$159	0.00	0.00							0.50	0.50	1.00	
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	Walid	$176	0.00	0.00							0.50	0.50	1.00	
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Jennifer Lafferty - IT Projects Coordinator	$195	0	0										
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Tarik - IT Projects Coordinator	$195	0	0										
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpeclstBus	FTE	OPEX/LL Coord/SCR Coord (Donna/Valerie)	$169	0.00	0.00										
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Joe	$176	0.00	0.00										
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	IT Admistration and Process Support for OPEX/LL (TBD)	$176	0.00	0.00										
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	Band G	FTE	Ryan	$208	0.00	0.00							0.50	0.50	1.00	
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Lisa	$176	0.00	0.00							0.50	0.50	1.00	
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	NR Project Risk Coordinators - Atef + 1 (NR)	$176	0.00	0.00										
U4	73038	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	AISC Project Risk Coordinators - 1 (AISC) + 1 (AISC)	$176	0.00	0.00										
U0	73072	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	Admin	FTE	3 EDMS Clerks	$111	0.00	0.00										
U0	73072	40105	Smith, Ryan	EDMS - Management Team - LOE	Labour	OBU	OBU	FLMANucIncSVHO	FTE	Angela Webster	$159	0.00	0.00										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	Walid	$176	0.00	0.00										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Jennifer Lafferty - IT Projects Coordinator	$195	0	0										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Non_Labour	Contracts	Non_EPC		$	Tarik - IT Projects Coordinator	$195	0	0										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	OPEX/LL Coord/SCR Coord (Donna)	$176	0.00	0.00										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Joe	$176	0.00	0.00										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpeclstBus	FTE	IT Admistration and Process Support (TBD)	$169	0.00	0.00										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	Band G	FTE	Ryan	$208	0.00	0.00										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SMTech	FTE	Lisa	$176	0.00	0.00										
U0	73072	40101	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	NR Project Risk Coordinators - Atef + 1 (NR)	$176	0.00	0.00										
U0	00000	ASIC	Smith, Ryan	Infrastructure and Risk Management - Oversight and Support	Labour	Core	Regular	SpclstTech	FTE	AISC Project Risk Coordinators - 1 (AISC) + 1 (AISC)	$176	0.00	0.00										
	Subtotal, FTE	73							FTE			7.00	7.00	9.00	8.00	7.00	7.00	7.00	7.00	7.00	7.00	0.00	
	Subtotal, $	11,752							$			11,632	120	0	0	0	0	0	0	0	0	0	

ONTARIOPOWER GENERATION

Plan

OPG Confidential	
Document Number: NK38-PLAN-09701-10223	Usage Classification: N/A
Sheet Number: 0009	Revision: R001

Title:
DR Program Support Functional Management Plan

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DR Program Support Functional Management Plan

NK38-PLAN-09701-10223-R001
2015-07-06

Order Number: N/A
Other Reference Number:

OPG Confidential

Prepared by: 2015-07-06
Steve Wiacek — Date
Controller (Program Support Project Manager)

Approved by: 2016-07-10
Gary Rose — Date
Director, Project Controls

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Revision Summary

Revision Number	Date	Comments
R000	2014-06-18	Initial issue.
R001	2015-02-18	Revised for RQE submission.

1.0 PURPOSE

This functional management plan defines the cost groupings and major work strategies in the Darlington Refurbishment (DR) Program Support Project.

2.0 MISSION

The Program Support Project was created in 2012 to capture various overhead and support costs for the DR Program. The project has several cost groupings with unique missions that aim to encompass the overall Refurbishment Project mission.

3.0 SVP OFFICE

3.1 Scope and Responsibilities

The SVP Office provides executive level leadership and oversight to the Refurbishment Project.

The position will no longer be filled as RPET/ NPET members will become direct reports to the SVP, Nuclear Projects.

4.0 DNGS INTEGRATION

4.1 Scope and Responsibilities

The DNGS integrators role includes;

Integrator 1:

- Coordinating campus plan activities,
- Breaking down barriers to getting work plans approved and resolution of conflicts between station and NR activities, day to day PCC interface,
- Coordinate the placement of all work removed from NR scope to ensure the work is completed in regular outages or in the project portfolio,
- Coordinate the Darlington Operator Resource Team (DORTs) on behalf of the station,
- Integration point for shared milestones between Refurb and the station

Integrator 2:

- Improving Fuel Handling reliability and integrating the Fuel Handling NR projects into the plan. This includes ensuring the appropriate staffing levels to both execute the work and defuel the unit within the schedule, ensuring no delays

Integrator 3:

- Integrate and manage the Defueling campaign commissioning

4.2 Resource Plan

Three station employees to 2016, future integration needs are included in the Project Execution plan and aligned with VP Refurbishment Execution.

5.0 FINANCE

5.1 Scope and Responsibilities

Nuclear Refurbishment (NR) Finance aims to be a trusted business partner with the NR Management Team by providing value-added advice focusing on financial reporting and controls.

5.2 Strategies and Initiatives

Interface with Corporate Finance functions, including; Business Planning and Reporting, Financial Services (ACTG, Transaction Processing), Tax, Risk, Investment Planning, Audit and Controllership (for Other Business Units (OBU) /Swing staff alignment).

5.3 Risk and Opportunities

Timely and accurate financial reporting and analysis, ensuring all matters pertaining to NR are properly reflected on the OPG financial statements based on US GAAP.

Ensure compliance with OPGs financial systems, policies and procedures with appropriate controls in place (Tempus, Oncore, Concur, Readsoft, NFRA, SAP, AS7, OAR, ICOFR, MD&A, Disclosure Items).

Major contract advice and support, such as; CFSTs, Pricing Evaluation Teams, Oncore utilization, invoice review and contractor audit.

5.4 Performance Measurement and Reporting

Direct accountability on key NR deliverables including; annual business planning, budgeting & forecasting, BCS and BoD requests and OEB evidence & interrogatories.

Financial oversight & challenge role to key NR deliverables including; Gate & purchase requisition reviews, Project & EV reporting, NR staffing & overtime controls and Portfolio management (FIP).

5.5 Resource Plan

Finance support is aligned with the OPG Other Business Units (OBU) Resource Plan. Functional support is provided from organizations outside of Refurbishment using OPG resources. Staffing is planned over the project to reflect the work profile defined in the Business Plans.

6.0 REGULATORY AFFAIRS (&CNSC)

Please refer to the *Darlington Refurbishment Licensing Management Plan – NK38-NR-PLAN-09701-10001-0007-R001*.

Refurbishment Assumptions for the RQE estimate:

- Estimate for 2015 to breaker open based on 2014/2015 RAP + 2015/2016 RAP and prorated by CNSC identified NR incremental effort.
- Upon breaker open (Oct 2016) assumption is 25% allocation of total CNSC fees with the remaining 75% to the operating units.
- Assumption is 50% for NR 2 unit outages (Q1 2021 - Q1 2024) of total CNSC fees with the remaining 50% to operating units.
- Assumption of 25% of total CNSC fees from Q2 2024-Q3 2025 with the remaining 75% to operating units.

7.0 COMMUNICATIONS

Please refer to the *Darlington Refurbishment Communications Program Management Plan – NK38-NR-PLAN-09701-10001-0014-R001*.

8.0 PEOPLE & CULTURE – HR (& MEMORANDUM OF UNDERSTANDING)

Please refer to the *Darlington Refurbishment Staffing Program Management Plan – NK38-NR-PLAN-09701-10001-0016-R002*.

9.0 PEOPLE & CULTURE – LABOUR RELATIONS

9.1 Scope and Responsibilities

Labour Relations (LR) support is provided in the following areas:

- Nuclear Projects Agreement: negotiating revisions to all 18 construction agreements for work in Nuclear (including Refurbishment)
- Refurbishment CPAA Classification: carriage of the ongoing CPAA dispute with PWU & BTU over the original work assignments and ongoing LR support for changes in scope and how that impacts the existing / future work assignments. The CPAA Steering Committee will have some kind of ongoing role in future Refurbishment work going forward and LR is responsible for the Steering Committee.
- Refurbishment PSA: non-trades PSA with the PWU for the work not covered by CPAA work assignments. Preparation for arbitration, business case development, meetings with the PWU to negotiate a settlement.
- BTU Greenmanning Training Team: established to begin training classes of BTU to perform the RP support role for BTU work on Refurbishment. Established a year + ago and will continue for at least another year until a contractor takes over the training (OPG is currently responsible for training the BTUs and we provide LR support for this training
- General LR support to Refurbishment for BTU Issues: e.g., Labour Requirements in contracts, offsite fabrication requirements for procurement, EPSCA jurisdictional status of the DEC, liaise with the BTUs regarding Refurbishment issues/ questions, CUSW rights to Refurbishment work, implementation of the NPA, etc.

9.2 Strategies and Initiatives

Going forward Labour Relations will support:

- Jurisdictional claims between the PWU and Trades for Balance of Work
- Society labour relations advice and guidance

9.3 Resource Plan

Funding for 1 FTE of Labour Relations support throughout the Refurbishment Project.

10.0 OTHER COST GROUPINGS

10.1 PWU Admin Support

PWU Admin Support resources are pooled and costs are held centrally within this project.

10.2 DEC Operating Costs

DEC operating costs include; labour, EPS & Materials, Utilities and Property Taxes. Based on occupancy percentage, the assumption for Nuclear Refurbishment's share of the overall costs is currently 90.4% and under review.

While it is anticipated there may be an opportunity in future for NR's decreased use, and cost for DEC office space – the timing or % is not quantifiable at this time. Current DEC space freed up by projects staff move to RPO (early 2016) will be offset by move back on CM, and Engineering staff, as well as NR's increased space needs.

There is a Durham wide space planning committee in place at the Nuclear level, but impacts on NR not known at this time.

10.3 Facilities Supplies

Please refer to *Assumption Log ID 00000712.* The facility supply budget planned centrally in Program Support includes all costs for office supplies (pens, paper, etc.) and printer maintenance and service call requests for all Refurbishment offices. The Refurbishment facilities offices include Darlington Energy Complex, RPO Building, RFRISA Building, RWPB Building, East Warehouse, Work Control Trailer and RP Trailer.

10.4 IT Overhead Costs

IT Overhead costs include the budget for Software licenses and New Horizon Service Desk support.

10.5 MTO Car Pool Initiative

As part of the Transport and Work Equipment (TWE) Fleet Optimization Initiative, OPG launched a car pooling initiative through a partnership with the Ministry of Transportation (MTO). As of Q4, 2014, the MTO costs for all Nuclear Projects employees will be expensed to the SVP Nuclear Projects Base OM&A RC.

10.6 Insurance (Liability / Property)

Please refer to the *DNGS Refurbishment Project – Owner Controlled Insurance Program NK38-REP-09701-0548245* for information on the Basis of Estimate.

OPG will provide insurance coverage for the entire Darlington GS Refurbishment Project under an Owner Controlled Insurance Program (OCIP), except for those

policies required to be provided by the Contractor. The OCIP includes insurance for the Early Works and Execution starting from 2013 to 2025, including 24 months extended maintenance cover. The Early Works insurance policy includes Primary Wrap-up Liability coverage and Builders All Risk coverage. All OCIP insurance policies are or to be purchased through the insurance Broker Marsh Canada Limited while the refurbishment program progress.

10.7 Travel / Expenses

Please refer to *Assumption Log ID 00000536*. The current RQE and Business Plan estimate assumes $1.5k per year of Business Travel Expenses (BTE) for every full time equivalent (FTE) plus an additional $15k per year for each RPET member, for both Definition and Execution phases.

10.8 Overtime

Please refer to *Assumption Log ID 00000536*. For Execution phase (2016 - 2026), the estimate will include 2 weeks (typically 35 hours per week) of overtime for every represented full time equivalent (FTE) included for each year.

10.9 Relocation Costs

Please refer to *Assumption Log ID 00000536*. Employee relocation costs are estimated at $250k per year (covers all regular staff) for the duration of Refurbishment Program (2015 – 2026).

10.10 Interest

Please refer to *Assumption Log ID 00000536*. Interest is applied to Capital projects until the asset is placed in service. Interest is calculated for project planning purposes by applying an interest rate to the monthly interest bearing base. The proposed rate is aligned with Corporate Investment Planning and the Refurbishment BCS and is higher than the OPG Business Planning instructions. The rate takes into account the borrowing is for a longer-term and therefore the short-term cost of debt does not apply.

11.0 APPENDIX – PROGRAM SUPPORT WBS

Nuclear Refurbishment Functional Program Support WBS	
WBS Description	**FMP Section**
00501 - Expenses	10.0
00701 - Interest	10.0
00711 - Program Mgmt Interest- Unreleased	10.0
10000 - SVP Program Mgmt	3.0
10101 - SVP Overhead	3.0
10201 - Management Consulting	3.0
20000 - Licensing Support- Program Mgmt	6.0
20101 - DN Licensing Support	6.0
20501 - CNSC License Fees	6.0
20504 - Licensing - Purchase Services	6.0
30000 - Communications- Program Mgmt	7.0
30101 - Strategic Oversight and Partnership Management	7.0
30201 - External Independent Oversight	7.0
30301 - Internal Independent Oversight	7.0
30401 - Third Party Review	7.0
30601 - Communications	7.0
30602 - Publications and Displays	7.0
40000 - Finance- Program Mgmt	5.0
40101 - Finance Support	5.0
50101 - Human Resources Support	8.0
50102 - Society MOU-PSA	8.0
60000 - Program Infrastructure- Project Mgmt	10.0
60101 - Facilities Building Management	10.0
60102 - Infrastructure Equipment for DEC and Satelite Offices	10.0
60201 - Administrative Services	10.0
60301 - Office Supplies and Equipment	10.0
60401 - Corporate Information Technology Licences and Support	10.0
60402 - IT Development Support and Oversight	10.0
60501 - NR Program Campus Plan Overhead and Site Land Use Planning (CP)	10.0
60601 - NR Program Liability Insurance	10.0
60602 - Insurance	10.0
60701 - NR Fleet Vehicles	10.0
70000 - Refurb Interface- Project Mgmt	4.0
70101 - DNGS Refurb Interface	4.0

ONTARIO POWER GENERATION

Plan

Document Number:	Usage Classification:
NK38-PLAN-09701-10223	N/A
Sheet Number:	Revision:
0010	R00

Title:
DARLINGTON REFURBISHMENT SUPPLY CHAIN FUNCTIONAL MANAGEMENT PLAN

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Darlington Refurbishment Supply Chain Functional Management Plan

NK38-PLAN-09701-10223-0010-R00
2015-08-15

Order Number: N/A
Other Reference Number:

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Revision Summary

Revision Number	Date	Comments
R00	2015-08-15	New document due to renumbering (superseded NK38-NR-PLAN-09701-10001 R01)

1.0 PURPOSE

The purpose of the Refurbishment Supply Chain (RSC) Functional Management Plan is to define the scope of services, deliverables, work activities and the responsibilities as related to the Nuclear Refurbishment (NR) program.

RSC is comprised of four distinct supply chain groups, all reporting to the centre led Business Administrative Services (BAS) Supply Chain. The primary group is Refurbishment Supply Chain which is matrixed to the NR program, but is also supported by Projects and Modifications SC, Vendor Oversight, and Darlington SC. The NR program is divided into 7 sub-projects. The model adopted by the NR program is to contract the work scope for each of the major sub-projects to a qualified Engineering Procurement and Construction (EPC) contractor through approved OPG procurement procedures. The actual engineering, procurement and construction work for a sub-project is performed by an External EPC contractor and not OPG. In some cases, a RSC Single Point of Contact (SPOC) from Refurb Supply Chain is matrixed to major sub-projects.

The RSC SPOC supports each of the sub-projects with the required Supply Chain/Procurement related work activities and deliverables. RSC is also composed of a “functional” component which establishes and facilitates the Supply Chain/Procurement standards through the RSC SPOC to support the sub-projects.

In addition, recently, the NR Organization has requested RSC to provide procurement support for materials. The requirements are not fully identified therefore resources are not solidified. The resources allocated to support this effort are based on estimated volumes of materials requiring procurement by RSC.

2.0 PROGRAM REQUIREMENTS

2.1 Mission

The mission of RSC is to support the project team as part of BAS Supply Chain with all procurement related activities in relation to overall cost, schedule and quality of the project. RSC will provide oversight on EPC contractor procurement activities, in coordination with the RSC SPOC and as documented in Project Oversight Plan.

2.2 Scope & Responsibilities

2.2.1 Scope

The objectives of the RSC Organization are to ensure the following is achieved for all procurement or supply chain matters:

a) Cost certainty and an appropriate/optimal level of risk transfer has occurred in each contract

b) Value for money is achieved

c) Projects are delivered efficiently, on time and with safety and production risks minimized.

2.2.2 Contract Strategy

The contract strategy determines the level of integration required between engineering design, procurement and construction for a given project. The contract strategy should support the project objectives in terms of risk transfer, delivery of goods or services and cost. Various contract strategies can be used; determination of the appropriate contract strategy is based on the following parameters:

a) level of importance of performance in the completed work

b) delivery time of the end product or service

c) bundling of the work (i.e determination of EPC, EP, PC etc.)

d) whether OPG will be “Constructor” or “Owner Only”

e) ability to administer and manage the contractual arrangement

The Project Organization is accountable for defining the contract strategy for all Refurbishment and Projects & Modifications work.

2.2.3 Procurement Strategy

The primary consideration of the procurement function in large projects is to ensure the correct procurement strategy is selected to align with the contract type to achieve the best value for money. The purpose of a procurement strategy is to achieve a balance of risk and control within each project. Items that are considered when developing the procurement strategy include:

a) addressing risks and constraints in the Scope of Work or Technical Specification in the contract documents

b) level of risk to be transferred to the vendor

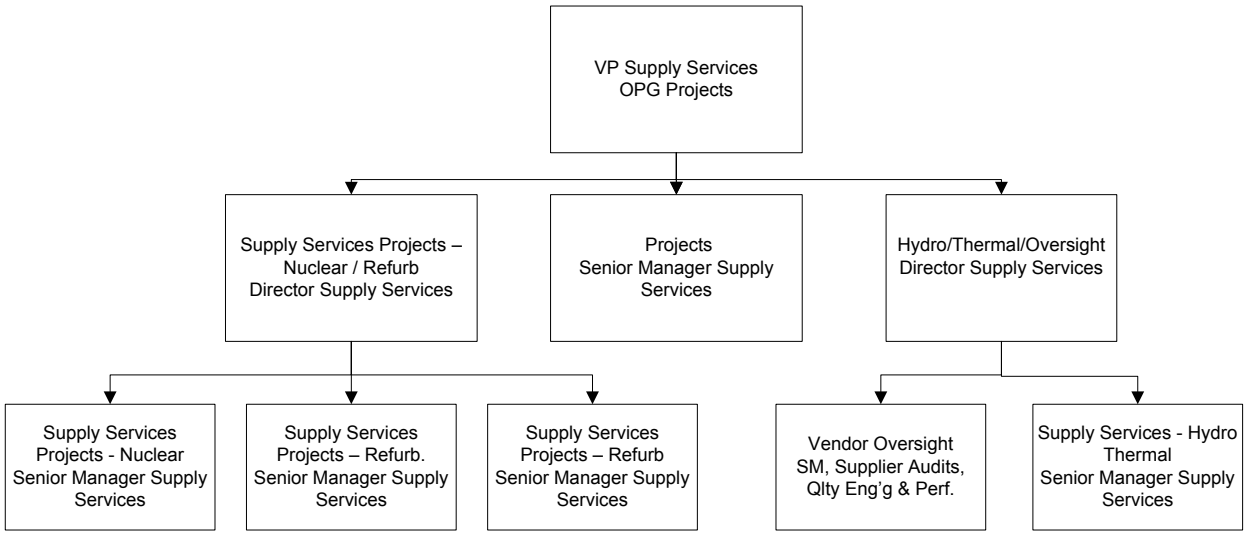
c) what needs to be done to achieve optimal risk transfer

d) timing of project execution

e) evaluation of availability and capability of vendors the ‘Make vs. Buy’ Decision and impact on the overall contract

2.2.4 The RSC is accountable for the procurement strategy and procurement oversight of all Refurbishment and Projects & Modifications work Responsibilities

This section describes the responsibilities of RSC throughout the Darlington Refurbishment Project (DRP) life cycle.



a) Award contracts on project scopes of work by using established procurement processes outlined in OPG-PROC-0164, Procurement Activities: Projects.

b) Assist projects in the identification, assessment and preparation/recommendation of strategies for DRP long lead and at risk materials and refurbishment related scope in Projects and Modifications.

c) Ensure the procurement process for the NR Program and sub-project contracts are in compliance with OPG-PROC-0164, Procurement Activities: Projects and N-COI-00120-00001, Contractor/Owner Interface Requirements for Nuclear.

d) Provide oversight of the contractor's procurement process based upon risk significance graded approach.

e) Support the RSC SPOC for a specific project to provide input on supply, procurement and quality services in the overall project oversight plans.

f) Provide commercial and/or contract administration of the EPC contractor/OPG contracts, for contract management/ administrative activities related to Supply Chain. Manage all procurement processes start to finish, including RFP documents, bid evaluation, negotiations and final award. Turnover conformed contract to Project Representative to manage. Prepare and process all amendments, manage changes to Letters of Credit and keep files up to date,

process/manage all formal claims, address contract changes and disputes that cannot be resolved by Project Representative.

g) Update purchase orders and contracts for approved contract amendments.

h) Support project in the resolution of contractor disputes, and lead the negotiation on any claims.

i) Support internal and external audits related to the procurement and materials management processes.

j) Qualify EPC contractors in collaboration with Strategic Sourcing Planning and Quality.

k) Verify that all EPC contractors and suppliers are qualified and on OPG's Approved Suppliers List (ASL). EPC contractors are encouraged to use sub-suppliers which are already approved on OPG ASL. However where a supplier is not in OPG ASL or the scope of qualification for a supplier needs to be changed, the EPC contractor shall inform OPG of potential new suppliers and obtain acceptance to use the new supplier.

l) Develop and execute activities related to contractor scorecards based on overall supply, quality and procurement activities.

m) Define Spare parts receiving process for projects to ensure all required spare parts are delivered as per schedule with all required supporting documentation.

n) Assist the Project in issuance of any existing material from the warehouse.

o) Manage non-conformances and take appropriate actions (eg. NCARs).

The Project Manager is responsible for the overall cost, schedule and quality of the project and RSC will provide support in oversight activities as the centre of excellence.

2.3 Assumptions & Constraints

Description of the assumptions and constraints for the DR program Supply Chain division:

a) Timelines for procurement support to projects follows standard procurement practices. Expedited timelines will require additional resources not budgeted for.

b) Scope of Work documents and technical specifications provided by Engineering are delivered as scheduled to support supply chain contract services and material procurement.

c) Work scope is defined in a timely manner and is of a sufficient detail to determine Long Lead Materials (LLMs), material at risk, strategy development and procurement.

d) RSC workload peaks in years 2015 to 2017 due to ongoing releases of new RFPs and contracts into Execution Phase of the project.

e) It is assumed that all materials management will be performed by the EPC contractors. Any materials procurement not completed by the EPC contractor will be limited to the requests/lists received from the project organization as of June 20, 2014.

f) Material Requests (MRs) to be completed by others

g) A portion of existing Supply Chain staff supporting Pickering would become available to support the Refurb Work Program beginning in 2021. Similarly, a portion of the Darlington Supply Chain staff would become available to support the Refurb Work Program in 2017.

h) For all “C” Contracts only, Spare parts procurement for each refurbished unit would be procured by OPG Supply Chain.

i) BASSC is responsible for qualification of EPC contractors/Suppliers on OPG ASL.

j) Refurbishment Design Support Group responsible to create Cat IDs.

k) A single EPC contractor for each of the sub- projects will be established.

l) Qualified EPC contractors are available.

m) Whenever BASSC is responsible for the procurement of material and services, the current OPG governance and practices will be followed. Interface agreement to define roles and responsibilities will exist.

n) All prerequisite items not part of the scope of work will be dealt with separately.

o) Since some of the new contracts are not purely EPC in nature, care is required in adjustment of oversight activities.

p) Qualified and experienced staff will be available to perform oversight and other supply chain functions.

q) Contracting Strategy followed:

    1. Retube Feeder Replacement (EPC)

    2. Islanding (Mix of EPC & ESMSA)

    3. Shutdown & Layup (Mix of EPC & ESMSA)

    4. Steam Generator (EPC)

5. Turbine Generator (EP and ESES Contract)
6. Fuel Handling (E and PC)
7. Balance of Plant – (Mix of E and ESMSA)
8. Other Projects
    i. Projects & Modifications – (ESMSA)

2.4 Strategy

This section defines the strategies of RSC for the completion of work scope described in Section 2.2. for the Procurement of Materials and Services:

(a) Oversight activities to be performed in accordance with N-GUID-09701-10022, Supply Chain Oversight Guide in the following Supply Chain activities:

a) Procurement process for NR program and the sub-project contracts.

b) Supply Chain/Procurement oversight of the EPC contractor for work post contract award.

c) Long lead and at risk material identification and mitigation.

d) Qualification of EPC contractors.

(b) Work shall be completed in accordance with OPG-PROC-0164, Procurement Activities: Projects and N-PROG-MM-0001, Materials Management.

(c) At risk and Long Lead Material will be managed by the Project Manager.

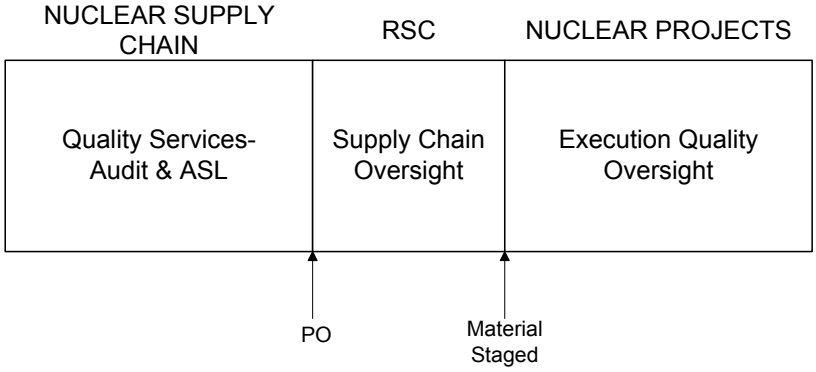
(d) The Refurbishment Project will utilize the existing OPG ESMSA Agreement whenever appropriate to leverage the contractors and/or to reduce timelines in lieu of establishing a new agreement specifically for the Refurbishment project.

(e) In accordance with OPG-PROC-0164, the Cross Functional Sourcing Team (CFST) will be engaged to provide required support on major contracts.

(f) All purchase orders shall be approved in accordance with OPG-STD-0017, Organizational Authority Register (OAR). All material/service requests shall be approved in accordance with the OAR, and N-PROC-MM-0001.

(g) RSC SPOC will be matrixed to selected project teams and the work direction will be provided by the Project Manager, while the RSC maintains the functional management accountability.

(h) The interface between Supply Chain Quality Services (SCQS), RSC and Projects, related to procurement oversight activities is shown below:



(i) Commercial turnover documentation will be provided to the execution management staff identifying the key elements of the negotiated contracts, specifically focusing on the commercial terms of the contract.

(j) EPC qualification of contractors as per N-PROC-MM-0010, Establishing and Maintaining Ontario Power Generation Nuclear Approved Suppliers List.

(k) Materials will be procured by EPC Vendor for most contracts. Any exception will be managed by RSC, as per requirements for material procurement provided to RSC on June 20, 2014 during 2015-2017 Business Plan Challenge Meetings with the Refurbishment Program Executive Team.

(l) Strategies for the execution of Supply Chain activities and processes are managed and directed by Centre Led Corporate Supply Chain initiatives. The Projects Supply Chain group participate and provide input into these initiatives to best meet overall goals of project supply chain excellence.

2.5 Milestones and Key Dates

Remaining key milestone date for the RSC are the award of the Fuel Handling Powertrack Refurbishment Contract in 2015.

All other milestone dates for major contracts have been achieved to date.

2.6 Major Work Summaries

(a) Definition Phase Activities:

- Support pre-execution contracts, including preliminary/design engineering, reports and analysis, competitive RFP's and Work Requests for major projects and ESMSA.
- Negotiate and award major contracts.

- Implement contract amendments, manage the contract amendment process.
- Support project managers in vendor management/oversight of procurement of long lead materials for EPC Contracts.
- Participate and support audit programs.
- Review Procurement/Material/Quality Plans for EPC contracts.
- Provide Oversight on Procurement Quality activities of the EPC contractors.
- Initiate SCR as required and follow up on internal CARs created by EPC contractor on Oversight findings/observations.
- Provide oversight on sub-suppliers of EPC contractors.
- Participate in the qualification process of vendors in OPG ASL by SCQS.

(b) Execution Phase Activities:

- Support contract administration and management of large EPC Contracts for major projects.
- Address any claims/warranty work, contract amendments, contract renewals/renegotiation and ongoing work programs.
- Receipt materials and free issue to EPC Contractor in conjunction with SCQS, where applicable.
- Participate and support audit programs.
- Purchase spare parts for “C” contracts only.
- Provide oversight on procurement activities for emergent and incremental scope.

(c) Project Close Out Activities:

- Address all outstanding claims, payments and contractual obligations.
- Close out Purchase Orders, properly file and document contract history.
- Participate and support audit programs.

2.7 Risk

2.7.1 At Risk and Long Lead Materials

For the EPC contracts, materials will be procured by the EPC contractor under their QA Program. To satisfy the outage milestone, long lead materials needs to be identified and procured in a timely manner. The long lead materials are defined as any material which has 6 month or more delivery time after purchase order is issued. Also, the EPC Contractor should identify any other material which may have a risk to the delivery schedule.

2.7.2 General Risks

The current Supply Chain organization is resourced based on known work demands or contract requirements. Should the Projects Organization change their contracting strategy or requirements for major contracts, there is a risk that sufficient Supply Chain resources will not be available to support incoming work beyond what is known.

All other Supply Chain risks are managed through the centre led Corporate Supply Chain group, in which Refurbishment Supply Chain and Projects and Modifications Supply Chain is incorporated.

2.8 Resource Plan

The resourcing strategy for the project includes a complement of both full time and temporary staff (Management, Society and PWU) as well as contract staff to meet project deliverables and schedule milestone dates.

These projects individually have different contracting strategies; however, most projects executed as part of the Refurb Program follow an “Engineer – Procure – Construct” or “EPC” Contracting Strategy. This “EPC” contracting strategy allocates most project commercial risk and liability to the contractor, including schedule risk, financial risk, procurement risk, scope risk and more. Of the seven sub-projects, contracts have been awarded for SG, TG, RFR, Defueling (Fuel Handling) and Islanding (Bulkhead). Remaining contracts to be awarded are Balance of Plant and Fuel Handling. Radiation Protection Services is planned to be self performed. Most of fuel handling scope has been removed from refurbishment.

Refurb Supply Chain and Station Supply Chain are working together for purchasing activities relating to materials procurement. Currently there are staff funded from Refurb budget who are working under Station Supply Chain supervision to complete Refurb related cyclical and PM work scope. During transition the same approach will continue as Refurb and Station Supply Chain continue to work together, accommodating changes as the work scope increases or decreases on each side based on the type of work. The funding for the Refurb work has already been allocated in the budget and the details can be found in release 4D.

<u>Procurement Oversight</u>

Currently, a combination of OPG staff and contractors are in the process of defining and refining the oversight process and also performing the oversight. Existing staff complement is as follows:

- 1 FTE Manager (Band H)
- 4 FTE(s) Sr. Procurement Specialists (MP 5)*
- 3 FTE(s) Assistant Procurement Specialist (MP 3)**
- 1 Managed Task Contractor
- 1 Augmented Staff Contractor

**** one position vacant***
***** three positions vacant***

The oversight on EPC contractors starts right after the contract is awarded. Oversight guidelines have been developed for different stages of the EPC Contractor Procurement Process including manufacturing activities at sub-suppliers locations. During the Refurbishment outages, there will still be regular maintenance work carried out related to Preventive Maintenance (PM) and cyclical scope and some of the work may be executed by OPG. The roles and responsibilities were clarified in a recent communication to the entire Project Management Team. The Supply Chain support will be as per normal Outage and Innage activities and Darlington Station Supply Chain will continue to provide the support for such scopes of work. Two full time staff has been allocated to perform this work for Darlington Station Supply Chain.

In the event that the contracting strategy changes from an “EPC” model to a “PC” or “C” model, then additional resources in both the MP 3 and the MP 5 job categories will be required. Additional oversight support would be provided by Contract Staff (non OPG Staff). This is due to increased source surveillance and potential quality issues with vendors due to the need to manage interface issues between the “E” and the “PC” contractor. These resource requirements are defined further in subsections of this Report.

Projects and Modifications Procurement

The Supply Services – Projects and Modifications department supports Darlington Refurbishment projects as well as non-refurbishment projects at Darlington, Pickering, and NWMD.

Darlington Refurbishment work makes up approximately 60% of the department’s work. The majority of the work is performed through the ESMSA EPC agreements. Requirements to support material procurement are met through support from the station supply chain staff. Movement away from the EPC model toward OPG’s self performance of the procurement function will require additional materials management resources within the Supply Services – Projects organization.

The current Supply Services – Projects organization is composed of:

- 1 FTE Manager (Band G)
- 3 FTE Sr. Specialist Strategic Planning/ Senior Procurement Specialist (MP 5/6)
- 4 FTE Assistant Procurement Specialist (MP 3)

Refurbishment Procurement

The current Supply Chain group is organized and resourced to support the Darlington Refurbishment "EPC" Projects as described above. The assumption is that all design engineering, material procurement, construction services procurement will be completed through the award of a single 'EPC' contract (exceptions noted under 'Assumptions and Constraints'). Based on this assumption, current resources (Q2, 2015) allocated to support the DR Program are as follows:

- 2 FTE Manager (Band G)
- 1 FTE Management Administrative Assistant (Temporary)
- 6 FTE(s) Sr. Specialist Strategic Planning (MP 5/6)
- 7 FTE(s) Assistant Procurement Specialist (MP 3) (6 MP3's in 2016 and beyond)
- 1 Managed Task Contractor (F&G) – TCD: End of Q2, 2015
- 2 Augmented Staff Contractors – TCD: End of Refurbishment (BOP& RFR)

The role of the Supply Chain organization is to provide procurement support for the major contracts, including procurement strategy, RFP development, negotiating plans, negotiation/award of major contracts, development and approval of contract amendments, support to awarded contracts (claims management, dispute resolution, interpretation of agreements, processing of change orders, etc), contract closeout. In addition, Supply Chain supports other Refurb work programs, including Engineering Support (OSS Contract), Functional Support (Misc. Contracts, F&G Contract), Miscellaneous Major Contracts (PHT Pump Motor RFP, Valve RFP), Construction Services Oversight, EPAG.

Although both Band G mangers will support projects, one will also have the primary accountability to procure materials.

As per RSC Agreement with Refurbishment Execution – Projects, RSC will procure a limited amount of materials in support of the Project. The FTE's required to support this initiative are estimated based on current materials lists requiring procurement support (see Assumptions & Constraints). The estimated additional FTE's to support this initiative (for one Unit) are:

- 1 FTE Sr. Specialist Strategic Planning (MP 5)
- 4 FTE MP3 - Supporting Material request analysis
- 2.8 FTE MP3- Supporting Non-Safety related Cat IDs review
- 6.4 FTEs - MP3 - Bulk Purchasing etc

- 3.2 FTE Stock Keeper for Warehouse (PWU/BTU)

- 3.84 FTE Receiving Inspector/Source Surveillance Specialist (PWU)

It is anticipated that these resources will be acquired either through internal job postings or external hire. Given the refurbishment program timelines, some of these resources will need to be acquired by Q2, 2015 in an effort to support the purchase and procurement oversight of materials. Peak volume of material procurement is expected to occur during 2014-2016 for Unit 2 Outage. The same will be required for the remaining outages. Therefore, a contract FTE has been allocated to support this peak volume period.

As the DR Program moves closer to the first Refurbishment Outage, it is anticipated that work demand will peak in years 2015 – 2019 to manage the learning curve, then remain steady through subsequent Refurbishment Outages (i.e. 2021, 2022).

In the event that the ESMSA Contracting Strategy changes from an “EPC” model to a “PC” or “C” model, then additional resources in both the PWU, MP 3, MP 5 job categories will be required. This is primarily due to the increase in procurement work to purchase materials and award more large contracts to support engineering and construction work packages.

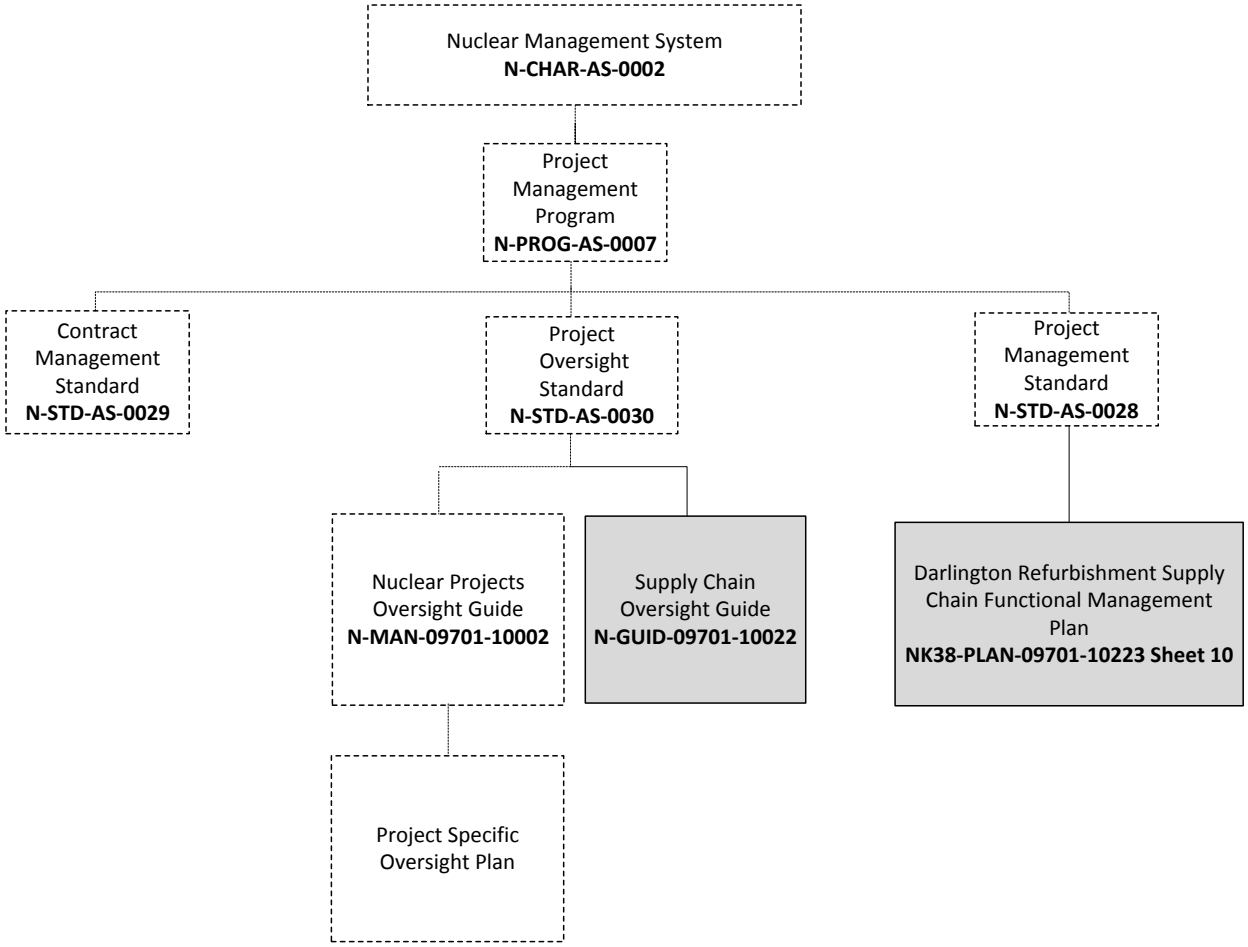
Currently, three FTE’s have been ‘matrixed’ to various project organizations, including RFR, TG/SG, and BOP. It is estimated that (2) additional Contractor FTEs may be required to support the RFR and BOP project in 2015 and beyond (Functional Direct).

Remaining resources in the RSC organization will provide ‘functional indirect support’ to the project organizations, as directed by the Vice President and Senior Manager of Supply Services - Projects

Any additional resources required to support temporary peak work volumes will be acquired as contract labour on an as needed basis (functional indirect).

2.9 Management Document List

In order to effectively manage the NR Program RSC has established various documents. The relationship among the various strategies and plans are shown below:



3.0 ROLES & ACCOUNTABILITIES

This section describes the roles and accountabilities within Darlington Refurbishment.

a) Project Manager

(i) Responsible and accountable for successfully completing the Project, on time, on budget and as per the specified quality requirements.

(ii) Responsible for all Project Activities/deliverables.

(iii) Responsible for managing the EPC contractor.

(iv) Approves the Project Oversight Plan and is accountable for all project oversight activities.

b) RSC SPOC

(i) Part of the Project Team as a functional group member matrixed to the Project for large EPC Contracts.

(ii) Responsible and accountable for supporting all the Projects Supply Chain related deliverables within the project.

(iii) Responsible for providing input to the Project Oversight Plans, working with peers in procurement oversight team to implement and report oversight activities as identified in the plan.

(iv) Ensures Supply Chain functional Standards are incorporated.

(v) Establishes effective communication ("the interface") between, Project Team, RSC, and EPC contractor for any procurement related issues.

(vi) Develops, implements and communicates KPI and metrics for procurement on behalf of the project.

(vii) Assists with managing contracts, preparing amendments, resolving commercial issues, interpretation/enforcement of terms, addressing claims.

(viii) Draws on the functional resources on an as needed basis.

c) Vice President Refurbishment Supply Chain

(i) Act as the customer service lead for BASSC to the NR Program.

(ii) Responsible/accountable for preparing the Procurement Oversight Plan, Implementing oversight activities as identified in the plan, KPI/metrics and communicating results.

d) Functional Organization

(i) Establishes the Supply Chain Standards.

(ii) Supports the Project in preparing the Project Procurement oversight Plan.

(iii) Supports the Project RSC SPOC in implementing and reporting the Procurement Oversight activities and functional standards as identified in the Project Oversight Plan.

(iv) Supports the Project RSC SPOC to prepare, implement and review/understand KPIs and metrics for Procurement Oversight.

(v) Supports Project Contract Management regarding Contract Management Issues.

(vi) Provides feedback to the Project Manager/ Project Team on Procurement Oversight KPIs/metrics and any project procurement related issues through the RSC SPOC.

(vii) Supports Project team in the negotiation and settlement of claims.

(viii) Provides Oversight of ASL for all projects.

(ix) Ensures adherence to corrective action program across contractors.

(x) Identifies adverse trends in a specific Project Oversight triggering the need to look across all the EPC contractors, or same contractor on a different project.

(xi) Is accountable for managing the process to address contract amendments, resolution of claims.

3.1.1 Other Business Unit Support

No.	Division	Support Requirement
1	BASSC	ASL Qualification & Requalification
		Material Analyst / Buyer
		Warehousing
2	Law	Procurement Process, EOI, RFP, RFQ, Negotiations & Contracts
3	Corporate risk and insurance	OCIP Development & OCIP Mgmt
4	Managed Systems Oversight	Governance Support

4.0 DEFINITIONS & ACRONYMS

ASL	Approved Supplier's List
BASSC	Business Administrative Services Supply Chain
CFST	Cross Functional Sourcing Team
DRP	Darlington Refurbishment Project
EOI	Expression of Interest
EPC	Engineering Procurement and Construction
KPI	Key Performance Indicator
LLM	Long Lead Material
MSA	Master Service Agreement
NR	Nuclear Refurbishment
OAR	Organizational Authority Register
OBU	Organizational Business Unit
OCIP	Owner Controlled Insurance Program
RFP	Request for Proposal

RFQ	Request for Quotation
RSC	Refurbishment Supply Chain
SPOC	Single Point of Contact

5.0 REFERENCES

- NK054-PROC-0025, DNNP Contract Management for EPC Company
- NK054-PROC-0043, DNNP Claims Management
- N-PROG-MM-0001, Materials Management
- N-PROC-MM-0001, Requisition of Services
- N-PROC-MM-0010, Establish and Maintain OPG Approved Supplier List
- N-PROC-MM-0016, Purchase Order Preparation and Award
- N-PROC-LE-0007, Nuclear Refurbishment – IIP Darlington
- OPG-PROC-0164, Procurement Activities : Projects

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Document Number: NK38-PLAN-09701-10223	Usage Classification: N/A
Sheet Number: 0012	Revision: R001

Title:
The Darlington Refurbishment Construction Execution Functional Management Plan

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The Darlington Refurbishment Construction Execution Functional Management Plan

NK38-PLAN-09701-10223-0012-R001
2015-10-10

Order Number: N/A
Other Reference Number:

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R	2015-08-12	Initial issue.
R001	2015-10-10	Include Safety Group, Training and Quality Group reference, remove Radiation Protection Detail

Records Table

The following Records may be generated by use of this document and shall be registered in the appropriate document management system in accordance with the following table:

Record Created	Associated Form or Template Number	QA Record? Y/N	Filing Information/Retention (AIMS Type/Sub-Type)
None	N/A	N	None

1.0 PURPOSE

This document details the scope, responsibilities and staffing requirements for the Construction Execution and Project Field Support function for the Darlington Nuclear Refurbishment Project. The information applies to the support and oversight requirements for each of the project bundles and site facilities required by the execution work force on site during the Darlington Refurbishment Project life cycle. This execution FMP offers additional details related to key execution support positions/groups noted as Supply Chain Integration, Programs Strategy, Project Unit Director 1 in addition to Safety Team and Training Group.

The Departments within the Construction Execution Division included in this FMP are:

- NR Supply Chain Integration
- NR Programs Strategy
- NR Project Unit Directors
- NR Training
- NR Conventional Safety

Note: The Execution Organization includes the Quality Management Group. Due to the complexity of the QMG a standalone Functional Management Plan is in place, reference NK38-PLAN-09701-10223 SHT 0014.

Note: For Nuclear Refurbishment Training Function reference N-TQD-901-00001 "Nuclear Refurbishment Training & Qualification Description and NK38-PLAN-09701-10007, "Darlington Refurbishment – Project Training Work Plan

2.0 VISION, MISSIONS AND OBJECTIVES

2.1 Vision

The vision of the Nuclear Refurbishment Construction Execution organization is to develop and proactively perform vendor support and oversight activities while maintaining high safety and quality standards leading up to and during the planning, execution and close out phases for the refurbishment of Darlington CANDU units. Following completion of the Refurbishment Program, all units will be returned to service reliable and leak free, with the intent of extending the operating life of each unit for 30 years.

2.2 Construction Execution Mission

Our mission is to ensure Darlington units are refurbished safely, efficiently, with quality and as scheduled with minimal impact on the operating units. We will provide proactive support and oversight on the planning, preparation (mobilization) and execution during construction activities by our vendor partners in order to provide assurance that the standards and contract obligations are met in the areas of Safety, Design, Quality and Schedule. The Darlington Refurbishment Construction Program Management Plan NK38-NR-PLAN-09701-10001 sheet 0012 provides the format by which each project bundle will be supported by the Construction Oversight Function.

- Programs Strategy function will develop and drive execution strategies proactively continuously seeking opportunities during the duration of Darlington's refurbishment.
- Project Unit Director 1 will integrate Execution's Release Quality Estimates (RQE) deliverables required from Project Managers through Q2, 2016.
- Supply Chain Integration will, in collaboration with the EPC Vendors develop and implement an integrated procurement and logistics oversight and guidance program.

2.3 NR Conventional Safety Mission

OPG will execute the DN Refurbishment project in a manner consistent with OPG's safety values and objectives. The project will be executed in a manner that holds **"Safety is our CORE Value"** as the critical commitment aspect for OPG and Contractors.

2.4 NR Training Mission

Due to the unique requirements associated with a refurbishment outage (multi-employer, owner-only islanding, Owner/Constructor configuration, the large scope and duration of the project, etc.), it is recognized that a dedicated training program is required for Darlington Refurbishment, to ensure that the Project is completed in a safe manner, on time, and on budget.

2.5 Objectives

Construction Oversight and Project Field Support for the Darlington Refurbishment will support the individual project directors proactively with qualified and competent resources that have the experience required to execute effective oversight management. Construction oversight group will interface with the Quality Management Group to coordinate and optimize oversight and surveillance activities.

Strategies will be in place and continuously developed to support an efficient and aligned effort throughout the Execution Organization.

Create and maintain an integrated database supporting Reports and Metrics related to DNRP Execution, including the tracking of Project related materials in transit, long and short term storage, inside and outside of the Protected Area.

3.0 SCOPE AND RESPONSIBILITIES

3.1 Phase 2 Preparation (Dec 2013 - Oct 2016)

The current phase of the Darlington Refurbishment Project has the Execution function supporting across the project bundles in the areas of identifying/monitoring risk, providing oversight for pre-Refurbishment field activities and Vendor program alignment/efficiencies.

Development of the construction execution strategy, a collaborative effort, working with Vendors and Bundle leadership to gain common understanding of activities has been issued and is considered a "living" document. (Ref. NK38-GUID-09701-10031)

- The Construction Oversight and Project Field Support Team (CO&PFS) will support the project teams and their Vendors with proactive coordination and supportive services. We will be acting as "enablers" and "barrier busters" directly supporting Vendor field activities.

- Construction oversight management includes monitoring and reporting on Vendor's performance for safety, quality and schedule. The CO&PFS and Quality Management Group will be responsible to ensure the Vendor is executing the work in accordance with the QA program specified in the contract.

The Program Strategy function generally deals cross-functional / cross-bundle issues. Work of the Program Strategy function will be reduced at the beginning of second Refurbishment (Unit 3) and be eliminated before the third unit is started. The work activities of the Program Strategy function will include providing support for the ongoing support to the VP Execution on

strategic and high level reporting and issue resolution. Program Strategy function maintains contact with INPO/WANO for activities supporting Refurbishment Execution and runs the Bruce Power collaboration activities. The work includes providing the Execution function with HIT/SIR team functionality for critical and emerging issues through the pre-execution and first unit Refurbishment. Team building and other organizational alignment initiatives will be carried out by the Program strategy function. The Project Management development will be another significant work activity. Program Strategy function coordinates with PAG, IA, CNSC and others on behalf of the Execution organization.

Execution RQE deliverables (estimates, schedules, PMP's, risks, assumptions) integrated along with an integrated database (metrics) is the responsibilities of the unit director.

Supply Chain Integration will support the project teams and their Vendors with the establishment and ongoing coordination of a Vendor operated integrated logistics system to provide both Owner Supplied and Vendor Supplied materials to the project.

Safety Team will integrate OPGs Conventional Safety principles with all Contractors working on Refurbishment as per NK38-PLAN-09701-10113-SFY-01. Prepare an Integrated Safety Plan while reviewing and approving of plans for Waste Handling and Conventional Safety training etc.

Nuclear Refurbishment (NR) Training Department will support project bundles developing and implementing Training Plans to ensure contractor staff are qualified to carryout refurbishment work as per NK38-PLAN-09701-10007, "Project Training Work Plan".

In addition, NR Training performs training oversight activities in support of project bundles as per NK38-GUID-09701-10021, "Guideline for Training Oversight".

3.2 Phase 3 Execution (Oct 2016 – 2026)

Oversight of Chemistry & Environment, Radiation Protection and Health & Safety

Managing normal waste and waste disposal.

Support Training Oversight activities for project bundles as per NK38-GUID-09701-10021 "Guideline for Training Oversight (refurbishment)" and N-GUID-09701-10122 "Guideline for Nuclear Refurbishment -Training Plan Development".

Ensure all NR modifications are analyzed for training impact by managing the NR Training Change Control (TCC) as per N-GUID-09701-10118 "Nuclear Refurbishment - Training Change Control"

Execution of Project Training Work Plans to update and maintain qualifications for plant staff including Modification and Return to Service (RTS) training

Ensure standards of safety (Nuclear, Conventional, Radiological Chemical and Environmental) are maintained.

Provide sustainable Vendor support and oversight of each Refurbishment project bundle. Monitor Behaviors, Safety, Quality, Schedules for;

- BOP
- TG / SG
- RFR / FH
- SDLU / RSF

4.0 BASIS AND ASSUMPTIONS

4.1 Basis

The basis driving this long term plan is:

- Effective field support and oversight is recognized industry wide as a key requirement for mega Construction Projects such as Darlington's Refurbishment.
- Continuous, planned and sustainable support/monitoring of Vendor activities results in improved project performance.
- Industry best practices and OPEX are utilized in planning and development of Construction Oversight/Field support organization and strategies.
- Significant issues and opportunities will arise throughout the Refurbishment Program
- Rapid development of cross functional strategies is needed to ensure continued effectiveness in Refurbishment execution.
- Utilization of robust integrated Reports and Metrics allow for greater understanding of large projects.

4.2 Execution Assumptions

- First unit outage commences October 2016, followed by the remaining units per the refurbishment schedule.
- The correct number of qualified staff is available either through transfers from PN/DN internally or through augmented staff process.

- Security Resourcing as per 2014 NK-38-REP-09701-0497224

4.3 Training Assumptions (543/544/545/546/547/550/551):

- Vendors are responsible to Train their workers and supply training materials to OPG with the with the exception of Radiation Protection, Work Protection, NGET, Interface & Islanding Training which is OPG Training's accountability.

- NR Projects to submit to NR Training, Vendor Resource graphs to describe estimate staff numbers by month and by trade bin for the duration of Unit 2 Project and to define Training Demand Estimate so Training Course Supply is planned to accommodate training demand.

- Training Target Population for Vendors conducting work under Extended Services Maser Services Agreement (ESMSA) – includes Vendors conducting Engineering, Procurement and Construction work under OPG Quality Assurance Program.

4.4 NR Conventional Safety Assumption

- NR Conventional Safety will be a days-based function and is not anticipated to be working shift or to be available for on-call. NR Conventional Safety Management staff will be available during off hours for notifications purposes.

- Vendors will follow their own Safety Programs (as per N-GUID-09701-10011 Safety Management Essentials) and will have their own safety personnel monitoring their program. Review of Vendor safety programs and oversight will be required from NR Conventional Safety staff to ensure programs meet standard and contract personnel are adhering to the program.

- Vendors to follow N-PROC-MA-0012 for OPG system work protection.

- Inside Vendor terminal points, follow work protection process that meets or exceeds OSHA and the Darlington Refurb Safety Management Essentials N-GUID-09701-10011 section 4.1 Strategies.

5.0 STRATEGIES/INITIATIVES

5.1 Execution

- Construction Oversight and Project Field Support will develop and sustain a philosophy of proactive "enablers" and "barrier busters", working closely with Vendors.
- Construction execution will develop a field support "coverage"plan based on risk which will effectively monitor, coach and support field activities.
- Construction Oversight and Project Field Support will increase staffing according to approved resourcing plan.
- Identify competencies and training requirements related to Construction Execution Team. A Construction Coordinator Qualification and training program is now in place with staff linked. Qualification ID. # 390033 - Contract Construction Coordinator.
- Roles within the Construction Execution Team will be defined to ensure clarity and understanding of expectations, duties and responsibilities.
- Collaborative efforts with Vendors to implement and align common processes and programs through duration of Refurbishment (pre and post)
- Identify and assist in addressing gaps in Vendors programs related to specific OPGN requirements
- Establish protocols for common requirements such as storage areas, scaffold tagging, return to work requirements etc.
- Support execution Projects both vertically and horizontally utilizing "embedded" Coordinators for key bundles as well as SME's for such things as Pressure Boundary and FME etc.
- The Program Strategy function develops the necessary strategic initiatives that facilitate smooth and continuous implementation of the Refurbishment work programs. The type, nature and extent of the strategic initiative will vary depending on the nature and extent of the issue or opportunity.

5.2 NR Training

- Refurbishment is accountable for training program definition, training plans development, co-ordination and scheduling including Vendor training plan oversight/acceptance; training materials development and delivery oversight
- There are two types of Vendor-supplied training during Darlington Refurbishment:

a) Training developed and delivered by Vendor to their own staff (i.e. under Vendor QA Program)

b) Training developed and delivered by Vendor to OPG staff (operators, maintainers, engineers, etc.) (i.e. under OPG QA Program). The strategy and guidance on the practice of developing training and to describe the practice overview, requirements, activities, and key terms related to these requirements are reflected in the N-PROC-TR-0002 Control Of Vendor-Supplied Training and N-GUID-09701-10122 Guideline for Nuclear Refurbishment – Training Plan Development

- N-TQD-901-00001 "Nuclear Refurbishment Training & Qualification Description", defines training and qualification requirements specific to the refurbishment program associated with DNGS. The TQD applies to Contractor Personnel, NR Project OPG Personnel and DNGS and OPG Nuclear Fleet personnel.

- NK38-PLAN-09701-10007, "Darlington Refurbishment – Project Training Work Plan" identifies the accountabilities for the OPG and Contractor training and qualification activities.

- Since there is only one Main Control Room for all units, all Shift Managers, Control Room Shift Supervisors and Authorized Nuclear Operators must have completed the Modifications Training prior to the first refurbished unit being restarted. All Darlington Certified staff will be trained on both ("new" and "old" units) including continuing training and testing. This will continue until Unit 4 enters refurbishment, at that point all training will be solely on the new units. This approach is reflected in the NK38-PLAN-09701-10007 "Darlington Refurbishment Project Training Work Plan". See below regarding the strategy for the use of two simulators during Darlington Refurbishment.

- There are no modifications to Unit 0 as part of Darlington Refurbishment. As a result, for any modifications that may take place for Unit 0, these will continue to follow the process of simulator upgrades that happens every summer during simulator outage. This is reflected in the NK38-PLAN-09701-10007, "Darlington Refurbishment – Project Training Work Plan".

- N-REP-08920-0556866 - "Darlington Refurbishment Modification Training Simulator Strategy" and NK38-REP-09701-0490153 "Study for Strategies for the Use of Two Simulators during Darlington Refurbishment" reflect the strategy for the use of the two Darlington Full Scope simulators during the duration of the Darlington Nuclear Refurbishment (NR) project (and related system modifications). This strategy was developed in the context of maximizing the two Darlington Full Scope Simulators efficient use for training (initial and continuing); testing (initial and requalification); Simulator maintenance and modification; Training material modification and upgrades (e.g. lesson

plan, SEG, course material). Training and certification / recertification processes must continue to ensure that currently certified ANOs will be able to continue to operate all four reactor units and control room supervisory staff (CRSS / SM) will be able to continue to provide oversight for all four reactor units. This will ensure there will be no impact on the Main Control Room Shift Complement / # of required certified staff. The strategy focuses only on the differences between the unit configurations and the impact this has on unit operation and thus the impact on training / testing using a full scope simulator.

5.3 NR Conventional Safety

- Conventional safety requirements will be specified to all contractors and oversight of the program will be provided by the NR Conventional Safety department.
- The conventional safety organization will report to the corporate safety organization and will be attached to the program.
- Evaluate and endorse the contractors' safety programs for implementation and use on the Darlington Refurbishment Project.
- Monitor, identify and communicate non-conformances with the contractors' safety programs and OPG's performance specification for management of conventional safety on the project.
- Assist the contractor to remediate areas of non-conformance within reason and in accordance with terms and conditions of the specific contract between OPG and the contractor.

6.0 MILESTONE AND KEY DATES

Specific milestones for Construction Oversight, Procurement and Logistics, Safety and other functions are now detailed in the Ready to Execute Plan under various Execution Groups Milestones. This RTE map is scrutinized bi-weekly by Senior Leadership and provides an integrated view of key Milestones related to Execution. Currently this function (RTE mapping) reflects milestones and factors set out and supported by Project Bundles based on the approved master schedule.

It is recognized that Construction readiness is predetermined by these factors and therefore these are the primary drivers that will be used to demonstrate construction readiness for execution in the field leading up to and during the refurbishment.

Vendor schedules including major component acquisitions and service contract issue are integrated by work management for tracking inside of the Outage Work Management tool for metric review and issue identification/resolution. Program Strategy team will have milestones and activities defined at time of specific plan/initiative development.

RQE integration and key metrics/reports support etc continue through Q2, 2016.

Material supply and integration will have indicators accepted by and integrated with the Vendors, to enable the Project Managers to track and monitor the procurement and logistics performance of each Vendor by project bundle and schedule window.

NR Training milestones are reflected in the RTE and PIMS schedules.

7.0 MAJOR WORK SUMMARIES

7.1 Execution

The major work summaries for this revision include;

- Vendor support and oversight on RFR, BOP, SG, TG, FH, SDLU & RSF
- General Services maintaining Refurb unit, RPO, RFRISA, East warehouse
- Resource sourcing and filling positions within the function
- Oversight on the Holt road/ highway 401 execution

Per the POP requirements monitor KPI's to demonstrate readiness to execute construction activities in:

- Environmental compliance.
- Quality
- Welding, Pressure boundary & code compliance.
- Field change compliance and documentation.
- Training oversight.
- FME oversight.
- Schedule adherence and quantitative surveys.
- CWP and field documentation conformance and adherence.
- Compliance with engineering design requirements and maintaining design basis.
- Mobilization/demobilization complete.
- Construction Completion Assurance Declaration.
- Safety Oversight

The Program Strategy function currently has multiple strategic initiatives underway. OPG / Bruce Power Collaboration

- WANO / INPO / IAEA Support and Oversight

- Project Manager Development and Enhancement Program
- Project Management Mentality Maturity
- Project Management Performance Improvement
- (Execution) Stakeholder management (Internal and External)
- Organizational Effectiveness and Refurbishment Team Alignment
- (Execution) Program and Project Change Control

7.2 Functions

#	Major Work Areas Functions	Owner
1	Strategies for Health and Safety Oversight	Manager NR Safety
2	Training Change Control including Training Needs Analysis for all modifications	Senior Manager Refurb Trng
3	Hire and Train Health and Safety Staff to support Refurb	Manager NR Safety
4	Ensure vendor safety programs standards are equivalent to OPG	Manager NR Safety
5	Contractor on-boarding training including Radiation Protection, Work Protection, NGET, Interface & Islanding Training	Senior Manager Refurb Trng
6	Training Oversight support for project bundles and NR Engineering	Senior Manager Refurb Trng

8.0 RISKS ACTIONS AND OPPORTUNITIES

The tables below was generated and acts as a summary for the intent of this section of the FMP from the Program/Project RADAR site with complete details of assignment owners and mitigation measures available on the respective team sites.

8.1 Execution RISKs

ID	Title	Risk Description	Risk Response Type
2	[illegible]	[illegible]	Mitigate
683	Poor EPC Vendor performance may require additional oversight during all phases, resulting in an increase in staff costs in OPG	Based on the experience of the past three CANDU refurbishments the Owner has had to become significantly involved in all phases (Definition through Execution) due to the vendor's inability to meet contractual commitments on cost, schedule and quality. This has required the Owner to build an oversight organization capable of supporting/enhancing the planning, execution and technical supervision of the work. Current EC forecast of OPG oversight management support for EPC contractors for Unit 1 and have the required capabilities to meet the contractual commitments on safety, quality, cost and schedule. Should the OPGX repeat itself on Unit 2 then significant schedule impact could occur and considerable qualified resources would be required.	Mitigate
687	Vendor OMP's are late and/or of poor quality, causing field execution delay, cost over	The risk is that Commissioning Work Packages (CWP) may enter execution ready needs required due to one of the following: late delivery of poor quality completed and detailed engineering, and/or lack of qualified resources to engage and review CWP's, and/or lack of a defined detailed management process and schedule in the engaged CWP vendor.	Mitigate
721	40 Rate Table for Construction Oversight Role	The 40 Rate Table was amended during the last phase of 40 planning. A Construction Oversight Role was identified but the rate in the rate table was a reduced substantially. The risk is that we may not be able to hire the qualified staff at the new assumed rate.	Accept
716	Increased Cost of Facility Maintenance may be underestimated.	The risk is that, due to not having a finalized contract, the assumptions around the costs of the Facility Maintenance contract are underestimated, resulting in cost increases to the project.	Mitigate
118610	Infrastructure facilities not available or are inadequate, e.g. complaints, overtime, [illegible]	The risk is associated to the fact that facilities are inadequate, e.g. leading to operational complaints, overtime, [illegible] Potable Water and Sewage facilities, [illegible]	Monitor

11969	OPG Owned Utilities need to be moved as part of Holt Rd./South Service Rd./Hwy 401 Realignment	OPG equipment, e.g. Near Boundary Gamma Monitors, Standby Generator, need to be moved due to the extensive construction taking place as part of the realignment. There could be a schedule impact to MTO's overall project if this work is not coordinated correctly.	Monitor
12222	Contingency Requirements for Holt Road Interchange Work Underrated	The risk is that the contingency requested at Gate 3 for the Holt Road work being performed by the MTO is underrated due to [illegible] of expertise in executing this type of work. This may result in a requirement to use additional contingency during execution of the work.	Avoid

8.2 Functions RISKs

ID	Title	Risk Description	Risk Response Type
550	Significant contractor event occurs	Risk of a [illegible] facility or serious injury caused by poor execution work practices would have a negative effect on the project schedule and result in financial loss.	Mitigate

The major risks associated with failing to properly staff the Program Strategy function are:

- Significant opportunities to produce greater value for OPG and our customers will be lost, and
- Significant issues will remain unaddressed and will turn into major threats to the Refurbishment program due to lack of timely intervention.
- Project infrastructure isn't at the desired performance level and additional external Mega-Construction support required via the Construction Owners Support Vendor
- Quality Management/Control of Vendors QA programs requires additional support and monitoring (FE/QS)
- Laundry costs elevated beyond 40M (estimate 57M)

8.3 Execution Opportunities

- Opportunities to explore having one Vendor supporting common needs of Vendors such as Scaffold storage and installation, Tool Crib, Chemical Cabinets etc where and when practical.
- Material movement utilizing single Vendor or single process
- Fall protection coordination
- Confined Space Coordination
- Asbestos sampling and removal
- Additional details tracked as vendor alignment initiatives (Vendor Leadership Meeting)

8.4 Functions Opportunities

The staffing strategy is strategically set up to reduce resourcing requirements after the first unit is refurbished. Once the level of support is clearly defined and new processes are in place and proven during the Test Period and First Unit, then staffing will be streamlined accordingly for subsequent units.

Here are some other examples of these value added, already implemented, sorted by each department.

8.4.1 Construction Execution

Based on OPEX from Bruce, Safe Storage, WANO and in alignment with AP930 (Supplemental workers) the OPG fleet Oversight std 32 along with the related Instruction was revised and aligned with industry best practice. Refurbishment Construction Execution played a key role in those revisions which now align the Nuclear Fleet in Supplemental worker oversight principals and fundamentals. The enhanced Construction Coordinator qualification utilized existing PELS (no new programs required) and added Mentorship/Qualification cards, Oral review Boards, Dynamic learning activities and final Interview by Construction Director to provide a robust field focused training and qualification process.

8.4.2 Conventional Safety

Conventional Safety will continue to utilize the Health and Safety centre-led function throughout the course of NR, allowing for the sharing of resources with the Health and Safety Solution Centre, Health and Safety Centre of Excellence and DNGS Safety Staff. A master service agreement has also been established to contract out Industrial Hygiene (IH) sampling services as needed instead of having an IH tech on staff. The sharing of these resources reduces duplication of effort and the number of dedicated health and safety staff required to support Refurbishment. In addition, the work being executed by vendors is being completed under the vendors' own Health and Safety programs allowing for greater efficiencies in a construction environment. OPG Health and Safety have developed N-GUID-09701-10011 Darlington Safety Management Essentials. This is the standard to which all vendor NR Health and Safety programs are held ensuring consistent quality of vendor health and safety programs

8.4.3 Training

- Training Budget has been structured to realize cost efficiencies with subsequent Units being refurbished as it is assumed that the majority of modifications are similar.
- Training Budget includes Contractor allocated funds to efficiently manage incremental training workload and supplement full time training staff.
- Opportunities for reduction to occur in the areas of Refurbishment Modifications Training Development and Delivery and support for incremental demand of on-boarding / in-processing training generated by the Refurbishment Program.

9.0 PERFORMANCE MEASUREMENT AND REPORTING

Construction Oversights reporting and measuring tools along with frequency of reporting will be as described within each of the associated POP's for the respective bundles and as per the contractual terms between OPG and the vendor. The requirements as outlined below will be monitored and reports generated for compliance in the areas of;

- Safety Performance
- Schedule Adherence
- Scope Control
- Technical Quality Performance Including Rework And Attention To Detail
- Interface And Communication Effectiveness
- Environmental Performance
- Contingency Plan Effectiveness
- Project Completion Risks

Support for Integrated Metrics and Reports will continue through completion of Darlington Refurbishment

Construction Execution will have a suite of indicators developed to indicate their specific functional performance. O&C, Coverage, Effectiveness, etc.

Program Strategy will have indicators defined and incorporated into each specific initiative. Indicators will reflect whether the initiative resulted in the improvement or goal initially targeted.

10.0 ORG RESOURCE PLAN

10.1 Execution Resource Plan

- This section describes the organization and staffing make-up for the Construction Oversight and Project Field Support function for the life cycle of the DR project life cycle. In general, Construction Oversight and Project Field Support resources increase from a target of 18 in Q2, 2016 to a high of 42 in 2017- 2020, reducing yearly to ~25 in 2025.

- Unit Director 1 currently has a staff of three which will be maintained through Q2, 2016.

- Programs Strategy team will increase resources to a total of four as detailed in the Org chart for the duration of the Darlington Refurbishment. Purchased Services will be used on an as need basis and funding will be requested as the necessary resources for individual initiatives are developed.

- The Supply Integration group will staff with two additional personnel (targeted for 2015) to provide direct procurement and logistics oversight.

- See Appendix A

- Construction Execution organization will provide field support staff to the DRP Quality Management (QM) organization. The selection of the field support staff will be performed by the Construction Execution organization with assistance from the QM organization to ensure availability of qualified staff. This strategy supports the QM organization meeting the objectives outlined in the DRP Quality Management Organization Functional Management Plan (NK38-PLAN-09701-10223 SHT XXX), as well as resource demands to perform field surveillance activities through all phases of the project.

10.2 Training – NR

- For Training Organization and Staffing Plan refer to NK38-REP-09701-10093, "White Paper: Darlington Refurbishment – Training management".

10.3 Conventional Safety – NR

- For Health and Safety Organization and Staffing Plan refer to NK38-PLAN-09701-10113-SFY-01, "Conventional Safety – Ownership Transfer Plan".

11.0 ABBREVIATIONS AND ACRONYMS

BoP	Balance of Plant
BTU	Building Trades Union
CAP	Corrective Action Plan
CNSC	Canadian Nuclear Safety Commission
CO&PFS	Construction Oversight and Project Field Support
CWP	Comprehensive Work Plans
EPC	Engineer Procure Construct
FME	Foreign Material Exclusion
KPI	Key Performance Indicators
MOE	Ontario Ministry of Environment
MOL	Ontario Ministry of Labour
MTO	Ontario Ministry of Transportation
NR	Nuclear Refurbishment
PB	Pressure Boundary
POP	Project Oversight Plan
QS	Quality Surveillance
RFR	Re-tube and Feeder Replacement
RFRISA	Re-tube and Feeder Replacement Island Support Annex
RPO	Refurb Project Office
RPPE	Radiation Personal Protective Equipment
SD/LU	Shut Down/Lay Up
TSSA	Technical Standards and Safety Association

12.0 REFERENCES

[R-1] N-GUID-09701-10118 – NUCLEAR REFURBISHMENT – TRAINING CHANGE CONTROL

[R-2] N-GUID-09701-10120 – GUIDELINE FOR CONSTRUCTION OVERSIGHT

[R-3] NK38-PLAN-09701-10113-SFY-01 – CONVENTIONAL SAFETY – OWNERSHIP TRANSFER PLAN

[R-4] NK38-PLAN-09701-10007 – PROJECT TRAINING WORKPLAN

[R-5] NK38-REP-09701-10093 – WHITEPAPER DARLINGTON REFURBISHMENT TRAINING MANAGEMENT

[R-6] N-REP-08920-0556866 - DARLINGTON REFURBISHMENT MODIFICATION TRAINING SIMULATOR STRATEGY

[R-7] NK38-REP-09701-0490153 - STUDY FOR STRATEGIES FOR THE USE OF TWO SIMULATORS DURING DARLINGTON REFURBISHMENT

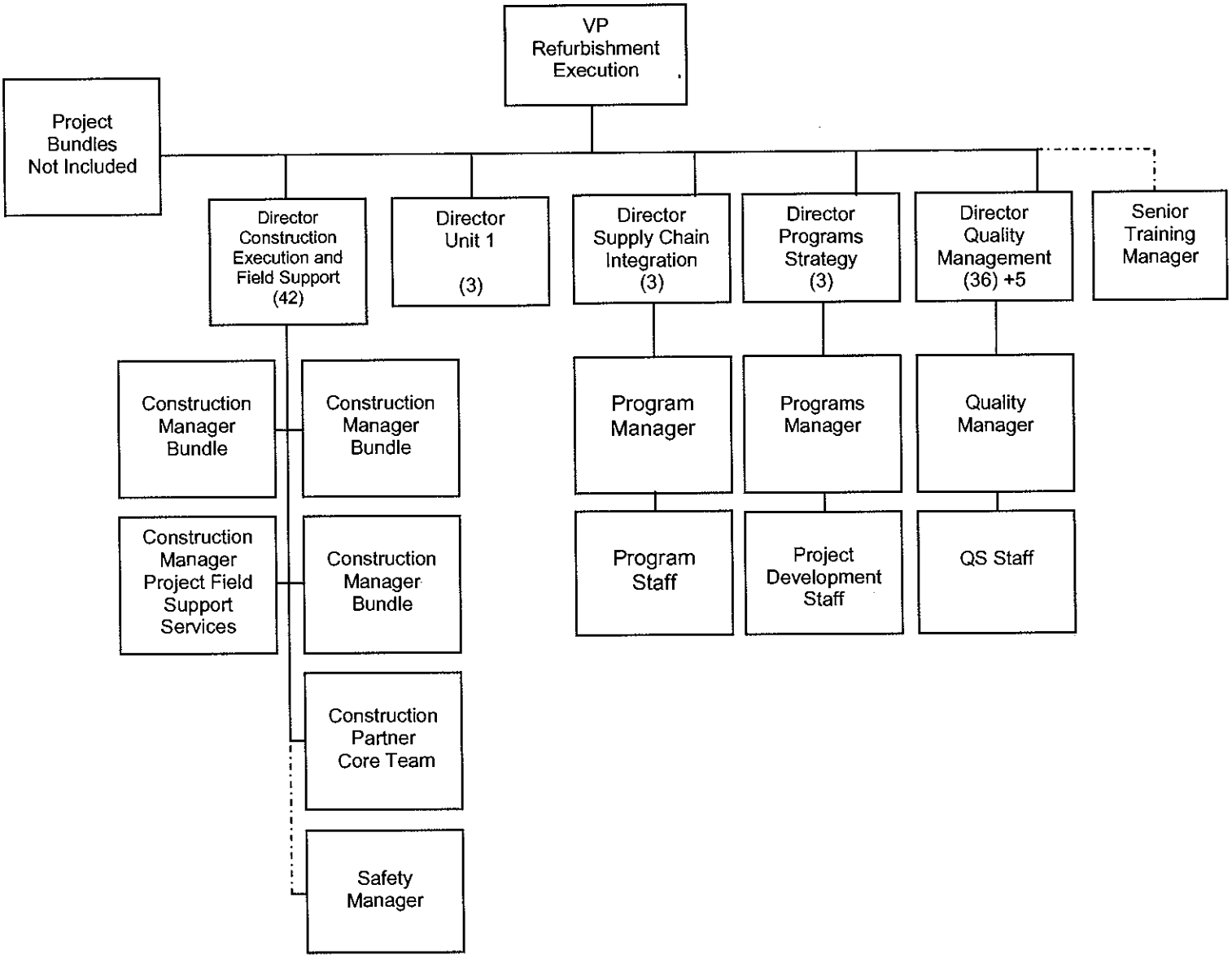
[R-8] N-TQD-901-00001 NUCLEAR REFURBISHMENT TRAINING & QUALIFICATION DESCRIPTION

[R-9] NK38-GUID-09701-10021 GUIDELINE FOR TRAINING OVERSIGHT (REFURBISHMENT)

[R-10] N-GUID-09701-10122 GUIDELINE FOR NUCLEAR REFURBISHMENT – TRAINING PLAN DEVELOPMENT

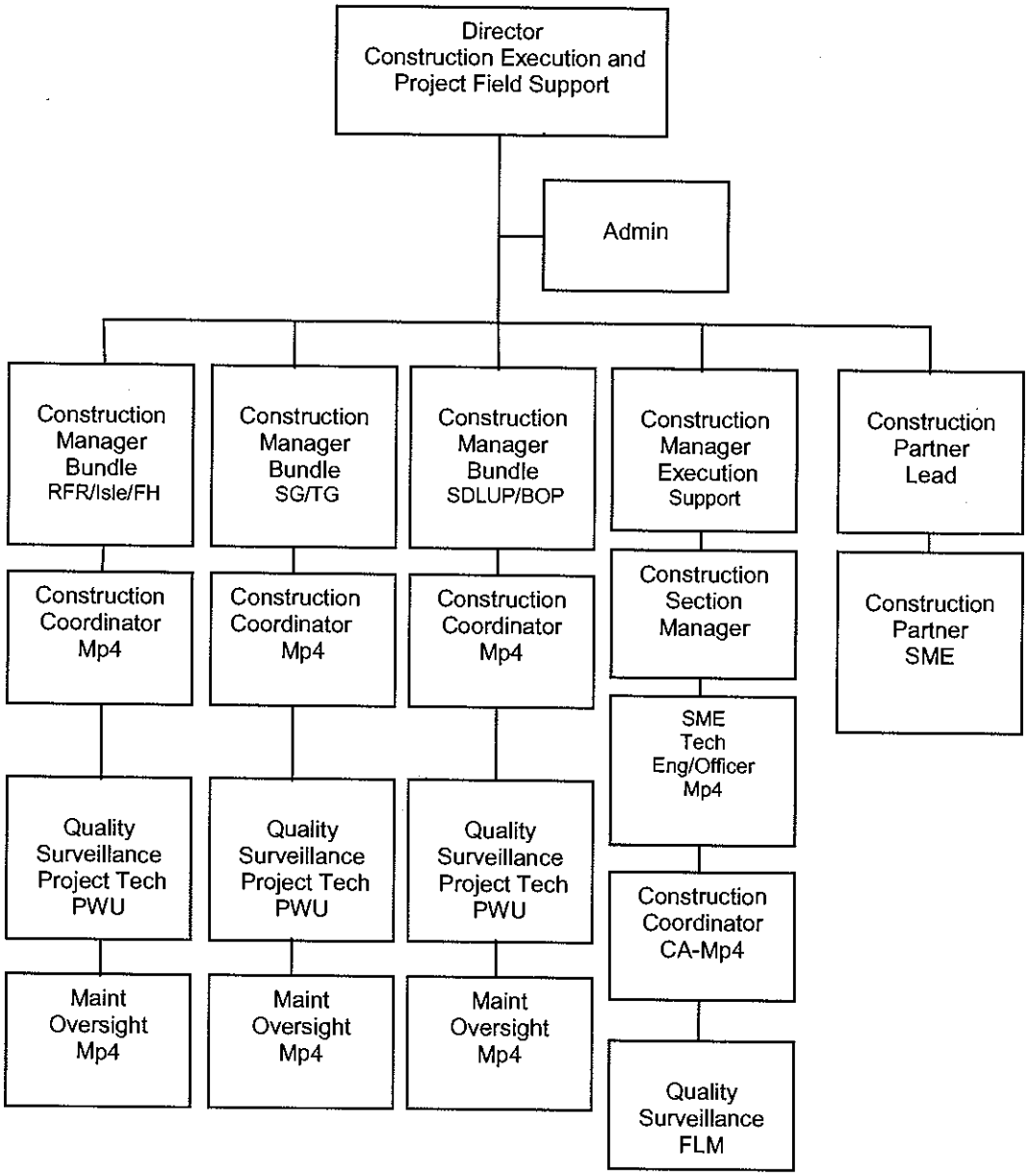
Appendix A: Execution Organization Charts

Refurbishment Execution Organization



Appendix A (Continued)

Construction Execution and Project Field Support



Note: Resource numbers for positions will increase and decrease as per the approved staffing plan strategy.

ONTARIOPOWER GENERATION

Plan

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Document Number: NK38-PLAN-09701-10223	Usage Classification: N/A
Sheet Number: 0014	Revision: R000

Title:
DARLINGTON REFURBISHMENT PROGRAM QUALITY MANAGEMENT ORGANIZATION FUNCTIONAL MANAGEMENT PLAN

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Darlington Refurbishment Program Quality Management Organization Functional Management Plan

NK38-PLAN-09701-10223-0014-R000
2015-11-03

Order Number: N/A
Other Reference Number:

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R000	2015-11-03	Initial issue.

Records Table

The following Records may be generated by use of this document and shall be registered in the appropriate document management system in accordance with the following table:

Record Created	Associated Form or Template Number	QA Record? Y/N	Filing Information/Retention (AIMS Type/Sub-Type)
None			

1.0 PURPOSE

This document details the scope, responsibilities and staffing requirements for establishing the Darlington Refurbishment Program (DRP) Quality Management Organization. The document will:

1) Briefly outline an approach for the creation of the matrixed Refurbishment Quality Management Organization.
2) Identify the necessary changes to the Refurbishment Organization to allow for the Quality Management Organization mobilization, trial and readiness for Unit 2 Refurbishment Outage.
3) Establish finance and manage cost.

The proposal presented herein is intended to minimize cost and allow the use of existing resources in OPGN to the greatest extent possible.

2.0 MISSION

The mission of the DRP Quality Management Organization is to:

1) Implement a centralized organization for the DRP utilizing existing matrixed staff to the greatest extent possible.
2) Implement a continuous quality surveillance process through issuance of a DRP Quality Plan and other executing procedures that addresses the quality and regulatory requirements from shutdown layup, engineering (design and procurement), commissioning to final turnover to Operations.
3) Provide ability for the Quality Management Organization to escalate and implement corrective actions for critical issues.
4) Provide assurance that Configuration Management is maintained by performing continuous surveillance activities during all phases of the project.
5) Coordinate in an efficient manner with other internal and external assessment activities.

Figure 1 depicts the expected flow of work within the proposed Quality Management Organization and Darlington Refurbishment Project.

EXPECTED RESULTS

- Maintain configuration management of the changes between paper and plant.
- Maintain and oversee documentation for regulatory interface per the licensing basis.
- Provide feedback to project Managers on non conformances and corrective actions required.
- Confirm Comprehensive Work Packages reflect committed work in the Contractor owner interface.
- Maintain a quality view point on the completion of construction and handover from vendors to OPG project staff and from project staff to Operations.

3.0 SCOPE AND RESPONSIBLITIES

3.1 Scope

Tables 1 and 2 depict the CSA N286-05, Management System Requirements for Nuclear Power Plants and N286-12, Management System Requirements for Nuclear Facilities management system principles that will be monitored by Nuclear Oversight, Quality Management and Management System Oversight groups.

The Project Quality Management Organization will conduct continuous quality surveillance activities on the Refurbishment projects during the following phases:

1. Shutdown/Layup
2. Design
3. Procurement
4. Construction
5. Commissioning
6. Available for Service
7. Unit Readiness
8. Closeout

Surveillance activities will be performed utilizing a graded risk based approach that will focus on:

1) Safety significant items,
2) Regulatory items (including Safety Improvement Opportunities (SIOs) and Integrated Implementation Plan (IIP) commitments), and
3) Other Production and Reliability related project items.

The following principles will be considered for conducting surveillance activities throughout all phases of the project:

1) Review of work conducted by Contractors based on Contractor performance.
2) Review of nuclear safety significant items and Regulatory items (Licence Conditions Handbook (LCH) requirements).
3) Review of items critical to Operation.
4) Review of both Contractor and OPG performed work.
5) Review of completed and in-progress Items to show rate of progress and configuration management.
6) Review of modification and non-modification work activities.
7) Review of IIP Items (SIOs, Environmental Assessment (EA) Items).

An implementing document will be prepared to outline the details associated with the above surveillance activities.

3.2 Responsibilities

Figure 2 shows the proposed new Quality Management Organization. The DRP Quality Management Organization is being established to maximize the use of the existing nuclear governance and project staff. The following outlines the accountabilities of the key positions and groups.

3.2.1 Director, Quality Management

- Develop and implement a DRP Quality Plan which takes its authority from the DRP Project Charter and Nuclear Management System that ensures all of the required project requirements are met.
- Monitor, observe and perform continuous quality surveillance on each phase of the DRP.
- Provide assurance through the quality surveillance activities that Project Completion Assurance is obtained through each phase. This includes:
    - Review of regulatory requirements in the LCH and Contractor Owner Interface Requirements (COIR),
    - Integrate OPG governance into the licensing basis for refurbishment tasks,
    - Ensure processes and forms exist for Refurbishment activities,
    - Check integration into P6 schedule to be followed by all,
    - Do field checks to verify tasks are complete,
    - Check Vendor Document Management System (VenDM)/Electronic Document Management System (EDMS) are populated and retrievable, and
    - Co-ordinate and oversee regulatory interface.
- Interface with other DRP internal and external assessment activities to co-ordinate and optimize the required quality surveillance activities for the DRP.
- Establish metrics and reporting requirements that assess effectiveness of the DRP Quality Plan.
- Can direct specific quality surveillance activities based on risk and Operating Experience (OPEX).

- Oversee management of records of changes to the Units during refurbishment.
- Establish process to escalate and implement corrective actions for critical issues.

3.2.2 Manager, Completion Assurance

- Oversee the Field Execution, Performance Reporting and Records groups in the Quality Management organization.
- Interface with the other Quality Management groups in implementing the overall mandate of the organization.
- Plan, schedule and complete quality surveillance activities through all phases.
- Ensure each phase of the project completion assurance is obtained.
- Ensure non-conformances related to quality surveillance are identified and critical issues are escalated to the Director, Quality Management.
- Recommend strategies for issue resolution and corrective actions related to quality surveillance activities.
- Take direction from Director, Quality Management.

3.2.3 Matrixed Staff

The following groups are matrixed from Nuclear Refurbishment and OPG Nuclear to the Quality Management Organization:

- Quality Engineering, Refurbishment Engineering ➔ Engineering & Contract Management.
- Supplier Audits, Quality Engineering & Performance, Supply Services OPG Projects ➔ Procurement & Materials.
- Document & Information Management Program, I M Program ➔ Records.
- Refurbishment Licensing Support, Nuclear Regulatory Affairs & Stakeholder Relations ➔ Regulatory Affairs.

In addition to their existing responsibilities, these groups will:

- Plan, schedule and complete quality surveillance activities as agreed to with the Director, Quality Management.

- Interface with the Quality Management organization to support achieving the overall mandate of the organization.
- Monitor, identify and communicate any non-conformances related to quality surveillance activities.
- Identify critical issues related to quality surveillance activities for escalation to the Director, Quality Management.
- Assist with issue resolution and corrective action implementation related to quality surveillance activities.

4.0 ASSUMPTIONS AND CONSTRAINTS

4.1 Assumptions

- Matrixed staff will be able to support the Quality Management Organization within the existing budget (i.e., no additional budget or resources will be required).
- Facilities (space allocation, work stations etc.) for new hires will be allocated at the Darlington Energy Complex (DEC) in a timely manner.
- Proximity of new groups and matrixed staff will be addressed to allow efficient communication and coordination of activities.
- Records Room to facilitate Canadian Nuclear Safety Commission (CNSC) access to DRP documents (paper and electronic) will be established at the DEC in a timely manner.

4.2 Constraints

- New positions will be posted in accordance with the respective Collective Agreements. Therefore, on boarding off new hires is subject to timing of posting and completion of selection process.

5.0 STRATEGIES/INITIATIVES

5.1 Establishment of New Organization

Organization Design Change request has been processed in accordance with OPG-PROC-0166 to establish the new Quality Management Organization.

5.2 Staffing Strategy

The overall staffing strategy is to maximize utilization of existing Refurbishment staff by matrixing staff. Initial establishment of the organization will also utilize contract staff until the organization is functional. There will also be a need for new staff in order to meet the overall mandate of the new organization.

The anticipated changes to the Refurbishment Organization are summarized in the following sections.

5.2.1 Changes to Refurbishment Nuclear Safety Organization

The following changes will need to be implemented to the Refurbishment Nuclear Safety Organization (see Figure 3):

1. The Director, Nuclear Safety will transition to the new Quality Management group. The position of Director, Nuclear Safety will be eliminated.

2. The Nuclear Safety Integration (NSI) section will be disbanded earlier. Note, the Systems and Components Engineering Department has work that compliments ISR/IIP work and it was planned for this department to absorb the NSI staff by end of 2015. Hence the proposal is to disband the Nuclear Safety Integration (NSI) Section earlier than the planned year end date.

3. The Nuclear Safety Nuclear Refurbishment (NR) group currently supports the Refurbishment Project via the Director, Nuclear Safety. In lieu of reporting the Director, Nuclear Safety, the Nuclear Safety (NR) section can report directly to the VP, Refurbishment Engineering.

The changes noted above will need to occur in parallel with the establishment of the new Quality Management Organization. Organization Design Change request has been processed in accordance with OPG-PROC-0166 to process changes to the Refurbishment Nuclear Safety Organization.

5.2.2 Changes to Other Groups in Refurbishment

Quality Engineering, Refurbishment Engineering

- Group will be matrixed to Quality Management Organization

Refurbishment Licensing Support, Nuclear Regulatory Affairs & Stakeholder Relations

- Group will support the Quality Management Organization as it currently does for the DRP.

Supplier Audits, Quality Engineering & Performance, Supply Services OPG Projects

- Group will be matrixed to Quality Management Organization.

Document & Information Management Program, I M P

- Group will be matrixed to Quality Management Organization.

5.3 Hiring of New Staff

The DRP Quality Management Organization will consist of the following new positions:

1) A new Director (Director, Quality Management).
2) A new Manager (Manager, Completion Assurance).
3) A new Section Manager (Section Manager, Performance Reporting).
4) Five new Society positions (Senior Technical Engineer, Performance Reporting).

See Figure 2 for additional details.

5.4 Training Strategy

Quality Management Organization staff will be trained in accordance with N-TQD-901-00001, Nuclear Refurbishment Training and Qualification Description.

5.5 Budget Strategy

In order to achieve the mandate of the new Quality Management Organization the creation will not be at a net zero cost. Although majority of the staff and budget will come from the existing Refurbishment Organization, there will be a need for new positions and budget as outlined in Table 3 and Table 4. Table 5 outlines the planned resources for the new organization.

Nuclear Refurbishment Change Control Form (CCF 663) has been processed for establishment of the new Quality Management Organization under Refurbishment Execution. Budget for the new organization for the duration of the DRP will be established and cost will be managed.

5.6 Process Improvement Strategy

Process improvements and lessons learned will be implemented upon completion of the pre-test and test period self assessments as part of the Readiness to Execute Milestones.

6.0 MILESTONE & KEY DATES

Actions to mobilize the organization are scheduled to meet the DRP Readiness to Execute Plan Milestones as outlined in Table 6.

Table 7 lists the projects identified for review to validate Quality Surveillance Guidelines. The surveillance activities associated with these projects and IIP Items have been input into the Project P6 schedule. Additional surveillance activities will be planned and completed based on a risk based approach as outlined in NK38-GUID-09701-10038 R000, Darlington Refurbishment Quality Surveillance Guide.

In addition, Self Assessment RF15-001553 is planned to be completed in preparation for a CNSC Type II Inspection on Engineering Change Control for Refurbishment (specifically Powerhouse Steam Venting System (PSVS), End fittings, Calandria tubes and Feeders) scheduled in January 2016.

7.0 MAJOR WORK SUMMARIES

7.1 Execution

- Develop, maintain and implement a DRP Quality Plan that ensures the quality and management system requirements for the DRP are executed and completed.
- Establish and execute a project Quality Management Organization that:
- Monitors, observes and performs continuous quality surveillance on each phase of DRP as a matrixed organization.
- Provides assurance through the continuous quality surveillance activities that Darlington Refurbishment Project Completion Assurance is obtained.
- Can escalate and implement corrective actions for critical issues.
- Interfaces with other DRP internal and external assessment activities to coordinate and optimize the required quality surveillance activities for DRP.
- Establish metrics and reporting requirements that assess effectiveness of the DRP Quality Plan and surveillance activities performed.
- Oversee management of records of changes to the units during refurbishment.

7.2 Function

Table 3 outlines the function for the key positions in the Quality Management Organization.

8.0 RISKS & MITIGATION ACTIONS

8.1 Risks

The following risks have been identified in the Risk Management Oversight Tool (RMO) for further review and assessment under Risk Number 00013769:

1. The number of planned Records and Field Execution staff may not be sufficient to support the planned work.

2. Space at the DEC may not be available for new hires and it may not be possible for the groups to be close in proximity.

3. Hiring of qualified staff may not occur in the timeline required.

4. Space at the DEC may not be available for a Records Centre.

8.2 Mitigation Actions

The following mitigation actions are planned or have been taken:

- A review is planned to assess the organization resource demands as part of the Readiness to Execute Plan.

- Paper work has been processed through Human Resources (HR) Nuclear Projects group to address immediate hiring needs.

- Manager, Facilities (Facilities & Projects) has been contacted to identify space allocation needs.

9.0 PERFORMANCE MEASUREMENT AND REPORTING

Quality Management organization will raise non-conformances related to quality surveillance and escalate critical issues. Recommended strategies for issue resolution and corrective actions related to quality surveillance activities will also be identified.

Quality Management reporting (including frequency of reporting), measuring tools and performance indicators will be established as part of the Readiness to Execute Plan. Specific requirements will be identified after the “Complete Pre-Test Self Assessment” Milestone identified in Table 6 is achieved.

10.0 RESOURCE PLAN

Establishment of the Quality Management Organization will maximize matrixed staff from the existing Refurbishment Organization and budget from the existing Refurbishment Organization. There will be a need for new positions and budget as outlined in Table 3 and Table 4. Table 5 outlines the planned resources for the new organization.

11.0 DEFINITIONS & ACRONYMS

11.1 Definitions

None

11.2 Acronyms

CCF	Change Control Form
CNSC	Canadian Nuclear Safety Commission
COIR	Contractor Owner Interface Requirements
CSA	Canadian Standards Association
DEC	Darlington Energy Complex
DRP	Darlington Refurbishment Program
EDMS	Electronic Document Management System
HR	Human Resources
LCH	Licence Conditions Handbook
NR	Nuclear Refurbishment
NSI	Nuclear Safety Integration
OPEX	Operating Experience
OPG	Ontario Power Generation
PSVS	Powerhouse Steam Venting System
RMO	Risk Management and Oversight
VenDM	Vendor Document Management

12.0 REFERENCES

1. N-CHAR-AS-0002, Nuclear Management System.
2. D-PCH-09701-10000, Darlington Refurbishment Program Charter.
3. NK38-NR-PLAN-09701-10001 SHT 0023, Darlington Refurbishment Program Quality Plan.
4. NK38-GUID-09701-10038 R000, Darlington Refurbishment Program Quality Surveillance Guide.
5. N-GUID-09701-10022 R002, Supply Chain Oversight.
6. OPG-PROC-0166, Organization Design Change.
7. N-TQD-901-00001, Nuclear Refurbishment Training and Qualification Description.
8. NK38-PLAN-09701-0559561, Transition Plan for Establishing the Darlington Refurbishment Program Quality Management Organization.

Appendix A: Figures

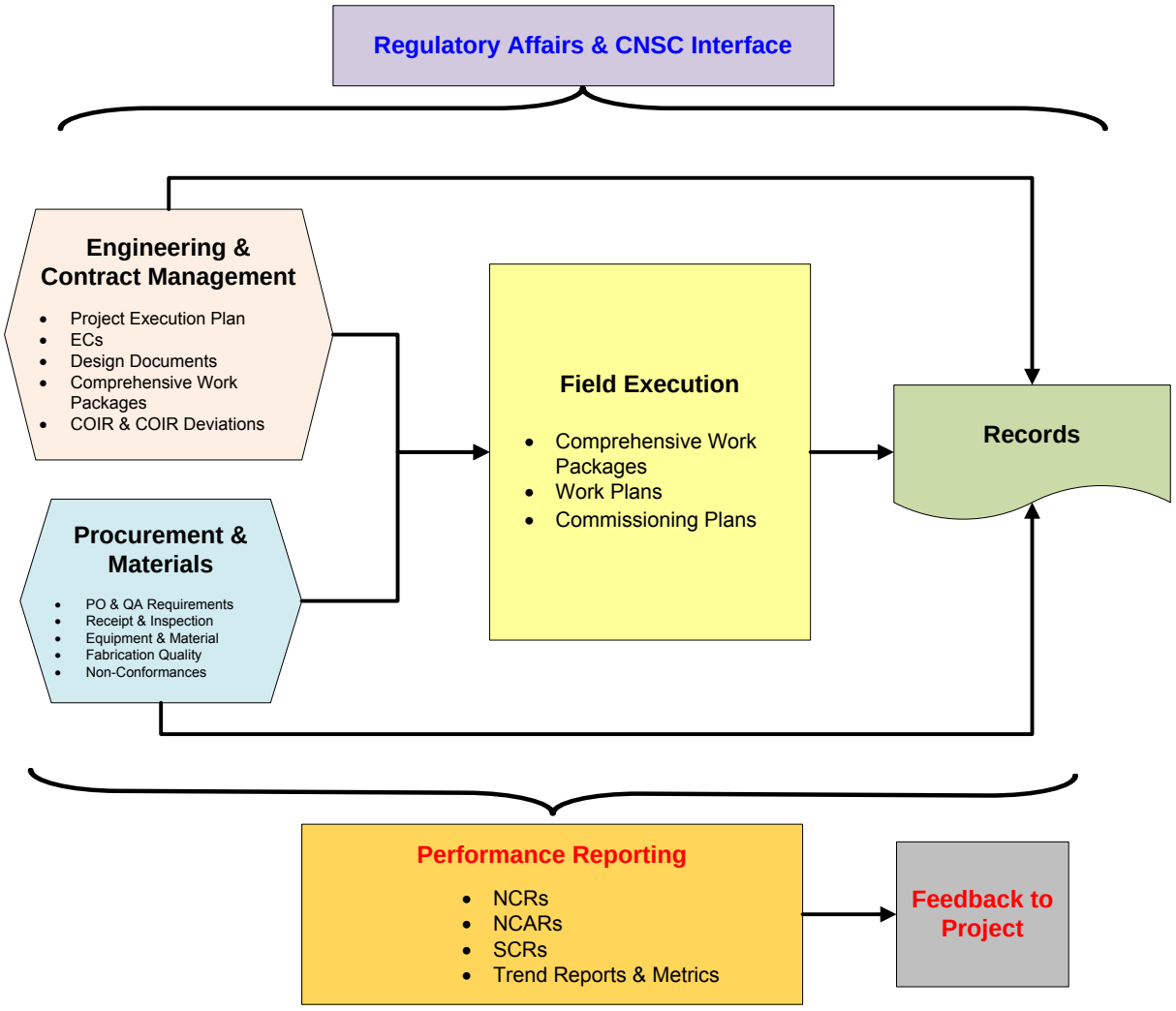


Figure 1: Expected Quality Management Work Flow

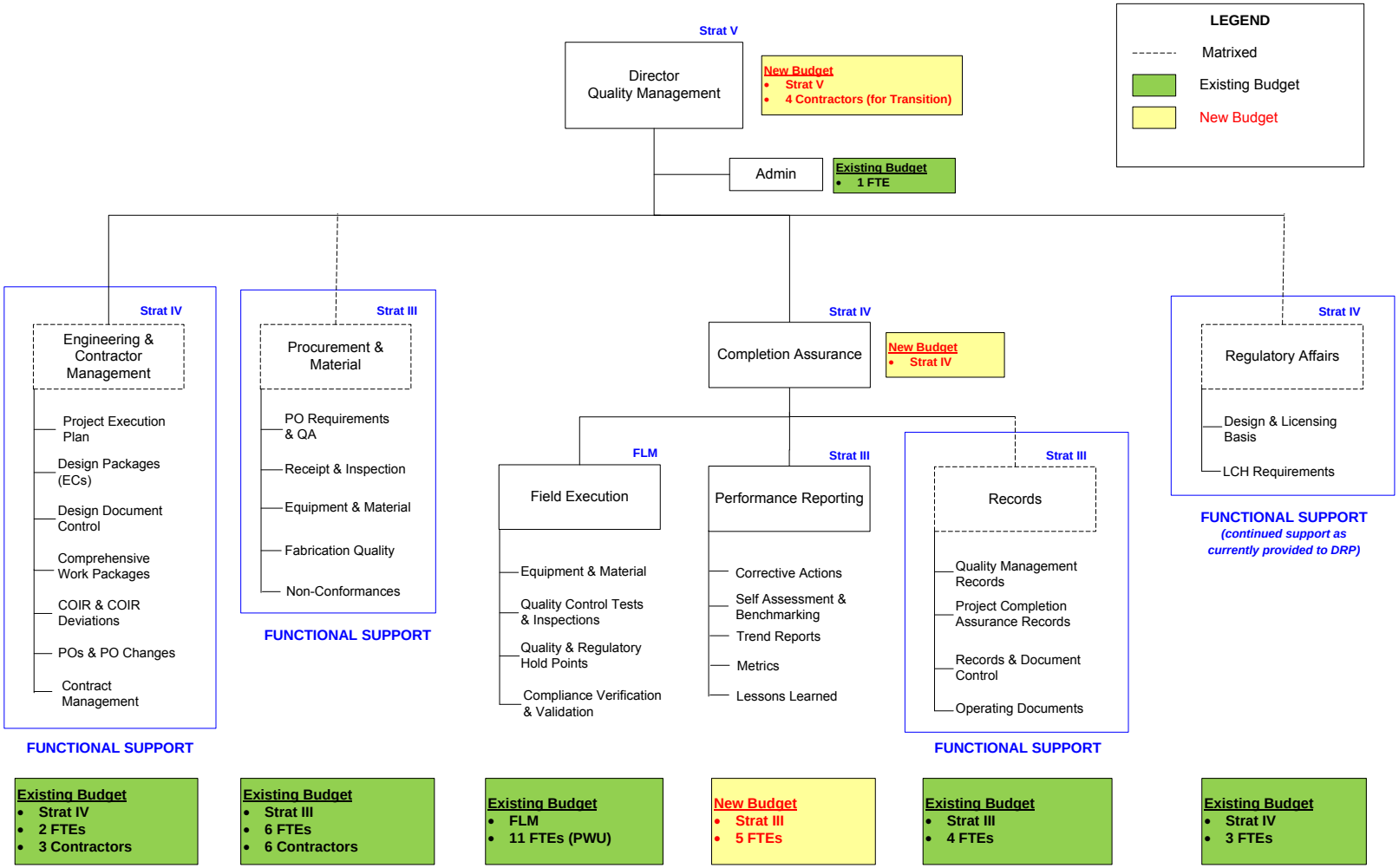
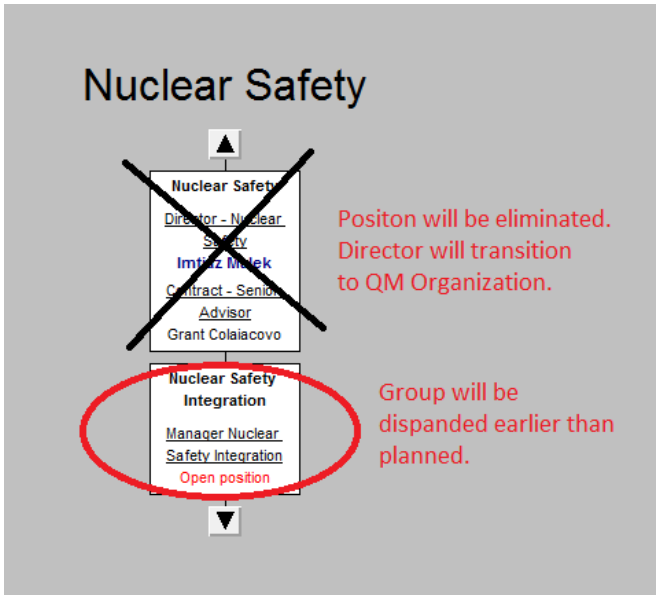


Figure 2: Quality Management Organization



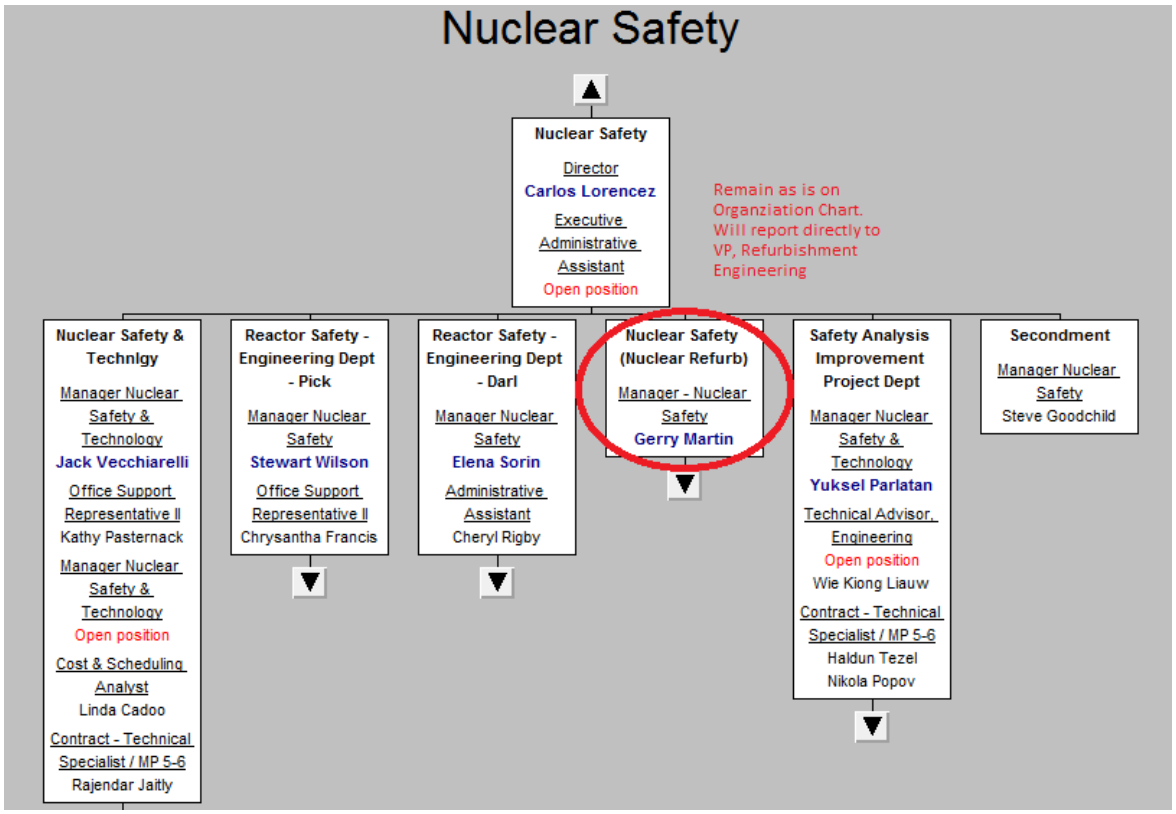


Figure 3: Transition of Staff from Nuclear Safety Group

Appendix B: Tables

Table 1: CSA N286-05 Management System Principles Mapping

Principles *(Refer to CSA N286-05 Section 0.2)*	N-CHAR-AS-0002	D-PCH-09701-10000	
	Nuclear Oversight	DRP Quality Management	DRP Management System Oversight
1. Business is defined, planned, and controlled.	✓		✓
2. Organization is defined and understood.	✓	✓	
3. Personnel are competent at the work they do.	✓	✓	
4. Personnel know what is expected of them.	✓	✓	
5. Work is planned.	✓		
6. Experience is sought, shared, and used.	✓	✓	✓
7. Information is provided in time to people who need it.	✓	✓	✓
8. Performance of work is controlled.	✓		
9. Preparation and distribution of documents are controlled.	✓	✓	
10. Work is verified to confirm it is correct.	✓	✓	
11. Problems are identified and resolved.	✓	✓	✓
12. Changes are controlled.	✓		
13. Records are maintained.	✓	✓	
14. Assessments are performed	✓	✓	✓

Table 2: CSA N286-12 Management System Principles Mapping

Principles *(Refer to CSA N286-12 Section 4.1.2)*	N-CHAR-AS-0002	D-PCH-09701-10000	
	Nuclear Oversight	DRP Quality Management	DRP Management System Oversight
a) Safety is the paramount consideration guiding decisions and actions.	✓	✓	✓
b) Business is defined, planned and controlled.	✓		✓
c) Organization is defined and understood.	✓		
d) Resources are managed.	✓	✓	
e) Communication is effective.	✓	✓	✓
f) Information is managed.	✓	✓	
g) Work is managed.	✓	✓	
h) Problems are identified and resolved.	✓	✓	✓
i) Changes are controlled.	✓		
j) Assessments are performed.	✓	✓	✓
k) Experience is sought, shared, and used.	✓	✓	✓
l) The management system is continually improved.	✓		

Table 3: Positions Required to Establish Quality Management Organization

Position	Function	Availability
	Existing Budget / New Budget	
Director, Quality Management **(STRAT V)**	• Oversight of quality management • Interface with other quality organizations • Manage Regulatory interface • Define areas for review & Non conformance packages • Manage and oversee records for configuration management	Full time position with new budget.
Manager, Engineering & Contractor Management **(STRAT IV)**	• Develop, maintain and issue Engineering & Contractor Management quality metrics • Support /participate/lead self assessments, benchmarking and lessons learned • Perform Engineering & contract surveillance activities • Co-ordinate Engineering & Contract SCRs • Co-ordinator required training	Full time position with transitioned staff and budget from Quality Engineering department.
Manager, Procurement & Material **(STRAT III)**	• Plan, conduct and report on oversight performed by Supply Chain on Procurement contracts per N-GUID-09701-10022. Typical oversight activities include: ○ Procurement planning ○ Pre award activities (bid evaluation, selection of sub contractor, PO requirement to sub contractor, procurement documents prior to release, COIR clauses related to pre award activity) ○ Post award activities (COIR clauses related to post award activity, contract administration and source inspection, manufacturing process, post delivery/material management)	Full time position with matrixed staff from Supply Chain Procurement Oversight
Manager, Completion Assurance **(STRAT IV)**	• Oversee and co-ordinate Field Engineering, Performance Reporting and Record activities	Full time position with new budget.
Foreman, Field Engineering **(FLM)**	• Plan, conduct and report on field surveillance activities. Typical surveillance activities include: ○ Equipment and material ○ Quality control test & inspections ○ Quality & Regulatory Hold Points ○ Compliance verification & Validation	Full time position with PWU staff from existing budget.
Manager, Performance Reporting **(STRAT III)**	• Prepare Performance Reports (metrics, trend reports) • Plan and conduct self assessment and benchmarking activities • Records lessons learned • Issue corrective actions	Full time position with new staff and new budget.

Position	Function	Availability
	Existing Budget / New Budget	
Manager, Records **(STRAT III)**	• Plan, conduct and report on Records • Project completion assurance records	Full time position with matrixed staff from CIO organization.
Manager, Regulatory Affairs **(STRAT IV)**	• Interface with Regulator	Full time position with matrixed staff from Refurbishment Regulatory Affairs (continued support as currently provided to DRP).

Table 4: Summary of Proposed Staff Changes

Position	Number to FTEs	
	Matrixed Staff (Existing Budget)	New Staff (New Budget)
Director - Strat V		1
Manager – Strat IV	1 (Engineering)	1 (Completion Assurance)
Section Manager – Strat III	2 (Procurement) 1 (Records) 1 (Regulatory Affairs)	1 (Performance Reporting)
MP 2/3/4/5/6, PWU or New Grads	2 (Engineering) 6 (Procurement) 4 (Records/CIO) 3 (Regulatory Affairs)	5 MP4 (Performance Reporting)
FLM & PWU	1 FLM (Field Execution) 11 PWU (Field Execution)	
Contractors	3 (Engineering) 6 (Procurement)	4 (for Transition)
Summary	• 41 Matrixed Staff within existing budget • 8 New Staff with new budget • 4 Contractors with new budget (for transition to end of 2016)	

Table 5: Quality Management Organization Resource Summary

Position	Resource	Unit	Additional Information	2015 (Q4)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Quality Management	Regular	FTE	Director	1	1	1	1	1	1	1	1	1	1	1
Quality Management	Regular	FTE	Admin	1	1	1	1	1	1	1	1	1	1	1
Quality Management	Contract	FTE	Advisor/Contractors	4	4	0	0	0	0	0	0	0	0	0
QM, Engineering & Contract Management	Regular	FTE	Manager	*	*	*	*	*	*	*	*	*	*	*
QM, Engineering & Contract Management	Regular	FTE	Sr. Tech Eng/Officer	*	*	*	*	*	*	*	*	*	*	*
QM, Engineering & Contract Management	Contract	FTE	Advisor/Contractors	*	*	*	*	*	*	*	*	*	*	*
QM, Procurement & Materials	Regular	FTE	Section Manager	*	*	*	*	*	*	*	*	*	*	*
QM, Procurement & Materials	Regular	FTE	Sr. Tech Eng/Officer	*	*	*	*	*	*	*	*	*	*	*
QM, Procurement & Materials	Contract	FTE	Advisor/Contractors	*	*	*	*	*	*	*	*	*	*	*
QM - Completion Assurance	Regular	FTE	Manager	1	1	1	1	1	1	1	1	1	1	1
QM - Completion Assurance, Performance Reporting	Regular	FTE	Section Manager	1	1	1	1	1	1	1	1	1	1	1
QM - Completion Assurance, Performance Reporting	Regular	FTE	Sr. Tech Eng/Officer	5	5	5	5	5	5	5	5	5	5	5
QM - Completion Assurance, Field Execution	Regular	FTE	FLM	*	*	*	*	*	*	*	*	*	*	*
QM - Completion Assurance, Field Execution	Regular	FTE	PWU	*	*	*	*	*	*	*	*	*	*	*
QM - Completion Assurance, Records	Regular	FTE	Section Manager	*	*	*	*	*	*	*	*	*	*	*
QM - Completion Assurance, Records	Regular	FTE	System Analyst/ Specialist	*	*	*	*	*	*	*	*	*	*	*
QM - Regulatory Affairs	Regular	FTE	Section Manager	*	*	*	*	*	*	*	*	*	*	*
QM - Regulatory Affairs	Regular	FTE	Sr. Tech Eng/Officer	*	*	*	*	*	*	*	*	*	*	*

* Matrixed Staff

Table 6: Quality Management Organization Readiness to Execute Plan Milestones

No.	Milestone Description	Date	Status
1	Issue DRP Quality Plan	31Jul2015	Complete
2	Obtain Formal Approval for new organization	14Aug2015	Complete
3	Establish Organization (initial staffing)	31Agu2015	Complete
4	Prepare Draft Quality Surveillance Guidelines	31Aug2015	Complete
5	Inform Regulator	10Sep2015	Complete
6	Issue Quality Surveillance Guidelines	30Sep2015	Complete
7	Commence staff training	30Sep2015	Complete
8	Integrate Surveillance Activities into P6 Schedule	31Oct2015	Complete
9	Field Surveillance Start	15Jan2016	Open
10	Pre-Test Self Assessment	31Jan2016	Open
11	Test Electronic Document Management System	15Apr2016	Open
12	Test Period Self Assessment	30Apr2016	Open
13	Unit 2 – Issue Updated Quality Surveillance Program Plan	30May2016	Open
14	Lessons Learned Implemented & Resource Risks Identified	31Aug2016	Open

Table 7: Recommended Projects for Review for Validation of Quality Surveillance Guideline and Planned Self Assessments

Project No.	Description	Bundle	Vendor	Master EC No.
73360	Third Emergency Power Generator (EPG3)	BOP	ES Fox	117504
73380	Shield Tank Overpressure Protection (STOP)	BOP	Black & MacDonald	121247
73365	Containment Filtered Venting System (CFVS)	BOP	ES Fox	117408
73370	Powerhouse Steam Venting System (PSVS)	BOP		118633
73398	Emergency Service Water (ESW)			121751 / 122845
73471	Emergency Filtered Air Discharge System (EFADS) & Control Modification	Unit Islanding		117296
73118	Retube Waste Processing Building	RF&R		123213
73538	Service Air - Install and Tie-in	Shutdown Layup		123466
73537	Breathing Air - Install and Tie-in	Shutdown Layup		122092
73769	SHIM	BOP	OPG	129344
73821	Power Distribution DS5	Campus Plan	Black & MacDonald	117600
73476	EQ Mod 5/6 CB	Unit Islanding	Black & MacDonald	120326
73164	Fuel Handling – Irradiated Fuel Bay Heat Exchanger (IFB HX) Plate Replacement	Fuel Handling		None

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Guideline

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Document Number: NK38-PLAN-09701-10223	Usage Classification: N/A
Sheet Number: SHT 0004	Revision: R000

Title:
NUCLEAR REFURBISHMENT ENGINEERING FUNCTIONAL MANAGEMENT PLAN

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Nuclear Refurbishment Engineering Functional Management Plan

NK38-PLAN-09701-10223-SHT 0004-R000
2015-07-29

Order Number: N/A
Other Reference Number:

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R0000	2015-07-28	Updated for the RQE Budget process and current status of Engineering functional activities. Reformatted to meet requirements of NK38-GUID-09701-10023, Functional Management Plan Guideline. Updated to reflect the changes in the organization made during the RQE review of the Functional Engineering. List of Milestones & Key dates, Main NR Risk and Resource Plan have also been revised based on comments received from t he RQE review. Replaces previous issued Engineering Functional Management plan (NK38-PLAN-09701-10203, Rev 0)

Records Table

The following Records may be generated by use of this document and shall be registered in the appropriate document management system in accordance with the following table:

Record Created	Associated Form or Template Number	QA Record? Y/N	Filing Information/Retention (AIMS Type/Sub-Type)

1.0 PURPOSE

The purpose of the Nuclear Refurbishment Engineering Functional Management Plan (FMP) is to establish the framework and overall direction for Refurbishment Engineering within Nuclear Refurbishment (NR)[1]. The FMP identifies the purpose, mission, assumptions, strategies, scope, organization, responsibilities, work processes, resource requirements, milestones, and related processes to support the engineering function.

The VP of Refurbishment Engineering is the owner of this document and is accountable for its definition and implementation.

This Management Plan has been updated to support the RQE submission and the final year of "Definition Phase"[2] through to program closeout.

2.0 MISSION

Vision

To perform as a world class engineering team that sets the benchmark for CANDU refurbishments.

Mission

To engineer regulatory compliant inspections, modifications, repairs, replacements, surveillance and monitoring to enable Darlington operations to perform safely and reliably for a further 30 years.

3.0 SCOPE AND RESPONSIBILITIES

Refurbishment Engineering has overall Engineering and Design Authority accountability for the Refurbishment scope of work, including all units in the refurbishment state. For the NR project, a significant portion of the plant modifications will be executed under a modified Engineering Procure Construct (EPC) contracting model whereas Refurbishment Engineering must ensure that appropriate interfaces and oversight protocols are maintained throughout the design, procurement, installation, commissioning and closeout processes to ensure compliance with design requirements. All modification work will follow the ECC risk based process. The level of engineering staff involvement with the planned modifications will be proportional with the level of risk to the Refurbishment Program, the complexity of the design, its effect on Safety and the past performance of the Contractor Agency involved.

[1] The acronym NR for Nuclear Refurbishment is sometimes also used to refer to the Darlington Refurbishment Program (DRP).
[2] The project phases are Initiation, Definition, Execution and Close-out

The scope of the projects within NR varies from new construction, modifications to existing facilities and systems within and outside the operating island as well as repair and replace activities. The different types of projects require distinctly different approaches. Consequently, a variety of contract structures and methodologies are deployed for the NR program and are described in more detail in Section 5.

The NR Engineering organization differs from the rest of the OPG fleet project organizations in that there are dedicated Systems and Components, Nuclear Safety and Procurement Engineering staff.

The following are the objectives of Refurbishment Engineering:

a) Obtain the necessary corporate, government and regulatory approvals through preparation and submission of the Integrated Safety Review (ISR), the Environmental Assessment (EA), the Global Assessment Report (GAR), and Integrated Implementation Plan (IIP) for Nuclear Refurbishment (NR).

b) Support the establishment of regulatory certainty, to the degree possible, for NR and subsequently bounding the uncertainty prior to submission of the Release Quality Estimate (RQE) to the OPG Board.

c) Timely and comprehensive completion of technical studies and a plant condition assessment to determine the appropriate project scope.

d) Engineering and support of detailed outage planning in order to finalize the project scope, cost and schedule.

e) Support in the project execution teams

f) Perform engineering work according to governing procedures for each phase of work.

3.1 Scope

The responsibility of defining engineering scope rests with Refurbishment Engineering. The scope statement as provided in Section 3.0 of D-PCH-09701-10000, Darlington Refurbishment Charter, sets the broad outline for the physical scope of work (along with the constraints) for the NR.

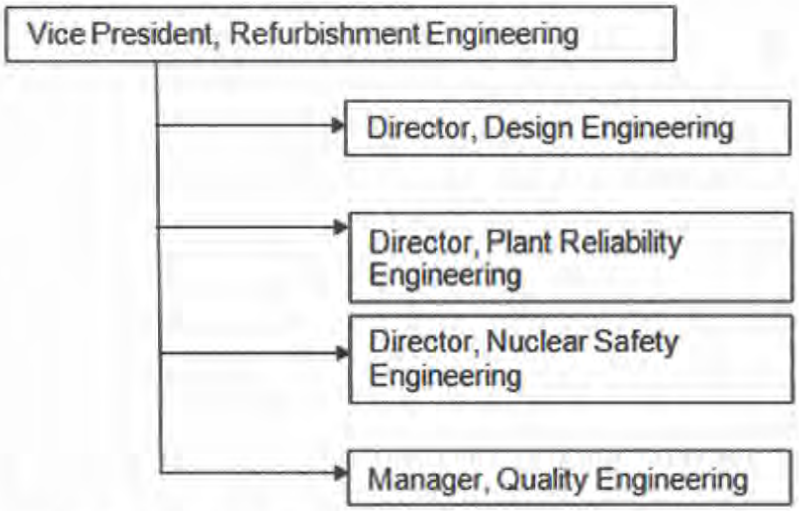
The scope of work for the refurbishment of each unit has been determined by a thorough condition evaluation of Darlington's systems and equipment and the results of the Integrated Safety Review. This process is consistent with CNSC RD-360 – Life Extension of Nuclear Power Plants. The Components Condition Assessment Recovery project covers the scope of all systems in an Aging Management Database and all components with a Criticality Code of 1 and 2 in the Master Equipment List (MEL). All CCAs in the system have been screened, reviewed and revised for compliance with governance and technical accuracy as per NK38-PLAN-09701-10155, "Darlington Life Extension Corrective Actions From NSRB DN12-EN-04". The aging management actions arising from the 58 Safety Related Systems are further

considered for inclusion into the Integrated Implementation Plan (IIP) based on the criteria defined in the report.

3.2 Responsibilities

Refurbishment Engineering work is performed according to the framework of programs, standards, procedures, and instructions for performing engineering established in N-PROG-MP-0007, Conduct of Engineering. Refurbishment specific practices are specified in the Program Management Plan – NK38-NR-PLAN-09701-10001 (sht 008).

The major blocks of the Refurbishment Engineering organization structure are as follows:



Section 7.0 provides a detailed description of each department's roles and responsibilities for the various phases of the project. An overview of the major work program elements for each engineering department is described in the following sub sections.

3.2.1 Design Engineering

- Provide the Design Authority role as defined in N-STD-MP-0024
- Approve all permanent and temporary design changes, prepare, review, verify and approve design packages
- Either prepare and approve in-house design deliverables or collaborate with Contractors to develop, then accept and approve Contractor design deliverables including:
- Cat ID creation, writing procurement specifications, Item Equivalency Evaluations and setting Cat IDs to ready
- Support for CWPs, assessing and material procurement
- Response to discovery issues
- Close out of modification packages

3.2.2 Plant Reliability Engineering

- Specification of Life Cycle Plans, Periodic Inspection Programs, Maintenance requirements and In-Service Inspection requirements
- System surveillance, health reports and walkdowns
- non-modification, cyclic and preventive/predictive maintenance support"
- Preparation of Return to Service specifications and work plans/procedures
- Support Mod AFS, SAFS and RFS activities
- Commissioning Procedures
- Technical support to Projects
- Engineering Authority for Refurbishment Scope Control
- IIP activity status review and close out reporting.
- Support for the Fix It Now and High Impact Issues Teams

3.2.3 Nuclear Safety Engineering

- Integrated Safety Review, Integrated Implementation Plan, Global Assessment Report and ongoing support for regulatory issues.
- Outage Safety Assessments and Analysis, Deterministic Safety Analysis and Probabilistic Safety Analysis
- Nuclear design assist safety analysis, either directly or through verifying and accepting Contractor work

3.2.4 Quality Engineering

- Implement process improvements for EPC contractor interfaces
- Drive overall Engineering Quality Improvements
- Prepare Quality Engineering dashboard
- Prepare/revise, review, and approve applicable NR Engineering governance
- Act as primary interface between Nuclear Engineering Governance and Refurbishment Engineering
- Provide Engineering SCR coordination and Training coordination support
- Perform or support self assessments, benchmarking, and OPEX reviews,
- Support and facilitate Quality Surveillance
- Manage Engineering Human Performance Improvements

4.0 BASIS AND ASSUMPTIONS

N-MAN-00120-10001-RISK-07, Nuclear Refurbishment Actions, Issues, Decisions, And Key Assumptions Management, describes the Actions, Issues, Decisions, and Key Assumptions (AIDA) management process for NR. This process ensures that actions, issues, decisions, and important assumptions are properly identified, documented, approved, and managed.

Examples of the more significant program assumptions that are maintained in the Assumptions Log are:

- Engineering and Design Authority will be delegated from the Darlington organization to the Nuclear Refurbishment organization once a unit is defueled and dewatered. It will remain with the Nuclear Refurbishment organization until execution of the refurbishment outage for that unit is completed Engineering and Design Authority will revert to the Darlington organization upon synchronization of the unit.

- Refurbishment Engineering resource estimates include functional engineering support only. Matrix engineering staff and other project support (including in-house modification work) is funded by the specific projects. Reference assumptions log ID 344-345, 364, 365-367, 387-391 and 560-562.

- There are no major changes in the modifications and/or the conduct of the refurbishment between the first and subsequent units. Efficiencies of duplicate designs have been included within the estimates, and have resulted in significant savings for the subsequent units.

- 17 FTE will be carried as contingency funding, and documented in the Risk Management Oversight Tool (RMO), in the event that the risk is realized that Plant Reliability (Systems/Components engineering) have missed activities or underestimated the resource loading (i.e. for EFIN, Commissioning shift support, OCC/PCC commitments)

- Refurbishment Engineering will execute engineering work within the governance structure and expectations set out by the OPG Chief Nuclear Engineer. Refurbishment Engineering governance may be developed to interpret and apply OPG governance in the refurbishment context. EPC contractor governance will be applied to EPC work only after Refurbishment Engineering has confirmed the Contractor governance meets the requirements of OPG governance.

- The current Design Basis, as defined by the Safety Report, Design Manuals, Operating Manuals, Operating Policies and Principles, Operational Safety Requirements and current Operating License will be maintained to the extent possible. However, the need to revise and/or create new commitments or requirements may result from the results of the Integrated Safety Review (ISR), the Environmental Assessment (EA), development of Beyond Design Basis requirements, or Fukushima follow up.

- The Darlington first unit outage reference plan date of October 2016 is based on presently known life-limiting mechanisms and is constrained by the aging of the pressure tubes and related components within the reactor vessel. The plan is to bring unit 2 back into service prior to refurbishing the second unit, unit 3. Subsequent units are planned to be refurbished with an overlap between units 3 and 1 and between units 1 and 4. With two units out of service for refurbishment at the same time, additional steps will need to be taken with the common systems and defense-in-depth.

Significant program constraints include:

- All engineering personnel must place nuclear safety as their first and overriding priority.

- The design basis will be maintained or design and safety margins will be improved. Design and Safety margins will not be degraded. Redundancy, diversity, and defence in depth will be maintained or improved.

- Continued operation of Darlington is largely dependent on the work that is required for long term safe operation of the plant as described in the CNSC's Regulatory Document RD-360: Life Extension of Nuclear Power Plants. OPG's operating licence for DNGS will be amended to introduce specific conditions for the regulatory control of life extension projects. OPG must adhere to the requirements of the Nuclear Safety and Control Act, the Canadian Environmental Assessment Act, all associated regulations, and to all licence conditions. Approval for return-to-service is contingent upon demonstration by OPG that all licence conditions were met.

- The committed refurbishment work identified in the IIP, NK38-REP-03680-10185 defines the regulatory requirements for NR.

- Configuration Management is maintained

5.0 STRATEGIES / INITIATIVES

Several of the following strategies result from the fact that NR requires more engineering staff than are available in OPG or that would be cost effective to hire for the duration of the project and then release at the completion of the project.

5.1 Working with Contractors

5.1.1 Selective Use of Engineer, Procure, Construct (EPC)

A range of approaches are used to perform engineering work depending on the nature of the work, expertise required, and availability of OPG staff to perform the work. Criteria for the decision to do work internally or to use EPC contractors are described in the next section on Make/Buy decisions. Work performed internally (make) uses normal OPG engineering processes and governance. Work performed externally via EPC (buy) requires OPG to specify Owner's requirements. With the exception of Commissioning, EPC Contractors can complete some or all of Engineering, Procurement, and Construction work activities using their own Managed System or QA program. In order to confirm fitness for service, OPG will oversee EPC contractors to obtain assurance that the Managed System is acceptable to OPG, that the EPC work is performed in compliance with the Managed System, and that the contracted deliverables are received in an acceptable form.

With respect to Commissioning, since OPG is the CNSC licensee, OPG must perform the commissioning work in compliance with OPG governance. EPC Contractors may be consulted for support but are not qualified to do commissioning work.

The standardized interface requirements as specified in N-COI-00120-00001, Contractor / Owner Interface Requirements for Nuclear (COIR) will be used to ensure consistency of approach while allowing customization on a project by project basis.

5.1.2 The "Make/ Buy" Decisions

Make versus buy decisions are based on the following criteria recognizing that either OPG or Contractors may execute engineering programs, based on best use and availability of resources.

OPG staff will be used for:

1. Real time station support
   - System & component engineering
   - Plant design support/parts engineering
   - Fuel and physics
   - Reactor Safety support

2. Management of Engineering Contractors
   - Own and approve modification and Commissioning Requirements
   - Oversight & acceptance of products
   - Direct the commissioning activities

3. Expertise unique & important to OPG e.g. Fuel Channels
4. Engineering programs to meet codes and industry standards
   - Contract management
   - Technical project management

Contractor staff will be used for:

1. Detailed design for projects to meet OPG's Design Requirements
2. Expertise not unique to OPG e.g. Turbine/ Generator, obsolescence
3. Support where Contractor has the best expertise e.g. Darlington Fuel Handling design by General Electric- Hitachi
4. Studies/ reviews/ analysis
5. Engineering programs to meet codes and industry standards
6. Research and development

5.1.3 Extended Services Master Service Agreements (ES-MSA)

ES-MSA Contractors have been assigned to a number of Refurbishment Projects including for example D_2O storage, Shield Tank Overpressure, Auxiliary Heating Steam, and Containment Filtered Venting System projects. OPG has developed detailed MDRs that provide the Contractors with specific requirements. While the ES-MSA projects were originally set up as essentially stand-alone projects with all engineering work being done by the Contractor under OPG Oversight, this approach proved to be inefficient and was not achieving project expectations for cost, schedule

or quality. Consequently Refurbishment Engineering shifted to an active management and collaborative role in the completion the ES-MSA Engineering work.

In support of the collaborative approach a Collaborative Front End Planning (CFEP) process has been developed (reference 12). This intent of the CFEP is to get all key stakeholders together to establish project scope before mobilization of the Contractor. The CFEP is intended to reduce downstream scope additions or changes that are required as a result of missing information about requirements.

- OPG works collaboratively with Contractors throughout the project to clarify OPG requirements expedite information flow and ensure deliverables meet the standards set forth by the OPG Management team. In the limited cases where the knowledge base required to make the correct decisions are not within the Contractor organization, or where disagreements occur, OPG provides written technical direction to the Contractor. A simplified review process uses informal collaborative interfaces during ongoing Contractor work and reserves formal Comment and Disposition for technical errors

The Contractor works collaboratively with OPG Refurbishment Engineering staff assigned to the project, some of whom are assigned to the Contractor offices. To the extent possible, Design Team Leader and Modification Team Leader roles are executed by OPG regular employees. The staff in these roles provides a key front line leadership and integration role for the modification process from start to finish. Additionally they provide essential knowledge gained from the evolution of the modifications to the base operating organization at the Modification Available for Service (MAFS) and turnover. If OPG regular staff are not available, preference is given to transferring OPG staff from other engineering roles and backfilling the vacated roles with supplemental staff from the OSS. Specialist roles are filled by OPG regular staff if available or supplemental staff from the Owner Support Services (OSS).

5.1.4 Resident Engineers Seconded To Contractors

The OPG Resident Engineer interfaces between OPG NR Design and EPC design Contractors, to gain assurance of compliance, alignment and fulfillment of expectations. The Resident Engineer facilitates effective design interface with different OPG stakeholders. Roles and responsibilities include:

- Facilitates interfaces between the Contractors and OPG
- Facilitates successful completion of ES-MSA projects
- Assures required alignment between Contractor and OPG expectations for all ES-MSA projects
- Other duties as delegated by the responsible Department Manager or Section Manager

5.1.5 Matrix Organization

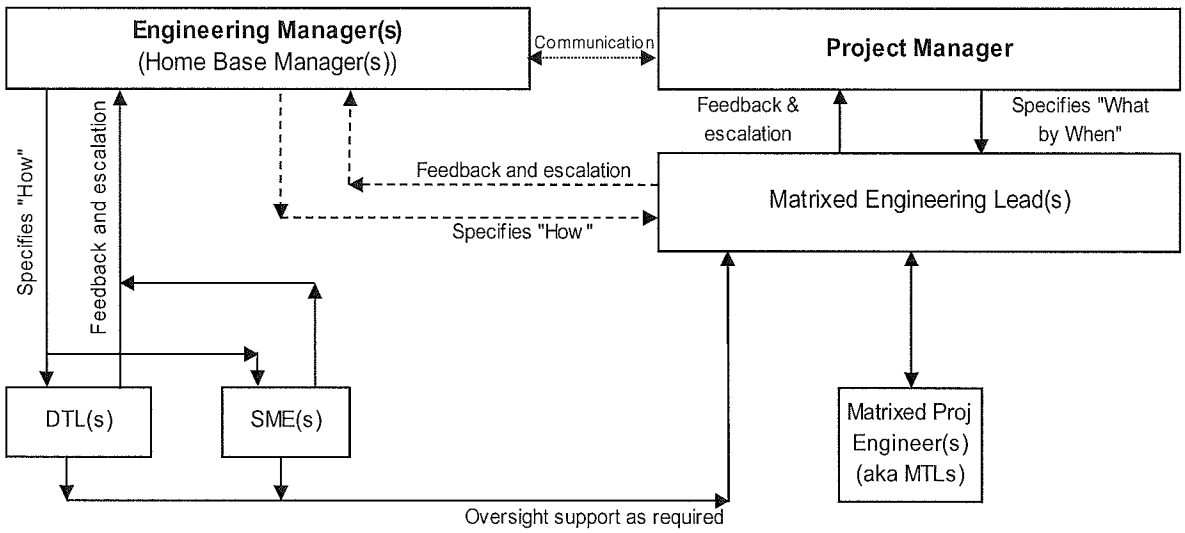
Engineering will support the Refurbishment Execution organization through a matrix structure i.e. a Lead Engineer and Modification Team Leads from Refurbishment Engineering will have a dotted line to the Project Manager. The Project Manager will

specify what is required by when. The Engineering Manager will specify how the work will be done in compliance with engineering governance.

As per N-STD-MP-0024, Engineering and Design Authority, all aspects of Engineering and Design accountabilities and responsibilities for Darlington Refurbishment Program have been delegated by the Chief Nuclear Engineer to the VP, Refurbishment Engineering. To support that accountability, engineering activities required in support of project execution teams are performed by matrixed engineering staff. Each Project bundle has at minimum, one Engineering Lead, assigned to direct and oversee engineering work along with several matrixed project engineers. A description of the roles and responsibilities of the Engineering Leads and Matrixed Project Engineers is included in Appendix B and depicted in the following figure.

Figure 1: Role relationships

Project Model - Matrixed Engineering



5.2 Use of Nuclear versus Non-Nuclear Standards

In general standards that apply inside the Protected Area fall under Federal jurisdiction and apply nuclear standards. Outside the Protected Area fence Provincial jurisdiction and non-nuclear (commercial) standards generally apply unless the structures, systems and components (SSC) have significance to plant safety. There is a significant cost advantage to applying commercial standards where possible since for example, the National Building Code (Federal standard) requires seismic assessment whereas the Provincial codes do not.

For refurbishment projects that are not safety related and outside the Protected Area, there is a cost incentive to apply non-nuclear or commercial standards and this is expected wherever possible.

Where SSCs are safety related, or are inside the Protected Area, the Collaborative Front End Planning approach (reference 12) will be used to establish scope and specify requirements before the project is mobilized. Use of CFEP will ensure that the more onerous requirements applicable to such SSCs are captured and thereby avoid later scope additions in cases where the SSCs would otherwise apply commercial standards.

5.3 Commercial Strategy

The refurbishment commercial strategy selected by OPG is a multi-prime contractor model in which there is more than one prime contractor working on the project. OPG as the owner has a separate contract with each prime contractor. A prime contractor is responsible for the completion of the work under its particular contract, but not for the entire project. The owner is the integrator between the prime contractors and is responsible for the entire project.

Under this model OPG retains project management responsibility and design authority for NR. To execute the work OPG retains a number of contractors who are responsible for major project work packages. To guide OPG in active management of contracting activities, OPG has engaged external technical and project management experts to assist with the overall project management.

The benefits of this model are that OPG retains control over the entire NR, including the deliverables, costs and schedule. Retaining control by OPG is important given the scale, technical complexity and integrated nature of NR. OPG assigns risks to the party best able to manage the risk. This provides OPG with a better balance between the transfer of risk and the costs of the contractor services.

5.4 Interface with Station Engineering

Routine communications with Darlington Station Engineering is required to ensure effective turnover of station systems and accountabilities. NR interfaces with Station Engineering as follows:

1) Monthly transition planning/strategic meetings with Performance and Systems Engineering managers.
2) Monthly meetings to update Station Performance Engineering on the status of the NR work program. This is completed at a section by section level.
3) Monthly alignment meetings with NR and Station senior management (i.e. Strat IV and above).

5.5 Blue Chip Plan

A number of engineering activities are required to be completed for the 2015 Release Quality Estimate (RQE) milestone. A Blue Chip plan has been developed for implementation of ongoing engineering improvement opportunities in support of RQE. Blue Chip plan initiatives include:

- Assignment of Resident Engineers for Civil support

- Use of Design & Construction standards and existing parts documentation for purchase of new parts
- Reinforce understanding of the COIR and escalation of issues
- Strategies for Commercial Grade Dedication(CGD)
- Assessment of Q levels assigned for purchasing
- Field Change processes

Reference Appendix C for a complete list of Blue Chip initiatives.

5.6 Process Optimization

One of the goals of the QE Department is to manage processes that maintain or improve the performance of the Refurbishment Engineering function and the quality of its products. Strategies currently in play to achieve this goal include;

a) Process alignment within acceptable deviation where benefits result

Refurbishment Engineering governance must align with that of OPG Nuclear. Where deviation is permitted, it will be utilized within acceptable bounds, when impacts on Quality, Quantity, Timeliness, and Resources can be improved. The Requirements Traceability Matrix (RTM) is such an example as it is unique to Refurbishment Engineering and improves product quality while reducing resource requirements.

b) Use of Contractor expertise to bridge knowledge gaps

Refurbishment Engineering knowledge and experience with EPC contracts is currently limited. This gap is being addressed through the short term use of EPC experienced Contractors who are managing engineering governance. These contracts will be brought to a close as OPG staff experience with EPC processes build and/or the need for governance maintenance decreases.

6.0 MILESTONE AND KEY DATES

Milestones are established annually and are the basis for each manager's Annual Incentive Plan. For Refurbishment Engineering, the VP milestones for 2015 are:

2015 AIP Scorecard	Status	Comments	Tier Level	Complete	Champion
Darlington Refurbishment - Campus Plan D2O Storage Facility - Dyke Construction Complete		15-Jan-2016			A. Arnott
Fuel Handling /Defueling - Service Area Rehearsal Facility (SARF) In Service		15-Aug-15			S. Marinescu
Fuel Handling /Defueling - Universal Carrier Delivered		31-Aug-15			S. Marinescu
Darlington Refurbishment - Campus Plan 3rd Emergency Power Generator – Building complete and Generator in-place		14-Sep-15			D. Popovic
RL030 - OPG Board Approval of Refurbishment Budget (RQE Complete)		15-Oct-15			G. Rose
Fuel Handling / Defueling - Universal Carrier Commissioned on SARF		15-Dec-15			S. Marinescu
MLC1540 - Darlington Relicensing - License Term (CNSC Approval of Darlington Licence)		31-Dec-15			R. MacEachern
2015 Unit 2 Outage Milestones	**Status**	**Comments**	**Tier Level**	**Complete**	**Champion**
OP2140 – U2 Scope Ranked and Approved in OMS	✓	15-Jan-15	3	A	G. Boyd
OP2015 – U2 Initial Work Assessment Complete	✓	1-Feb-15	3	A	G. Boyd
OP2075 – U2 OMS WO Scope Freeze	✓	1-Jun-15	3	A	G. Boyd
RP135 – Design Authority Acceptance of Modification Packages (Interim Milestone to RP130)	✓	15-Aug-15	3		G. McCabe
RP130 – Design Authority Acceptance of Modification Packages	✓	15-Aug-15	2		G. McCabe
2015 NR Safety Improvement Opportunities SIO Key Milestones	**Status**	**Comments**	**Tier Level**	**Complete**	**Champion**
Diesel Fire Pumps Design Complete	✓	22-Sep-15			G. McCabe
2015 NR Engineering Self Assessment Key Milestones	**Status**	**Comments**	**Tier Level**	**Complete**	**Champion**
Regulatory Correspondence to CNSC Self Assessment	✓	23-Jan15		A	N. Smith
Compliance Check of Field Initiated Changes (FICs) Self Assessment	✓	14-May-15		A	N. Smith
Compliance Check of Detailed Design Packages (MECs & DECs) Self Assessment	✓	25-Jun-15			N. Smith
Product Quality Review MEL & BOM Updates Self Assessment	✓	30-Jun-15			G. McCabe
EPC PE Oversight Self Assessment	✓	15-Sep-15			G. McCabe
Product Quality Review / Quality of DCAVRs Self Assessment	✓	30-Sep-15			G. McCabe
Effectiveness Review of Shut-Down & Lay-up RTMs Self Assessment	✓	31-Dec-15			P. Ross
Human Performance Self Assessment	✓	22-Jan-16			N. Smith
2015 NR Project Bundle	**Status**	**Comments**	**Tier Level**	**Complete**	**Champion**
73612 BOP - Conventional Electrical Systems Detailed Design Complete	✓	28-Jan-15	3	A	G. McCabe
73157 FH - SDS Computers Replacement Detailed Design	✓	5-May-15	5	A	G. McCabe

Complete					
F&IP - 34000 □ Auxiliary Heating System Detailed Design Complete	✓	3-Jun-15		A	G. McCabe
73462 Islanding - Bulkhead & Containment (SNC) Detailed Design Complete	✓	19-Aug-15	3		G. McCabe
73622 BOP - Conventional Service Water Systems Detailed Design Complete	✓	10-Aug-15	3		G. McCabe
F&IP - 31555 □ D2O Storage Detailed Design Complete	✓	31-Aug-15			G. McCabe
2015 NR Engineering Key Milestones	**Status**	**Comments**	**Tier Level I**	**Complete**	**Champion**
Full disposition of all CNSC comments on IIP-R1	✓	31-Mar-15		A	I. Malek
IIP reporting tool live for NR access	✓	24-Mar-15		A	I. Malek
IIP change control Instruction issuance in AS7 and sent to CNSC	✓	25-Mar-15		A	I. Malek
IIP-Rev2 draft reflecting close out of completed IIP items	✓	7-Apr-15		A	I. Malek
IIP-Rev2 issued	✓	27-Apr-15		A	I. Malek

Establishing an accurate and realistic resource loaded schedule is a critical planning tool for Refurbishment Engineering. A multilevel schedule structure (level 0, 1, 2 and 3) has been developed with inputs from all stakeholders and is monitored and updated throughout the project lifecycle as described in N-MAN-00120-10001-SCH, Nuclear Projects Schedule Management.

The program Level I Integrated Schedule is defined in NK38-PLAN-00300-10000, Darlington Refurbishment Program Integrated Master Schedule. The Program Integrated Master Schedule (PIMS) identifies and tracks the important project milestones and key dates. A detailed description of schedule management is provided in reference [6]. In summary:

- Key engineering milestones have been included on this schedule either as a dedicated functional deliverable or as a project team deliverable supported by a functional engineering department.
- Schedules are updated on a regular basis, progress is monitored, tracked, and verified by Refurbishment Engineering.
- Schedule Performance Index (SPI) is monitored to measure progress compared to planned progress and calculated from the Proliance Cost Management Tool. Any schedule slippages are analysed to determine required correct actions/recovery plans.

A milestone reporting structure has been established to identify Key Program Control Milestones and to easily identify the level in the Organization that the Milestone is reportable to. The structure is described in the following table.

Table 1: Milestone Reporting Structure

Tier	Nature of Milestone	Definition
1	Commitments to the Board	Milestones that are commitments to the Boards or decisions at Board level.
2	Critical Impact	Milestones that are critical to the Program, normally documented in Phased based Program BCS's per Release Strategy.
3	Program Controls, including the NR AIP milestones and NR AIP Scorecard	Milestones that manage the health of the Program and keep it on track.
4	Project Gates	Project Gates (checkpoints of project preparation progress at which funding is release for the next phase).
5	Standard Project Milestones & Project Manager Milestones	Milestones at are within the gated process and are specific to the project life cycle.

Tier 1 to 3 milestones are summarized from the Darlington Nuclear Refurbishment Program Integrated Master Schedule in the following table.

Table 2: NR Tier 1 to 3 Milestones

Milestone name	Due date
All MDRs Complete	Complete
Review & Approve CCA's Impacting on IIP/GAR Report	Complete
Final CCA Report Complete NR.FN.FN.01.U0.73010.50.3.02 CCAs AMEC	Complete.
CCA Phase 2 - Prior to Effectiveness Review	Complete
Design Authority Acceptance of Modification Packages	15-Aug-2015
U2 All Projects Detailed Engineering Finished/ Design Modification Documents Finished	15-Aug-2015
Adjusters for Shim Mode - Regulatory concurrence / approval	30-Nov-2015
U1 Project Detailed Engineering Finished (Design	25-Mar-2017

Modification Documents Finished)	
U3 Project Detailed Engineering Finished (Design Modification Documents Finished)	28-Nov-2018
U4 Project Detailed Engineering Finished (Design Modification Documents Finished)	06-May-2020

The most up to date listing of milestones (including those for Tier 1 through 5) can be found in the monthly Nuclear Refurbishment Program Status Reports available in Asset Suite.

The Level 3 schedule provides a breakdown of the work below the work package level and shows all interfaces and shared resources between contractors and OPG. The Level 3 schedule is resource loaded for engineering work by discipline.

7.0 MAJOR WORK SUMMARIES

7.1 Design Engineering

Roles and responsibilities for design engineering for the various phases of the Project are as follows:

(**Note**: Design Authority role is provided per N-STD MP-0024 throughout the Refurbishment Project).

- Definition Phase
  - During this phase, all design and procurement support required for permanent and temporary modifications will be provided in compliance with the ECC process. Modification packages will be prepared and approved in-house or through engineering contractors. All work performed by contractors will include the collaborative approach and the CFEP process activities. All design deliverables are accepted or approved and if applicable, authorized through this department. The department provides inputs to Project Oversight Plans to assure that Contractors are performing work in accordance with the EPC framework.
  - Functional support from design includes assistance with identifying sources of information, directing to appropriate process / governance and review of design documents. Advice on design activities is also provided to ensure configuration management is maintained.
  - Procurement Engineering support for CAT ID creation, writing procurement specifications, item equivalency evaluations (IEE) and setting CAT IDs to ready

- Drafting office support for on-line wiring packages will be accomplished with a base staff made up of augmented and temporary staff. Managed task staff will be used to satisfy peak load requirements.

- Execution Phase
  - During Execution phase, roles and responsibilities for design engineering include:
    - Support for Comprehensive Work Packages (CWPs), assessing and material procurement.
    - Preparation and/or support for small modifications (RRAM's), temporary modifications (TMods) and Field Initiated Changes (FIC's)
    - Response to discovery issues
    - Design and procurement support for Repair and Replace activities and Inspection work. (cyclic work, non modification)
    - Support to Maintenance activities (Engineering Fix It Now (EFIN) team) and problem issues
    - Support for replication of modification packages units 1, 3 and 4. . It is expected this work will be completed during non peak load times

- Close Out Phase
  - It is anticipated that a transition phase will occur during the start-up of a refurbishment outage and the commencement of subsequent unit refurbishment outages. Support for AFS clean-up items will occur during this phase
  - Closeout of all modification ECC packages is required within 6 months of the unit AFS per the ECC process. Drawing office resources will be required to complete these close out activities
  - Closeout of material issues and assurance all relevant information is made available within Asset Suite.

7.1.1 Drawing Office (DO) – Refurbishment

Engineering, Procure and Construct (EPC) contractors prepare change papers on AutoCAD for new drawings as per N-COI-00120-00001 Contractor/Owner Interface Requirements (COIR). The OPG Refurbishment DO prepares change papers on AutoCAD for existing internal drawings. The DO also performs Online Wiring (OLW) Design, Issue and Status Updates for all Engineering Change (EC) modification packages (i.e. - EC packages prepared by EPC contractors and OPG Design Engineering).

DO – Refurbishment support will be required throughout the definition, execution and closeout phases of the NR project. During the definition phase, support is required for preparation of OLW packages and change papers (existing drawings). Execution phase will require support for the Field Initiated Changes (FICs) process, EC package revisions and replication of modification packages for subsequent units. Close out

phase support is required to revised and issue all finalized as-built documentation within 6 months of AFS completion.

7.1.2 Procurement Engineering

Design Engineering also provides Procurement Engineering support to Nuclear Refurbishment. This work includes CAT ID creation, writing procurement specifications, Item Equivalency Evaluations as well as setting CAT IDs to ready. Work also includes accepting Commercial Grade Dedication plans and preparation of design specifications. Procurement Engineering Support also provides support on Equipment Bill of Material and the Master Equipment List updates. All the above listed Procurement Engineering activities with the exception of CAT ID creation and setting CAT IDs to ready will be performed by the EPC contractor under the EPC model for the project scope of work awarded to the EPC contractor. Design Engineering will be providing oversight on the above activities as specified in the Project Oversight Plans. For cycle plan work and work that is not awarded to an EPC contractor, all the above activities will be performed by Design Support.

During the execution phase of the modification process, Procurement Engineering Support will be working with the Fix It Now and High Impact Issues Team. Procurement Engineering support also includes Preventative Maintenance support linked to station activities such as pre-Refurbishment work.

7.1.3 Human Factors Engineering

Human Factors Engineering oversight for modifications and changes is performed as per NK38-PLAN-06700-10001 to assure that the applicable Human Factors Engineering processes are followed, and that "the risk is minimized for the probability of human error on risk-significant and credited tasks". Human Factors Engineering support group works with stakeholders – Design Leads, Operations, Maintenance, Training and other OPG stakeholders and EPC Contractors – to provide guidance on applicable processes and oversight of modification Human Factors Engineering activities. They also account for the combined Human Factors Engineering impact of all modifications and changes, which will be summarised before the completion of Nuclear Refurbishment in support of DNGS license renewal.

Design Engineering interfaces with other groups to ensure work is performed with no overlap. Design Engineering works together with Darlington Plant Design under NK38-PLAN-09701-10113 SHT ENG-02, Refurbishment Design Engineering Ownership Transfer Plan. Support is provided to other divisions for common issues, such as activities within NR or Campus Plan assigned scope which applies to Darlington, implementation of the Safety Analysis requirements within NR scope, and Fukushima Project support as it relates to the NR scope.

7.2 Plant Reliability Engineering

Plant Reliability is made up of all Systems and Components engineering resources.

D-INS-09701-10004 details the roles and responsibilities for the NR Systems and Component Engineers. For the various phases of the Project these include but are not limited to the following:

- Definition Phase
  - During this phase, system and component ownership is a shared responsibility between Station Engineering and NR Engineering (both System and Component Engineering departments)
  - Roles and responsibilities for NR Systems and Components Engineering during this phase include evaluation/creation of ECR's, needs documents, DRAS, scope clarifications/refinements, inspection requirements, SOW's, lay-up/operational strategies, CCA's, COM's, resolution of holds, definition of inspection criteria, OMS scoping support, workplan preparation and review.

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- Execution Phase
  - During the execution phase, Plant Reliability will take System/Component ownership from Station Engineering for >50 systems as defined in the Ownership Transition plans (NK38-PLAN-09701-10113 ENG-01 and NK38-CORR-09701-0509687).
  - Roles and responsibilities for NR Systems and Components Engineering during this phase include (but are not limited to):
    - Manage overall system and component health of transitioned systems per governance.
    - Maintain components programs in accordance with equipment reliability governance.
    - Ensure systems and components are operating consistent with the design basis.
    - Provide fitness for service and condition assessments.
    - Review lay-up plans and RTS plans.
    - Monitor/support all repair/replace WO's (assessing support, holds removal, PMT, etc).
    - Support Scope Control.
    - Support the PM program (including SDLU RTM PM's).
    - Determine SAFS requirements and prepare documentation.
    - Support AFS and commissioning.
    - Create restart specifications.
    - Update aging management program.

- Close Out Phase

- It is anticipated that a transition phase will occur during the start-up of a refurbished outage and the commencement of subsequent unit refurbishment outages
- System/Component ownership and accountabilities will continue until the unit achieves full commercial operation
- Activities such as AFS clean-up items, system monitoring and testing will continue during this transition phase period.

7.3 Quality Engineering

Roles and responsibilities throughout the definition, execution and closeout phases of the Quality Engineering are as follows:

- Manages on behalf of Refurbishment Engineering the applicable governance, Station Condition Record (SCR) and Corrective Action Program (CAP), self assessments, benchmarking, OPEX reviews, Quality Surveillance, Oversight plans, Human Performance Improvement, and overall engineering Quality Improvements
- Primary interface between Nuclear Engineering Governance and Refurbishment Engineering to ensure that the unique needs of NR are being considered in the creation or ongoing revision of engineering governance
- Accountable for the creation of any Guides or Instructions required to provide program specific direction for implementation of engineering governance in the EPC environment of Nuclear Refurbishment. [NK38-INS-01920-10002, Darlington Refurbishment Quality Engineering Plan, which defines the processes, roles and responsibilities of the Quality Engineering (QE) function].

7.4 Nuclear Safety Engineering

Nuclear Safety Engineering is made up of the Nuclear Safety Analysis Department (NSAD) and Nuclear Safety Integration Department (NSID). Nuclear Safety Engineering has two (2) distinct departments, which have different responsibilities, resourcing strategies and timelines.

NSID
Responsibilities include ownership of the IIP, monitoring of the IIP progress, ISR/GAR work and re-licensing support.

- Definition Phase:
  - Much of the IIP work and other department responsibilities will be completed during the definition phase.
- Execution/Closeout phases
  - The responsibilities would mainly be oversight of the outstanding IIP items assigned to REFURB.

NSAD

- Definition Phase
  - Responsibilities include design assist analysis to support SIOs, risk reviews and mitigation, reviewing mods and workplans to support refurb execution, nuclear safety support of project bundles, maintenance of nuclear safety related documents impacted by refurb – such as OP&Ps, OSRs, and AIMs.

- Execution/Closeout Phases
  - Some responsibilities will remain during the execution phase, including day to day risk assessments

Other major engineering work programs are summarized as follows:

7.5 Ownership Transfer Plans

Ownership Transfer Plans (OTPs) have been prepared to ensure that personnel in Nuclear Refurbishment Engineering and Darlington Station Engineering have a clear understanding of specific activities and responsibilities associated with the preparations for unit shutdowns, as well as starting up the Darlington units after refurbishment and returning to a 4 unit operating configuration.

The activities and responsibilities include support for unit turnover, development and/or revision of training materials and delivery of training; transition of work management processes; program, process and procedure changes, hiring and training additional personnel, as required, to support refurbishment and return to service.

Specific department Ownership Transfer Plans are defined in:

NK38-PLAN-09701-10113 Sht: ENG-02	Design Engineering OTP
NK38-PLAN-09701-10113 Sht: NS-01	Nuclear Safety Analysis OTP
NK38-PLAN-09701-10113 Sht: ENG-01	System/Component Engineering OTP

7.6 Interfaces with EPC Contractors

OPG Project Managers are ultimately accountable for managing EPC Contractor performance, but there is a concurrent responsibility upon Engineering staff, particularly project Engineering Leads (if assigned) to provide assurance of acceptable Contractor performance related to engineering deliverables. Resident Engineers have a role in facilitating Contractor success through a consultative approach. Execution of engineering Oversight will support the Project Manager while simultaneously ensuring Engineering line management remains aware of, and is equipped to support engineering due diligence. Engineering Oversight of EPC Modifications is addressed by NK38-GUID-01900-10003, Darlington Refurbishment: Engineering Interface Requirements and the COIR [2].

Engineering staff, supported by their line management, will provide system stewardship, stay aware of and facilitate success of associated projects, consistent with;

(1) PEL 70172, Achieving High Levels of Engineering Performance;

(2) The Principles of Technical Conscience defined in N-PROG-MP-0007, Conduct of Engineering.

Engineering staff will follow a graduated approach when dealing with potential or actual deficiencies in the fitness for service of Contractor engineering deliverables. In particular, they will;

(1) Oversee EPC Contractor engineering process acceptability, process compliance, and deliverable acceptability.

(2) Provide input to the Contractor regarding fitness for service issues. Such input can be in the form of advice (not mandatory for the Contractor) or technical direction signed by the Project Manager (mandatory for the Contractor).

(3) Assess the timeliness and acceptability of EPC Contractor response to OPG's input and update the Project Manager and Engineering line (up to the VP if appropriate) for awareness and support purposes.

If it becomes evident that the Contractor engineering fitness for service issues are not being resolved in a timely manner, or cannot be acceptably resolved with Project Manager and engineering oversight, engineering staff will;

- Document the issue in a Station Condition Record (SCR) if appropriate.
- Adjust the Engineering portion of the Project Oversight Plan.
- Escalate the issue throughout the NR organization based on risk to Quality, Cost, Schedule, and Scope per escalation protocols documented in a letter of expectations – NR Design Engineering escalation of issues, NK38-CORR-01900-0525011.

7.7 Modifications

The key role of the Design Engineering Department is to support development of modifications as per N-PROC-MP-0090, Modification Process, which derives its authority from N-PROG-MP-0001, Engineering Change Control program. This includes the development and approval of the Modification Design Packages for refurbishment. The need for Modifications are identified in Darlington Scope Requests, Engineering Change Requests, Engineering Studies and Needs Documents. Modification deliverables are performed mainly by EPC Contractors with oversight from OPG Design Engineering. All design deliverables are accepted or approved and, if applicable, authorized, through this department. The department provides inputs to Project

Oversight Plans to assure that the Contractor is conducting design work in accordance with the EPC framework.

Design engineering also prepares design deliverables in-house. The work includes preparation, verification and approval of modifications and Non-identical Component Replacements. Functional support from design includes assistance with identifying sources of information, directing to appropriate processes and governance, and review of design documents. Advice on design activities is also provided to ensure configuration management is maintained.

Design Engineering maintains several core support functions: Procurement Engineering support, Human Factors Engineering support and oversight, Environmental Qualification support, Electrical Transient Analysis Program support, Digital Control Computer and Control Computers support (with additional support from the Computers and Control Design department), as well as drafting and On-line wiring support (with DNGS Drafting Office).

7.8 Design Completion Assurance

Design Engineering changes that are executed by EPC contractor agencies are subjected to a Design Completion Assurance (DCA) process. (Reference #3). The objective of the DCA process is to confirm the detailed design as documented, meets design and regulatory requirements and does not affect system performance or design basis.

A formal Design Completion and Verification Review (DCAVR) meeting is held as part of the Refurbishment DA acceptance process.

7.9 Planning for Commissioning and Return to Service

NR Engineering is accountable for supporting the commissioning and return to service for all systems transitioned to NR (D-INS-09701-10004 “NR Systems and Component Engineering Roles and Responsibilities”). The details of which systems are transitioned to NR System Engineering authority from Station Performance Engineering are detailed in the department ownership transition plan (NK38-PLAN-09701-10113 Sht. ENG-01) and the system ownership transfer memorandum of understanding (NK38-CORR-09701-0509687).

NR Engineering is accountable to accept all modification commissioning specifications from the EPC vendor (N-COI-00120-00001, Section 4.70). Once the specifications have been accepted, they are used as the basis for NR System Engineering to create modification commissioning workplans (N-COI-00120-00001, Section 4.72).

NR System Engineering is also accountable for producing the Return to Service Specifications, detailing all maintenance and testing completed on each system, including modifications (NK38-INS-09701-10002 “Nuclear Refurbishment Preparation Of Detailed Restart Specifications And Restart Reports”). NR System Engineering will also identify the required restart checks, inspections and tests required based on the unique nature of the specific system.

The culmination of this information will be input to the System Available for Service (SAFS) documentation (NK38-INS-09701-10005 "Nuclear Refurbishment System Available For Service Process"). Per this process, NR System Engineers are accountable for documenting that individual systems, or group of systems, can be credited to safely and reliably perform their design functions for continued unit operation. All SAFS's will be approved by the DOM.

7.10 Cost Breakdown Structure

The Cost Breakdown Structure is broken out by unit so that project funding can be released for each unit and to allow comparison of costs and schedules among units. Some units are paired or grouped as a common service. The standard breakdown is Project Management, Engineering, Procurement, Construction, and Close out. Inspection is added as applicable.

8.0 RISKS AND OPPORTUNITIES

8.1 Risks

Engineering Program Risks are maintained in the Risk Management Oversight Tool (RMO). Risks are monitored on a monthly basis with each Division Director. The risk management process is described in reference [10]. An Engineering Review Board periodically assesses the aggregate risks of significant Station Condition Records, Technical Operability Evaluations and Operational Decision Making actions on the impact of the site SOE, Design and Licensing Basis. The following table summarizes the current risks which represent the major and significant "heat" ratings (greater than or equal to 6). The table is updated on an ongoing basis.

Table 3: Main NR Risks

RADAR Risk No.	Risk Title	Risk Description	Heat (Current Score)	Risk Response Strategy
702	Resource Risk for Unit RTS, Commissioning and Close-Out	The risk is that there are not enough Systems and Components Engineering resources during Unit Return to Service (RTS)/Commissioning due to incrementally higher resource demands during the overlap of subsequent outages which delay the project execution. The cause of this may be inadequacy of appropriately trained staff in terms of numbers or Money available to add FTES that may be available to complete the work in a timely way.	4	If this strategy proves to be insufficient there is a risk that OSS/Augmented Staff will be required to support these periods where base Engineering numbers are inadequate.
723	Scope required to meet regulatory requirements increases	The risk is that during license renewal hearings, CNSC commission increase demands for additional actions as a result of intervener submissions.	4	1) Close off as many CNSC issues pre licensing hearings. - Action 3350 2) Be well prepared to report to commission and interveners. - Action 3351

RADAR Risk No.	Risk Title	Risk Description	Heat (Current Score)	Risk Response Strategy
750	CNSC Acceptance of IIP Items Completed as Acceptable Deviations	The risk is that CNSC may not accept the deviations from the original IIP commitment upon submission of completed IIP short of original commitment and after the application of change control. In addition, it may be that OPG may be unable to complete the IIP commitment as stated or within the allotted time. The cause may be deviations from the original scope of IIP depending on what is found following inspections such that original intent is not met or that time required to complete the work is inadequate. The impact of this would be increased cost and schedule and having to replan and reintegrate the work into the schedule. It will also impact on credibility with the CNSC.	3	There are no actions associated with this risk.
763	Hydrostatic Pressure Test pressure set point	There is a concern that if the hydrostatic pressure test is done with fuel in the core, the test pressure will exceed the fuel limit pressure.	4	Options to mitigate this concern is performing the hydrostatic pressure test with the core empty, or performing the hydrostatic pressure test with fuel in the core but reducing the pressure at which the test is performed.

RADAR Risk No.	Risk Title	Risk Description	Heat (Current Score)	Risk Response Strategy
770	Discovery and Emergent work impacting Engineering	During inspections or detailed reviews of tasks it is possible that new work will be identified and will require Engineering support. Discovery work in the plant in the past has never been zero and it is expected that some discovery work will be found during refurbishment outage and other IIP related work. The causes may be varied but centered around either inspections or re evaluation based on OPEX, or extent of condition, or new analysis. The impact of such emergent work could be further Engineering input as required beyond that has been included in the budget.	1	There are no actions associated with this risk.

8.2 Opportunities

Lean Engineering review is being performed for several engineering processes. Action plans are being developed to drive process improvements, clarify roles, reduce churn and remove bottlenecks which is expected to drive cost improvements within Engineering.

The Lean Engineering review is still in progress and is involving Engineering contractors in the process. Action plans being developed are expected to drive cost improvements within NR Engineering and Engineering contractor organizations.

Additional opportunities are identified in section 5 under Strategies/Initiatives.

9.0 PERFORMANCE MEASUREMENT AND REPORTING

9.1 Quality Metrics

9.1.1 Quality Dashboard

The Darlington Refurbishment Engineering Quality Dashboard provides metrics to OPG on the quality and schedule of Darlington Refurbishment Engineering projects. These

metrics are utilized to identify risks, downward performance trends, and highlight areas where additional project management focus is required. By monitoring the current state of the Refurbishment Engineering portfolio, corrective actions to mitigate risks and to increase overall portfolio performance can be implemented.

A Quality Dashboard has been created for the entire Darlington Refurbishment Engineering Program in a 3x3 matrix organized by topic (see table 1) .The majority of data is provided graphically (i.e. in bar/pie charts or tables) in the matrix. Additionally, the matrix is accompanied by a 'backing information sheet' which describes key assumptions, inputs, conclusions and additional detail. The project data displayed in the Quality Dashboard is collaboratively agreed upon with the Project Managers.

The Quality Dashboard is updated on a weekly basis such that performance can be measured at a sufficient frequency to allow implementation of corrective actions in a timely manner. It is presented at the weekly Engineering Schedule and Metrics Review Meeting and distributed as part of the meeting package. A summary of the Quality Dashboard will also be provided to the Refurbishment Project Executive Team (RPET).

Table 4: Darlington Refurbishment Engineering – QUALITY DASHBOARD

1) **Human Performance Indicator – Event Free Day Resets (EFDRs)**	2) **Active Request for Information (RFI) and Engineering Holds Summary**	3) **Engineering Qualifications – OPG and Contractors**
• Monitors the frequency of significant, adverse human performance errors	• Monitors the volume and turnaround time on requests for information by contractors (RFIs) and OPG work planning assessors (Holds). The magnitude of backlog is an indicator of potential impact on quality of engineering work.	• Monitors the level of contractor and OPG training qualifications in accordance with CSA N286 QA requirements.
4) **MEC/EC Revision Summary**	5) **Field Intent Change (FIC) Summary**	6) **Self Assessment and Corrective Action Summary**
• Monitors the churn on MECs/ECs and how often MECs/ECs are 'correct the first time'. Indicator of MEC/EC quality.	• Monitors non-intent revisions made to an approved or active EC prior to Available for Service (AFS). Indicator of MEC/EC quality.	• Monitors health of ARs and CAPs completion rate.
7) **Rejection by Approving Authority**	8) **ECC Site Modification Report Card**	9) **Resource Loaded Level 3 Schedule**
• Monitors rejections by approving authorities. Indicator of the quality of the preparer/verifier/approval process.	• Provides a roll-up of the % of close-out commitments, SCR modification index and design quality metrics. Monitors the effectiveness of the ECC process overall.	• Monitors the completeness of the Level III, resource loaded engineering schedule. Includes contractor and OPG resources required to meet project milestones.

A sample Quality Dashboard and accompanying backing information sheet are provided in Appendix D.

9.1.2 Adherence to the Quality Principles of CSA N286-05

The following is a table of the Quality Principles of CSA N286-05 and how Nuclear Refurbishment measures compliance to the principle. The governance in place to meet CSA N286-05 are identified in N-LIST-08130-10023, "CSA N286-05 to OPGN Governance Cross Matrix" to demonstrate the quality program is compliant with this standard.

No.	Quality Principle	Metrics
1	Business is defined, planned, and controlled	SPI, Milestones by WBS report
2	Organization is defined and understood	Functional Management Plan issued annually as per schedule. Relevant Human Performance trend codes in SCRs are monitored and trended.
3	Personnel are competent at the work they do	1. Training Qualification Index 2. Vendor training scorecard. 3. Relevant Human Performance trend codes in SCRs are monitored and trended.
4	Personnel know what is expected of them.	Relevant Human Performance trend codes in SCRs and O&Cs are monitored and trended.
5	Work is planned	SPI, Schedule performance (Quality Dashboard)
6	Experience is sought, shared and used	OPEX program metrics
7	Information is provided in time to people who need it	1. Engineering Holds/RFIs 2. Relevant Human Performance trend codes in SCRs are monitored and trended.
8	Performance of work is controlled.	ECC metrics, SCRs/CAPs trend report
9	Preparation and distribution of documents are controlled.	Issues with Control Documents, Backlog of Documents and Records are identified in SCRs and, if applicable, Event Free Day Resets (EFDR).
10	Work is verified to confirm that it is right	O & C reports. Adverse results of verification check sheets, self assessments and audits are recorded in SCRS.
11	Problems are identified and resolved	SCR & CAPs and trend reports
12	Changes are controlled	Site Modification Index
13	Records are maintained.	Annual records management self assessment by records officer for NR and Vendor compliance to CSA N286-05 (approved by SVP NP), SCRs raised for any issues
14	Assessments are performed	Self assessment schedule developed annually and tracked for completion.

Methods to measure adherence to quality principles of CSA N286-05:

Method	Quality Principles
Relevant trend codes in SCRs and O&Cs are monitored and trended.	2 - Organization is defined and understood 3 - Personnel are competent at the work they do 4 - Personnel know what is expected of them. 11- Problems are identified and resolved 10 - Work is verified to confirm that it is right
Site Modification Index	12 - Changes are controlled
NR OPEX Program metrics	6 - OPEX program metrics
Self Assessments, Audits, Surveys.	14 – Assessments are performed 9 - Preparation and distribution of documents are controlled. 8 - Performance of work is controlled. 13- Records are maintained.
NR program metrics (i.e. SPI,CPI, milestone completion)	1 - Business is defined, planned, and controlled 5 – work is planned
ECC process metrics	8 - Performance of work is controlled.
Engineering Holds/RFIs	7 - Information is provided in time to people who need it
EFDR	A significant event involving any of the quality principles may result in an EFDR

9.2 Performance Metrics

Performance measures are used to assess the extent to which performance is achieving the intended targets. If targets are at risk of not being met, corrective action is taken.

9.2.1 Earned Value Management System

An Earned Value (EV) management system reports progress on a project by project (or activity) basis with respect to the level 3 schedule. Reference N-MAN-00120-10001 sht: sch-07. This system is being used initially to support the RQE milestone

9.2.2 Contractor Metrics

Contractor reporting metrics are defined by the COIR and project Scope of Work (SOW). Typical reporting occurs on a weekly basis and includes reports of cost, schedule, risk, current status and look ahead dates. Reporting is on a project by project basis and also rolled up to the major Project Bundle level.

9.2.3 Oversight

Projects Oversight Logs system includes a module for recording of oversight findings. These findings are reviewed and reported at the monthly Oversight Steering Committee meetings.

9.2.4 Program Assurance Group

The Program Assurance Group (PAG) leads horizontal surveillances (across the projects) on a quarterly basis with support from Engineering and other functions. The Programmatic Oversight is based on the nine (9) INPO 09-007 principles and specific oversight scope addresses risks and themes emerging from Project Oversight data and OPEX.

Each functional area has a SPOC assigned who is part of a PAG Working Group which develops the Program Assurance Plan. The SPOCs are responsible for making recommendations for required horizontal oversight due to known project risks or common (across projects) emergent issues. SPOCs are required to be at a sufficient level in the function to allocate resources required to perform the planned PAG oversight activities. The plan is revisited and revised as necessary on quarterly basis by the PAG Working Group.

The PAG draft plan is discussed and negotiated with the Project Managers well in advance of the start of the planned oversight. The finalized PAG plan is reviewed by NPET and approved by the Director of MSO. The agreed upon plan is loaded by MSO into the Risk Management and Oversight tool (RMO) for tracking of scope, objectives, assigned team members, timing, and for documenting any findings / corrective actions required.

10.0 RESOURCE PLAN

Resource strategies related to availability of engineering expertise and the contracting strategy are described in Section 5. The Refurbishment Engineering staffing plan, staff levels and contractor requirements are based upon those strategies. There is a mix of capabilities throughout Refurbishment Engineering from experienced engineering staff to new hires. A high concentration of contract staff exists through OSS and augmented staff contracts.

10.1 Labour

A narrative of the resource plan for each engineering department is provided in the following sections. All resource plans and staff compliment numbers have been vetted through the RQE challenge process. All planning assumptions have been entered into the assumptions database and all risks associated with RQE planning have been input to RADAR.

10.1.1 Design Engineering

Engineering staff compliment and job family levels are provided in Table 5. A resourcing strategy using a combination of regular, OBU and augmented staff has been implemented. Augmented staff is required to meet peak work load requirements and where specialized resources are not available within core capability of the department. See section 7.0 for Design Engineering roles and responsibilities during the various phases of the project

Basis of Estimate:

- Design engineering staff are trained and qualified and no additional hiring programs will be required. Ongoing training and requalification of engineering staff will be required.
- The learning experience from unit 2 refurbishment will be utilized in subsequent refurbishment outages. Engineering efficiencies and learning factors have been applied to Design Engineering resource estimates and the RQE template for units 1, 3 and 4 refurbishment outages. Reference the following SharePoint links:

- http://catou-ogwspuwdc:9015/teamsites/nuclear/nuclsupport/Nucrefurb/PC/Forms/AllItems.aspx?RootFolder=%2fteamsites%2fnuclear%2fnuclsupport%2fNucrefurb%2fPC%2fReleases%2fRQE%20resource%20template&FolderCTID=0x01200011C9AADB5BAF7A4CBAD846D0C1BCD7DC&View=%7bAAB02184%2d503E%2d4080%2dBE1F%2dC33D32F1642B%7d
- http://catou-ogwspuwdc:9015/teamsites/nuclear/nuclsupport/Nucrefurb/Eng/Forms/AllItems.aspx?RootFolder=%2fteamsites%2fnuclear%2fnuclsupport%2fNucrefurb%2fEng%2fDesign%20Eng%2f4D%20Estimate%20Tool&FolderCTID=0x01200043740B599CD7084C8AA88503779542DD&View=%7b43FAD3B8%2d94C9%2d435F%2dA061%2d2A443C01490E%7d

- With the overlap of Units 1, 3 and 4 refurbishment outages, additional design engineering staff is not required for these multiple outages because of the efficiency gains from the Unit 2 refurbishment experience.
- The resource profile for Design Engineering will decrease slightly after issuance and support of unit 2 modification packages as well as replication of Units 1, 3 and 4 packages.
- Excluded from Functional Engineering estimate (i.e. included in Project Estimate, Non-P&M)
    - All functional engineering costs required to complete in-house modification or repair/replace activities
    - All engineering SME/OBU costs required to complete in-house modification or repair/replace activities
    - All engineering costs resulting from changes to existing modifications (FICs) and emergent modifications that will be completed in house

- All engineering support (whether provided by OPG staff, OSS or Aug staff) required for P&M projects is excluded from the functional estimates
- The resource profile for the Drawing Office – Refurbishment will remain constant throughout the definition, execution and closeout phases of the 4 unit project.

Table 5: Staff Compliment – Design

Regular Staff

	Band E	Band D		Band G	Band H				Band H	
Year	Core VP Engineering (Strat VI)	Core Directors (Strat V)	Core MG (Admin Assist + Admin)	Core Band G (Strat IV)	Core SM (Strat III) (soc + MG)	Core Eng Nuc Ops (Strat II)	Matrix Engineers (Strat II)		Aug Staff SM (Strat III) (soc + MG)	Aug Staff Eng Nuc Ops (Strat II)
2015		1	1	3	8	24.4			6.6	21.3
2016		1	1	3	11	21			3.3	14.8
2017		1	1	3	11	18			3.1	15
2018		1	1	3	11	18			3.2	15
2019		1	1	3	11	21			3	15
2020		1	1	2	11	17			2.1	12
2021		1	1	2	11	17			2	9
2022		1	1	2	11	16			2.4	9
2023		1	1	2	11	14			2	7
2024		1	1	2	11	14			2.5	7
2025		1	1	2	11	10			2.5	7
2026		0.2	0.2	0.3	0.7	1.5			0.1	0

OBU Staff

	Band E	Band D		Band G	Band H				
Year	Core VP Engineering (Strat VI)	Core Directors (Strat V)	Drawing Office Core MG (Admin Assist + Admin)	Drawing Office Core Band G (Strat IV)	Core SM (Strat III) (soc + MG)	Draw Office FLM	Draw Office FLMa	Core Eng Nuc Ops (Strat II)	Drawing Office (Strat II)
2015					1			3	7
2016			0	0.7	1	0.7	0.7	3	7
2017			0	0.7	1	0.7	0.7	3	7
2018			0	1	1	2	2	3	5
2019			0	1	1	2	2	3	5
2020			0	1	1	2	2	3	5
2021			0	1	1	2	2	3	5
2022			0	1	1	2	2	3	10
2023			0	1	1	2	2	2	10
2024			0	1	1	2	2	2	10
2025			0	1	1	2	2	2	10
2026			0	0.5	0	1	1	0	4.1

10.1.2 Plant Reliability Engineering

Plant Reliability is made up of all Systems and Components engineering resources. Engineering staff compliment and job family levels are provided in Table 6. A resourcing strategy consisting of the use of mainly regular staff has been implemented. See section 7.0 for Plant Reliability roles and responsibilities during the various phases of the project.

Basis of Estimate:

- Plant Reliability will ramp up to full compliment in Q2 of 2015 in preparation for the start of the U2 refurbishment outage in 2016. It is expected that staff will be qualified and in role in time for turnover of U2 systems.
    - The Station will provide 6 qualified System/Component engineers in exchange for 6 of the newly hired graduates

- A bridging strategy that utilizes augmented staff will be in place until new staff hires are qualified and in role. This is documented in the Systems and Components Transition plan as Revision 03.

- Throughout the execution phase for the four unit refurbishment (2016 to 2026) the resource profile for Plant Reliability will remain constant. Plant Reliability will take System/Component ownership from Station Engineering for >50 systems as defined in the Ownership Transition plans (NK38-PLAN-09701-10113 ENG-01 and NK38-CORR-09701-0509687).
  - 30 FTE's includes 24 SRE's and 6 CRE's.
  - Approximately 70 % of station systems will remain in service and will not have modifications or significant work performed during refurbishment. Station staff will retain responsibility for the majority of these systems during the refurbishment outage.
  - It is expected that, through proper system engineering work planning, the peak at the end of each refurbishment outage can be flattened as key activities (i.e. RTS specification creation) can be handled during non peak load times.
  - Project Engineers and Engineering Leads are matrixed to the Project Organization and funded by Project Bundles

  Reference the following SharePoint links:

  - http://catou-ogwspuwdc:9015/teamsites/nuclear/nuclsupport/Nucrefurb/PC/Forms/AllItems.aspx?RootFolder=%2fteamsites%2fnuclear%2fnuclsupport%2fNucrefurb%2fPC%2fReleases%2fRQE%20resource%20template&FolderCTID=0x01200011C9AADB5BAF7A4CBAD846D0C1BCD7DC&View=%7bAAB02184%2d503E%2d4080%2dBE1F%2dC33D32F1642B%7d
  - http://catou-ogwspuwdc:9015/teamsites/nuclear/nuclsupport/Nucrefurb/Eng/Forms/AllItems.aspx?RootFolder=%2fteamsites%2fnuclear%2fnuclsupport%2fNucrefurb%2fEng%2fDesign%20Eng%2f4D%20Estimate%20Tool&FolderCTID=0x01200043740B599CD7084C8AA88503779542DD&View=%7b43FAD3B8%2d94C9%2d435F%2dA061%2d2A443C01490E%7d

Table 6: Staff Compliment - Plant Reliability

Regular Staff

	Band E	Band D		Band G	Band H		
Year	Core VP Engineering (Strat VI)	Core Directors (Strat V)	Core MG (Admin Assist + Admin)	Core Band G (Strat IV)	Core SM (Strat III) (soc + MG)	Core Eng Nuc Ops (Strat II)	Matrix Engineers (Strat II)
2015	1	0		2	3.3	30.0	
2016		0		2	4	31.0	
2017		0		2	4	30.0	
2018		0		2	4	30.0	
2019		0		2	4	30.0	
2020				2	4	30.0	
2021				2	4	30.0	
2022				2	4	30.0	
2023				2	4	30.0	
2024				2	4	30.0	
2025				2	4	30.0	
2026				0.5	1	4.0	

OBU Staff

	Band E	Band D		Band G	Band H		
Year	Core VP Engineering (Strat VI)	Core Directors (Strat V)	Core MG (Admin Assist + Admin)	Core Band G (Strat IV)	Core SM (Strat III) (soc + MG)	Core Eng Nuc Ops (Strat II)	Drawing Office (Strat II)
2015						1	
2016						1	
2017						1	
2018						1	
2019						1	
2020						1	
2021						1	
2022						1	
2023						1	
2024						1	
2025						1	
2026						0.5	

10.1.3 Quality Engineering

Quality Engineering staff compliment and job family levels are provided in Table 7. A resourcing strategy using a combination of regular and augmented staff has been implemented. Augmented staff are required to meet peak work load requirements and provide specialized resources.

Basis of Estimates:

- The resource profile for Quality Engineering will remain relatively constant throughout the Project.

Table 7: Staff Compliment – Core VP and Quality Engineering

Regular Staff

	Band E	Band D		Band G	Band H			Band H	
Year	Core VP Engineering (Strat VI)	Core Directors (Strat V)	Core MG (Admin Assist + Admin)	Core Band G (Strat IV)	Core SM (Strat III) (soc + MG)	Core Eng Nuc Ops (Strat II)	Matrix Engineers (Strat II)	Aug Staff SM (Strat III) (soc + MG)	Aug Staff Eng Nuc Ops (Strat II)
2015	1	0	2	1		3		2	1
2016	1	0	2	1		3		0	1
2017	1	0	2	1		3		0	1
2018	1		2	1		2		0	1
2019	1		2	1		2		0	1
2020	1		2	1		1		0	1
2021	1		2	1		1		0	1
2022	1		2	1		1		0	1
2023	1		2	1		1		0	1
2024	1		2	1		1		0	1
2025	1		2	1		1		0	1
2026	0.2		0.2						

10.1.4 Nuclear Safety Engineering

Engineering staff compliment, job family levels and resourcing strategy (combination of regular and OBU staff) are provided in Table 8. Nuclear Safety Engineering is made up of the Nuclear Safety Analysis Department (NSAD) and Nuclear Safety Integration Department (NSID).

Nuclear Safety Engineering has two (2) distinct departments, which have different responsibilities, resourcing strategies and timelines.

NSID –This department is staffed with 7 resources reporting to refurb line management. As the IIP work and other department responsibilities consist of significant front end resourcing, with time, staff levels will be decreasing. In 2016 the department responsibilities will be transferred, with the appropriate staffing levels, to Plant Reliability (Components Engineering) Department.

NSAD – The 2015 staff complement for the department is 22 resources, all OBU, matrixed from the Nuclear Safety Directorate from 889 Brock Rd. As some of the resources are only required during the definition phase of the refurbishment, resource levels will drop as time progresses. Resource levels will slightly increase during times at which refurb outages overlap, due to the increased need to provide day to day risk assessments, but in general, will decrease in time.

Basis of Estimate for NSID:

- 7 FTE's includes 1 manager and 1 section manager in 2015.
- In 2016, the bulk of the work for NSID should be completed and the responsibilities and the people remaining will be transferred to Plant Reliability (Components Engineering) Department

Basis of Estimate for NSAD:

- Nuclear Safety staff are fully trained and qualified and no additional hiring programs will be required.
- 22 FTE's includes 1 manager and 3 section managers
- Department reduces to 2 section managers in 2020
- Resource levels vary with time, with a general decrease until the end of the last unit.
- It is expected that, through proper system engineering work planning, the peak at the end of each refurbishment outage can be flattened as key activities (i.e. RTS specification creation) can be handled during non peak load times.

Table 8: Staff Compliment – Nuclear Safety

Regular Staff

	Band E	Band D		Band G	Band H		
Year	Core VP Engineering (Strat VI)	Core Directors (Strat V)	Core MG (Admin Assist + Admin)	Core Band G (Strat IV)	Core SM (Strat III) (soc + MG)	Core Eng Nuc Ops (Strat II)	Matrix Engineers (Strat II)
2015		1		0.3	1	4.3	
2016		1					
2017		1					
2018		1					
2019		1					
2020		1					
2021		1					
2022		1					
2023		1					
2024		1					
2025		1					
2026							

OBU Staff

	Band E	Band D		Band G	Band H		
Year	Core VP Engineering (Strat VI)	Core Directors (Strat V)	Core MG (Admin Assist + Admin)	Core Band G (Strat IV)	Core SM (Strat III) (soc + MG)	Core Eng Nuc Ops (Strat II)	Drawing Office (Strat II)
2015				1	3	20.0	
2016				1	3	19.0	
2017				1	3	18.0	
2018				1	3	17.5	
2019				1	3	17.2	
2020				1	2	7.7	
2021				1	2	15.9	
2022				1	2	16.7	
2023				1	2	12.4	
2024				1	2	9.5	
2025				1	2	8.4	
2026							

10.2 Training and Qualification

Refurbishment Engineering training is described in NK38-PLAN-09701-10007, Darlington Refurbishment Project Training Work Plan. The Training Work Plan is structured to address the following identified three major project training areas:

(1) Contractor On-Boarding Training

(a) EPC contractor employee on-boarding training

(b) ES-MSA contractor employee on-boarding training

(2) Contractor Project/Job Specific Training

(3) OPG Personnel Training

(a) O&M personnel continuing training

(b) Engineering training

(c) Modifications and return to service training

N-TQD-901-00001 Nuclear Refurbishment Training and Qualification Guide describes the training requirements for all staff associated with NR, specifically, contractor personnel, Owner Support Services personnel, Nuclear Refurbishment, OPG personnel and Fleet OPG personnel

Contractor on-boarding of OPG QA programs and why specific deliverables are required has been presented to all engineering contractors. This material is also required reading for NR staff (PEL 71132)

OPG on-boarding of EPC vendor QA programs has been organized by Project Directors. Engineering staff training qualifications are documented in PELs 71376 to 71381.

10.3 Purchased Services

NR relies upon engineering expertise and services purchased from Owner Support Services (OSS) Contractors: AMEC NSS and WorleyParsons. The services include scoping, planning, contracting, active management and Oversight of EPC Contractors. The work is done under the OPG QA program.

10.4 Non-labour Resources

Refurbishment supported Information Technology tools include:

- DSR Database
- P6
- Proliance

- Reporting (takes input from P6 and Proliance)
- Electronic Document Management System (EDMS)
- SharePoint

Refurbishment Engineering gets any specialized IT support beyond the normal OPG configuration by purchasing hardware and software through the Section Manager, Program Infrastructure. A Decision Record and Analysis Summary (DRAS) is used to document the decision to purchase any specialized hardware or software

10.5 Professional Engineers of Ontario (PEO)

Nuclear Refurbishment staff are encouraged to obtain their Professional Engineering license from the province of Ontario and to maintain a current license status. Engineering contractors are required to comply with the PEO guidelines on sealing engineering drawings and documents – ref. N-COI-00120-00001, section 2.2.2.

11.0 CONTINUOUS PROCESS IMPROVEMENT

Continuous Process Improvement involves an ongoing cycle of planning work, executing work, checking the work results against expectations, and adapting the work processes to improve future performance. This approach is defined in OPG-POL-033. OPG Business Model has elements of a "Plan-Do-Check-Act" cycle. Continuous improvement is further defined in N-CHAR-AS-0002, Nuclear Management System. The Human Performance Improvement program described in section 11.1 complements the continuous process improvement process by specifically seeking ways to reduce the potential for human error. Assessment processes are described in sections 11.2 through 11.4. Initiatives that have resulted from identified needs or opportunities are listed in section 5. In some cases Directives are issued by the VP Refurbishment Engineering in order to bring focus to a particular topic that is in need of more attention, or constitutes a change in VP expectations.

11.1 Human Performance Improvement

The purpose of NK38-PLAN-09701-10116, Nuclear Refurbishment Engineering Human Performance Improvement Plan, is to minimize the frequency and severity of human performance events that could adversely influence the Nuclear Refurbishment Program or the Darlington Nuclear Station. Refurbishment Engineering uses the same Human Performance Improvement model that the DNGS Station Engineering uses with the three primary elements being: Leadership and Oversight, Culture and Skills and Knowledge. Each Engineering Department prepares a Self Assessment Plan to address Human Performance on yearly basis. The plan of self-assessments, (including Human Performance) for the subsequent year is input in the Nuclear Self Assessment Database before end of October. Quality Engineering will perform at least one Divisional Level Self Assessment every year.

Observation and Coaching is performed by NR Engineering as required by N-INS-09030-10004 Observation and Coaching [7]. This instruction has recently been issued

with a compliance date of January 16, 2015. Clarifications for Observation and Coaching within NR Engineering are expected to be provided in Q1 2015.

11.2 Self Assessment and Independent Assessment

A self assessment on the use of SCR system and Corrective Action Management is performed at least once a year to determine the following:

- Is the SCR system being used effectively by Refurbishment Engineering Staff to report adverse conditions?
- Do the SCR evaluations and completion of action assignments meet requirements of N-PROC-RA-0022, Processing Station Condition Records?
- How effective are the corrective actions carried out to address the adverse conditions identified?

A listing of Self Assessments that have been planned for the current year is provided in N-REP-09701-10007, Nuclear Refurbishment 2015 Self Assessment Schedule.

A self-assessment is carried out annually by Quality Engineering on the use of Observation and Coaching in Refurbishment Engineering.

11.3 Corrective Action Program

SCRs are initiated whenever an adverse condition is identified with either NR or Contractor Engineering Work Processes, Practices, Engineering Product Quality, Engineering Product Rejections, Engineering Rework or Resubmissions. Details of the adverse condition/event are identified so that it can be considered for declaring Department Event Free Day Resets. The threshold of SCR reporting is such that the majority of SCRs report low level events and result in disposition as D4 for trending. Low level reporting is important to reduce the probability of ECC Breakthrough Events. See attached the ECC Breakthrough Triangle (Appendix E).

SCRs are initiated using the Nuclear SCR database except when the adverse conditions impacts the ability to safely operate or maintain Darlington NGS in which case the SCR is initiated in the Darlington SCR Database.

SCR content includes details required to adequately describe the adverse condition and information required to determine applicable trend codes such as Event Based Codes, Human Performance Codes, Line Defined Codes, as discussed in N-LIST-01966-10001, Trend Codes Applied to Station Condition Records. It is an expectation that self reporting SCR's are submitted for all NR Engineering adverse conditions.

Appendix E indentifies typical quality issues along the Modification Process, (as applied to the Nuclear Refurbishment Engineering Work Stream); the issue identification responsibility through SCRs; and potential ECC Trend Codes.
Each departmental engineering section will have at least one person qualified to perform Apparent Cause Evaluations as per N-PROC-RA-0022, Processing Station Condition

Records. Action tracking completion notes are prepared in accordance with N-PROC-AS-0019, Action Item Management. SCR evaluation shall meet the criteria identified in N-FORM-11200, OPG Apparent Cause Evaluation Grading sheet and N-FORM-11149, OPGN Causal Analysis Quality Check Sheet (as referenced in N-STD-RA-0008, Incident Investigation).

A cornerstone of the Corrective Action Program plan is the use of the Event Free Day Resets (EFDR) for Refurbishment Engineering departments following the principles discussed in N-INS-09030-10002, Site and Department Level Event Free Day Resets. NR Engineering will use the criteria defined in Appendix-D of N-INS-09030-10002. Each EFDR will lead to a Flash Report or Lessons Learned Report to share the details of Human Performance issues with all NR Engineering staff.

Whenever a corrective action is assigned to NR Engineering staff, the individual will:

Accept/arrange for the acceptance assignment in Action Tracking if it is not already in "Accepted" status.

Estimate the work involved and make a plan for accomplishing the task and completing the assignment 7 days before its TCD.

Timely completion of corrective action assignment is a key indication of the health of the Corrective Action Program. If it is not possible to be completed 7 days prior to the due date, case by case approval is required from the respective Department Manager or Director. Under no circumstances will the Corrective Actions be permitted to go late.

Completion notes in Action Tracking as well as those in SCRs reported as complete will meet the requirements identified in N-PROC-AS-0019, Action Item Management. The completion notes are such that even those who may not have knowledge of the action may read the notes and gain an understanding of how the issue was addressed. The completion notes should give evidence of how the action was completed thereby resolving the issue. Use N-FORM-11240, Action Tracking Completion Notes checklist is of use in the context, to make sure the completion notes meet these criteria.

In addition to the OPG SCR and Action Tracking Processes described above, Refurbishment Engineering uses a process called Actions, Issues, Decisions, and Key Assumptions Management (AIDA) [5]. The purpose the AIDA Management process is to ensure Actions, Issues, Decisions, and Key Assumptions associated with Nuclear Refurbishment are properly identified, documented, approved, and managed. As noted in Section 1.2.2.1 of N-MAN-00120-10001-RISK-07, if an issue is an adverse condition (which includes any undesirable or questionable condition) an SCR is to be raised and the Corrective Action Program will be followed.

All adverse conditions and adverse trends are documented in the SCR database. Self-assessment actions are tracked in Asset Suite as 'Management' Actions. Actions that are related to improvement recommendations and improvement initiatives are documented in AIDA.

11.4 OPEX and Key Lessons Learned

The Nuclear Refurbishment Program has sought out, gathered, and incorporated a significant amount of industry knowledge and experience pertaining to the planning

and execution of major nuclear refurbishment and other mega rehabilitation projects including Bruce A, Point Lepreau and Pickering A Return to Service projects. Additional OPEX and lessons learned have been incorporated from benchmarking of non-CANDU NPPs and non-nuclear mega projects such as the Project Management Institute, INPO's Project Management web sites, industry working groups (COG, CII) and others. NR defines these "key lessons learned" as knowledge or understanding gained by experience. Applying these lessons learned is intended to reduce risk, improve efficiency, promote processes, and improve performance during all phases of the refurbishment program.

The NR OPEX program adheres to and supports N-PROC-RA-0035, Operating Experience Process. NR has established N-MAN-00120-10001-RISK-06 Nuclear Refurbishment Processing Operating Experience, and Key Lesson Learned. Both programs together collect and share information to enable continuous learning for NR.

Since 2007, the NR organization has identified 3 primary goals for its OPEX and Lessons learned systems and processes:

1. Sustain OPG's knowledge across the program;
2. Organize, train and share refurbishment project existing knowledge; and
3. Generate SCR and/or Risks as needed.

Formal OPEX program communications are presented through designated OPEX Lessons Learned meetings, web site, reports including metric's, and other project employee activities such as emails, newsletter articles, pre-job briefings, monthly lunch and learns, and an effective OPEX/Lessons Learned electronic library[3] for all employees and contractors to use. As a learning organization the search for relevant OPEX and lessons learned is an ongoing process.

11.5 Directives and Briefing Cards

Directives are issued by the VP Refurbishment Engineering when special focus is needed on some aspect of governance or when a particular interpretation of governance is to be applied. NK38-INS-01900-10001 provides instructions on preparing a directive. All directives issued to date have been included in this revision of the Engineering Functional Management Plan. All directives issued prior to the next revision of the Engineering Functional Management Plan will be included in that plan.

Briefing cards are issued by NR Engineering staff when specific information is required to be disseminated to the NR organization and engineering contractors. A period of 2 weeks will be allowed for the rollout period of a briefing card. Briefing card topics will be coordinated such that >3 months occurs between similar topics.

[3] http://catouo- gwspuwdc:9015/teamsites/nuclear/nuclsupport/Nucrefurb/Lists/Lessons Learned/Buckets.aspx captures Key Lessons Learned (#21) and also Internal Lessons Learned (#55)

12.0 STAKEHOLDER PLAN

The following table describes the stakeholders internal and external to Nuclear Refurbishment and provides strategies and communications plans relevant to their interests."

Table 9: Stakeholders

Stakeholder	Drivers and Interests	Strategies and Actions	Communication Plan Elements
Internal			
Refurbishment Engineering staff	• Clear definition of work, Resources, Schedule, Training, and supports needed. • Effective provision of OSS or other resources to maintain small post project footprint	• Employ other project functional groups to provide role appropriate support, including Projects and Controls, (scheduling, resourcing, metrics reporting) Supply Chain, Contract Management, Managed Systems Oversight	• Quad Chart Updates Status of issues such as risks, milestones, issues and mitigating actions, provided to support P&C quad charts. • Schedule Updates: Status of scheduled events, updated in P6 to provide source data for other P&C and engineering Metrics.
Project Managers	• Need engineering requirements to be defined, scheduled, estimated and executed. • Need reporting on required work • Reporting • Alarm before Fail • Enable correct fulfillment of COIR elements	• Meet the driving needs • Provide timely, measurable metrics	• Schedule updates, Engineering schedule meetings, Statements of Work,
Project Controls	• Understand work flows to be able to ensure engineering resource loads and scheduled tasks are accurate • Active interface to receive required information • Need information to ensure accurate metrics and reporting are provided	• Awareness of document tasks and status (start, finish, resources)	• Task information, support scheduling information update, milestone definitions and progress against milestones
Contract Management	• Enable correct fulfillment of COIR elements • Understand document flow status for	• Report status accurately and definably	• Estimates, contract definition support, Task Requests, Task Change Requests

Stakeholder	Drivers and Interests	Strategies and Actions	Communication Plan Elements
	Implementation of Contract Penalties or Awards		
Project Infrastructure	• Clear definition of space allocation needs • Clear identification of user groups	• Provide accurate, timely real estate needs	• Through identified process mechanisms (space allocation forms)
Commercial Strategies	• Ensure contracting strategies meet strategic direction	• Performance to contract strategies	• Quarterly updates, Contract Register updates
Managed System Oversight	• Effective application of the matrix model • Ensuring functions and projects are performing sufficient oversight to demonstrate a transition from a QA/QC role to a Quality Surveillance role • Sustainability of the Refurbishment Management System • Support for Functional Management Plans and Governance Framework	• Support Governance Framework, and implementing documentation • Support for Corrective Action transparency of information from Projects/Functions to Managed Systems Oversight to ensure organizational effectiveness	• Monthly trend reports • Metrics showing effectiveness of function and project teams
Licensing	• Ensure appropriate relationships with CNSC and meeting needs of Refurbishment with respect to licensing basis	• Demonstrated response to CNSC requests and to OPG commitments to regulator	• Corrective action program and applicable governance
Base Plant Staff	• Clear and timely identification of station work and required activities • Clear understanding of required schedule • Timely, accurate status reporting	Interface with station work control to provide deliverables as defined by outage and other relevant milestones	• Participation in Work Control meetings • Staff contributions to Outage Planning Center
External			
CNSC	• Safe Nuclear Operation • Timely response to CNSC issues • Meet License needs • Mitigate regulatory schedule uncertainty	• Demonstrated Safe Operation to License Conditions • Timely response to CNSC issues including support of CNSC issue resolutions	• Status log of response to CNSC elements • CNSC yearly report card for each station • Interfaces as defined by interfacing procedures

Stakeholder	Drivers and Interests	Strategies and Actions	Communication Plan Elements
TSSA	• Compliance with Pressure Boundary program as defined by Pressure Boundary Manual	• Demonstrate and document compliance with Pressure Boundary compliance • Support TSSA staff on site	• Corrective action program and applicable governance
Ministry of Environment	• Compliance with Environmental Regulations as defined by OPG Environmental Governance	• Demonstrate and document compliance with Environmental Governance	• Corrective action program and applicable governance
Ministry of Labour	• Compliance with Labour Law and Regulations as defined by OPG Governance	• Demonstrate and document compliance with Labour Governance	• Corrective action program and applicable governance
OEB	• Fiscal Responsibility (Simulate the effects of completion in a near monopolistic environment)	• Ability to understand costs around business • Reduction of cost to primary benchmark target (Bruce, and others) • Correct use of funds as allocated	• Benchmarkable fiscal data to demonstrate OPG meeting Stakeholder drivers. • Support of OEB hearings
CNO, NEC, other VP's	• Successful project completion within financial and other business constraints and goals.	• Application of expertise to Refurbishment, effective senior leadership oversight	• Safe Project execution • Value for money
CNE	• execution of engineering activities compliant with governance • expectations such that work will be done by the Contractors such that it meets the requirement of N-PROC-MP-0090. • Improvements and performance initiatives	• Use of appropriate governance • Rollup of previous elements • Demonstrated effectiveness of meeting goals.	• Rollup of previous elements • Knowledge retention metrics
PINO	• Compliance to Governance • Performance improvement • Execution of Corrective Action Program	• Audits, audit responses • Participation in Corrective Action Program	• Quarterly Trend Reports • CAP heath Metrics
Auditors, evaluators	• Assess Refurbishment Engineering performance	• Such interfaces are typically managed by the evaluating organization.	• primarily over a short period in planned and ad hoc meetings

Stakeholder	Drivers and Interests	Strategies and Actions	Communication Plan Elements
International organizations such as WANO or IAEA	• To obtain or provide information related to industry best practices, processes, benchmarking	• Managed by the QE Manager and/or QE specialist	• Primarily via ad hoc teleconferences.
Contractors	• Clear on boarding, off boarding process and activities • Clear and timely identification of work • Timely contract processing. • Clear understanding of timeframes • Timely, accurate status reporting • Enable correct fulfillment of COIR elements • Able to use EDMS, Asset Suite and OPG Document management Procedures (OPG-PROG-000, Information Management)	• See Section 5.7	See Section 5.7
CNSC	• Timeliness and quality of CNSC submissions. • Mitigate potential licensing risk.	• The Director, Nuclear Safety will monitor CNSC submissions and will routinely update the Refurbishment Engineering VP regarding concerns or trends in CNSC submissions.	Correspondence with CNSC will flow through Regulatory Affairs in order to maintain and improve the regulatory interface. Pressure Boundary Code Concessions flow through Regulatory Affairs to the CNSC.
TSSA	• Timeliness and quality of TSSA submissions.	• Ensure TSSA approvals are received as scheduled to avoid project schedule impacts.	• Correspondence with TSSA will flow through the Designated Licensing Authority for TSSA submissions which is the Director, Design Engineering.

13.0 REFERENCES

Developmental References

Construction Industry Institute (CII): Front End Planning

INPO 09-007: Principles for Excellence in Nuclear Project Construction

ANSI/PMI 00-001-2013: A Guide to the Project Management Body of Knowledge

Governance References

[1] N-STD-MP-0024, "Engineering and Design Authority".
[2] N-COI-00210-0001, "Contractor / Owner Interface Requirements for Nuclear".
[3] NK38-GUID-01900-10001, "Darlington Refurbishment: Design Completion Assurance".
[4] N-MAN-09701-10002, "Nuclear Projects Oversight".
[5] N-PROC-MP-0098, "Procurement Engineering Activities".
[6] NK38-NR-PLAN-09701-10001 Sht 0002, "Darlington Refurbishment Planning and Controls Program Management Plan".
[7] N-INS-09030-10004, "Observation and Coaching".
[8] N-MAN-00120-10001-RISK-07, "Nuclear Refurbishment Actions, Issues, Decisions, And Key Assumptions Management".
[9] N-INS-09030-10002, "Site and Department Level Event Free Day Resets".
[10] N-MAN-00120-10001-RISK-04, "Nuclear Refurbishment Risk Management & Contingency Development Guide".
[11] N-PROC-MP-0083, "Constructability, Operability, Maintainability and Safety (COMS)"
[12] N-GUID-00120-10011, Collaborative Front End Planning (CFEP) Process.

Appendix A: Definitions and Acronyms

Definitions:

Action	Tasks required to mitigate risks, validate assumptions, arising from meetings, arising from decisions or issues to implement OPEX lessons.
Adverse Conditions	Deficiencies, non-conformances, weaknesses with a process, document, or service, or conditions that adversely impacts, or may adversely impact plant operations, personnel, nuclear safety, the environment or equipment and component reliability
Decision	Records of management conclusions that is critical in maintaining an auditable trail of the NR Program changes, including changes in strategy, regulatory interactions, technology, resource, or scope.
Issue	Events that have 100 percent probability of occurring, or have occurred already and require resolution.
Key Assumptions	events that are accepted to be true without proof and may have a major impact to NR scope, schedule, cost, or quality

Acronyms

AIDA	Actions, Issues, Decisions, Assumptions
AIP	Annual Incentive Plan
ANSI	American National Standards Institute
BCS	Business Case Summary
BoE	Basis of Estimate
CAP	Corrective Action Program / Plan
Cat Id	Catalogue Identifier
CCA	Component Condition Assessment
CFEP	Collaborative Front End Planning
COIR	Contractor / Owner Interface Requirements
COMS	Constructability, Operability, Maintainability and Safety
CII	Construction Industry Institute
CPI	Cost Performance Index
CRC	Corporate Relations and Communications
DAIA	Design Agency Interface Agreement
DCAVR	Design Completion Assurance Verification and Review
DRAS	Decision Record and Analysis Summary
DSR	Darlington Scope Requests
EA	Environmental Assessment
EBOM	Equipment Bill Of Materials

ECR	Engineering Change Requests
EFDR	Event Free Day Reset
EDMS	Electronic Document Management System
EFIN	Engineering Fix it Now
ES-MSA	Extended Services Master Service Agreements
EPC	Engineer, Procure, Construct
EPCM	Engineer, Procure, Construct, Mange
ETAP	Electrical Transient Analyzer Program
EQ	Environmental Qualification
EV	Earned Value
FCN	Field Change Notice
FMP	Functional Management Plan
FTE	Full Time Equivalent
HIT	High Impact Team
HoS	Health of Scope
IIP	Integrated Implementation Plan
ISR	Integrated Safety Review
INPO	Institute of Nuclear Power Operations
FIN	Fix It Now
GAR	Global Assessment Report
NR	Nuclear Refurbishment
NRP	Nuclear Refurbishment Program
MAFS	Modification Available for Service
MDP	Modification Design Package
MDR	Modification Design requirements
MEL	Master Equipment List
MOE	Ministry of Environment
MOL	Ministry of Labour
NICR	Non-Identical Component Replacement
NSRB	Nuclear Safety Review Board
OEB	Ontario Energy Board
O&C	Observation and Coaching
OBU	Organizational Breakdown Structure
OCR	Observation and Coaching Report
OLW	On-Line Wiring
OMS	Outage Management System
OSS	Owner's Support Services
P&C	Planning and Controls
PIMS	Program Integrated Master Schedule
PINO	Performance Improvement and Nuclear Oversight
POP	Project Oversight Plan
PgMP	Program Management Plan
PMP	Project Management Plan
PM	Preventative Maintenance
PMI	Project Management Institute
PPR	Performance Plan Review
PSRB	Program Scope Review Board
P6	Oracle brand name for project management software
RADAR	Risk Assessment Database and Register

RFR	Retube and feeder replacement
RPET	Nuclear Project Execution Team
RQE	Release Quality Estimate
R&FR	Retube and Feeder Replacement
SAFS	System Available for Service
SCR	Station Condition Record
SIO	Safety Improvement Opportunity
SOE	Safe Operating Envelope
SPI	Schedule Performance Index
SSC	Structure, System and Component
TCD	Target Completion Date
TSSA	Technical Standards and Safety Authority
TQD	Training and Qualification Description
VOIR	Vendor Owner Interface Requirement (now COIR)
WBS	Work Breakdown Structure

Appendix B: Roles of Matrixed Engineers

Engineering Leads

Engineering Leads are matrixed from Engineering to support Project Managers in Project Execution. They take the lead for all engineering related issues including quality and safety and facilitate and expedite resolution of project technical issues in order to meet the overall cost and schedule project objectives. They ensure solutions and approaches are technically correct, effective and consistent with OPG expectations as per N-PROG-MP-0007, Conduct of Engineering, and N-STD-MP-0024, Engineering and Design Authority. They are part of the Plant Reliability Division and are matrixed to the Project Execution teams, receiving their day to day direction from the Project Manager but accountable to their engineering manager to identify, escalate and request support for engineering issues. . Though they will support the project by performing project management activities, the majority of their time is expected to be in support of engineering deliverables.

Engineering Leads, along with the matrixed Project Engineers, provide engineering Oversight as per the Project Oversight Plan to ensure correct interpretation and application of the SOE, Design Basis, and Licensing Basis, including appropriate margins, for the Refurbishment scope of work. As well, Oversight is provided to ensure that Contractors follow their ECC process in alignment with OPG processes. Engineering Leads facilitate any non-conformance resolutions and makes certain that all engineering decisions and acceptance of deviations to these decisions are made and accepted by the Refurbishment Engineering function.

Engineering Leads ensure technical changes to Refurbishment scope of work are approved by the appropriate Engineering Authority. Engineering Leads act as technical liaison with the engineering lead for the EPC Contractor. They provide technical leadership and day to day supervision for matrixed Project Engineering staff assigned to the project team and facilitates technical communication between project team and functional support organizations, including Supply, Nuclear Safety, Design, and Systems & Components Engineering, providing feedback and escalating issues as appropriate to Project and Engineering Managers.

Their specific activities may involve, but are not limited to, the following:

- Review engineering documents
- Acceptance of documents including design deliverables and non-conformances if specified in the project design plant
- Identify risks
- Facilitate or identify, co-ordinate and solicit stakeholder inputs to engineering deliverables reviews
- Prepare RFI responses
- Ensure engineering oversight provided for preparation of non-conformance resolutions

- Identify required engineering resources
- Ensure oversight of Constructability, Operability, Maintainability and Safety (COMS) [6] and design review meetings
- Ensure OPEX is embedded in Engineering deliverables
- Document assumptions and decisions
- Ensure schedule is in place for engineering deliverables
- Monitor cost and earned value of engineering deliverables
- Lead or participate in self assessments
- Communicate engineering expectations to matrixed engineers and rest of Project teams
- Review scope changes

Matrixed Project Engineers

Project Engineers are assigned to support Project Managers in Project Execution for all engineering related issues including quality and safety, and facilitate and expedite resolution of project technical issues in order to meet the overall cost and schedule project objectives. Project Engineers are part of the Systems & Components Engineering Department but receive their day to day work direction from the Engineering Lead. Though they will support the project by performing project management activities, the majority of their time is expected to be in support of engineering deliverables.

Matrix Engineers support the Engineering Leads to provide oversight as per the project oversight plan by executing assigned tasks to ensure correct interpretation and application of the SOE, Design Basis, and Licensing Basis, including appropriate margins, for the Refurbishment scope of work... For further description of the roles and responsibilities, refer to "Nuclear Refurbishment System And Component Engineering Roles And Responsibilities", D-INS-09701-10004-R001.

Appendix C: Refurbishment Engineering Blue Chip Initiatives

Blue Chip Initiative	Owner	Action #
1. Document and publish Engineering Directives Program on NR Engineering website for easy access.	N. Smith	3646
2. Assign Resident Engineer for Civil Engineering support to Refurbishment projects such as D2O.	G. McCabe	3647
3. Refresh expectations for Resident Engineers as we go into next phase of project.	G. McCabe	3648
4. Reinforce need to follow D&C Standards and selection of materials from standard stores catalog	R. Leekha	3649
5. Investigate opportunity to use documents/ drawings from previously purchased parts in lieu of insisting on brand new documents for newly sourced parts.	R. Leekha	3650
6. Investigate OPG performing PE Evaluations for outstanding D2O storage materials	R. Leekha	3651
7. Investigate use of field changes to document mark ups between revisions	N. Smith	3652
8. Revise processes to allow sequencing not specifically prescribed in the technical specification at the discretion of the project manager commensurate with the risk.	P. Ross/Z. Jazic	3653
9. Reinforce that the ECC process is a fully graded suite which needs to be understood and applied.	G. McCabe with Zaidi, Leekha,	3654
10. Reinforce with our staff an understanding of the COIR and process for escalation of issues so that the COIR is not seen as hurdle to getting work done.	P. Ross	3655
11. Perform Q Level Self Assessment	R. Leekha	3656
12. Investigate what makes sense to do in house as CGD and what should go out to other companies such as NLI and Kinetrics	R. Leekha	3657
13. Lean Engineering Process review.	N. Smith	3658
14. Issue memo providing clarification on equivalency of ISO 9001, Z299 and 10CRF50 quality standards.	N Smith	3665

ONTARIOPOWER GENERATION

Guideline

Internal Use Only	
Document Number: NK38-PLAN-09701-10223	Usage Classification: N/A
Sheet Number: SHT 0004	Revision: R000

Title: NUCLEAR REFURBISHMENT ENGINEERING FUNCTIONAL MANAGEMENT PLAN

Appendix D: Quality Dashboard

ONTARIOPOWER GENERATION

Darlington Refurbishment Engineering - QUALITY DASHBOARD

Owner: Neil Mitchell

Week Ending: July 24, 2015

(1) Human Performance Indicator - EFDR

Overall Status: (DSLE ≤ 59 days)

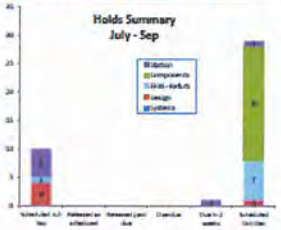
EFDR Total 2014: 9
- Q1 = 1; Q2 = 1
- Q3 = 2; Q4 = 5

EFDR Total 2015: 8
- Q1 = 2; Q2 = 5
- Q3 = 1

Days Since Last EFDR (DSLE): 16

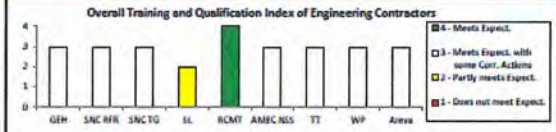
EFDRs in Rolling Qtr.	DSLE	Colour
< 3	DSLE < 31days	YELLOW
	DSLE ≥ 31days	YELLOW
3	DSLE ≤ 59 days	YELLOW
	DSLE > 59 days	RED
> 3	DSLE ≤ 59 days	RED
	DSLE > 59 days	YELLOW

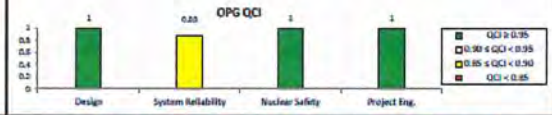
(2) Open RFIs and Engineering Holds Summary



Note: For more details on RFIs and Eng Holds, please refer to the backing sheet provided.

(3) Engineering Qualifications - OPG and Contractors





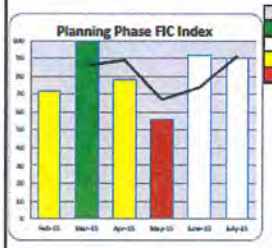
(4) MEC/EC Revision Summary

Master Engineering Change (MEC) Summary:
- Total # of MECs 103
- # of MEC Revisions (Rev. 1 or higher) 33

Engineering Change (EC) Summary:

Design Agent	# of ECs	# of EC Revs	Current Ratio
GHD	40	113	2.83
RCMT/AMEC	8	13	1.63
Algal	6	8	1.33
RCMT	197	188	0.95
HSL	156	89	0.57
SL	11	4	0.36
GEH	12	4	0.33
BWC	3	1	0.33
OPG	69	19	0.28
TETRATECH	33	9	0.27
SNC	117	14	0.12
AMEC	58	4	0.07

(5) Field Initiated Change (FIC) Index



Colour Codes
95-100%
85-84%
70-84%
< 70%

(6) Corrective Actions, Self Assessments, Briefing Cards

Corrective Action Summary:

Corrective Action Program (CAP) Category	Actual	Target	Status
Quality of Level 1 & 2 SCR Evaluations	0	2.22	
CAPs Past Due	0	0	✓
CAPRs Past Due	0	0	✓
Assignments (Non-CAPR) Past Due	0	0	✓

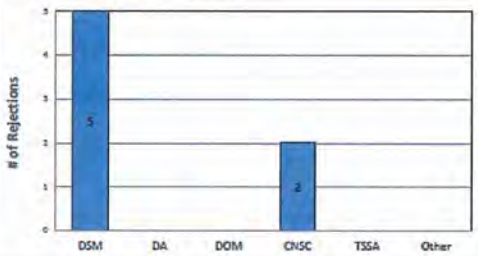
Poor | Marginal | Good | Excellent | No Data

Self Assessment Key Indicators (2015):
- Total # of Planned Self Assessments: 7
- Total # of Approved and Closed: 4

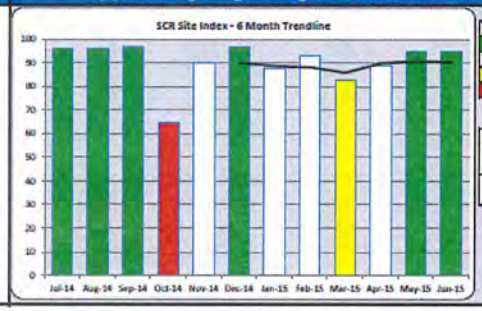
Directives and Briefing Cards Summary (2015):
- Total # of Directives and Briefing Cards issued: 15

(7) Rejection by Approving Authority

Note: Data used is over a rolling 12 month period.



(8) NR Design Engineering Site Modification Index



Colour Codes
95-100%
85-84%
70-84%
< 70%

6 Month Average = 90.5%

Target Index: > 90%

(9) EC Completion Status

Current Status	
MECs in scope	67
ECs in scope	257
ECs complete	152
ECs remaining	105

Forecast on remaining ECs	
ECs beyond Aug 15, 2015	71
* ECs finishing between Aug 15 and Dec 31, 2015	37
* ECs finishing in 2016	28
* ECs finishing in 2017	3
* ECs with No Finish Date	3

Backing Information for the Quality Dashboard

Box 1 – Human Performance Indicator – EFDR

1) **Q2, N-2015-10769 (2015-May-11):** MEC 122092, Project # 10-73537 requiring revision to scope of work, MDR, and Conceptual Design Report. (DEN-CON – Contractor performance). HuLL Report is attached to the SCR.

2) **Q2, N-2015-11034 (2015-May-13):** CFVS Valve weight incorrectly specified on Vendor drawing, in approved design documents. (DEN-CON – Contractor performance). HuLL Report is attached to the SCR.

3) **Q2, N-2015-11621 (2015-May-18):** Schedule Delays and Eng Rework cost impact to the Balance of Plant, Service Water modification Project due to Seismic Analysis issues. (DEN-CON – Contractor performance). HuLL Report is attached to the SCR.

4) **Q2, N-2015-14460 (2015-Jun-22):** Fire Water Margin Documentation – Refurb Support Facilities. (DEN-FO05 – Engineering Rework resulting in business impact > 10k). HuLL Report to be prepared.

5) **Q3, N-2015-15630 (2015-Jul-08):** NR Fission Chamber Guide Tube Design Delays. (D DEN-FO05 – Engineering Rework resulting in business impact > 10k). HuLL Report to be prepared.

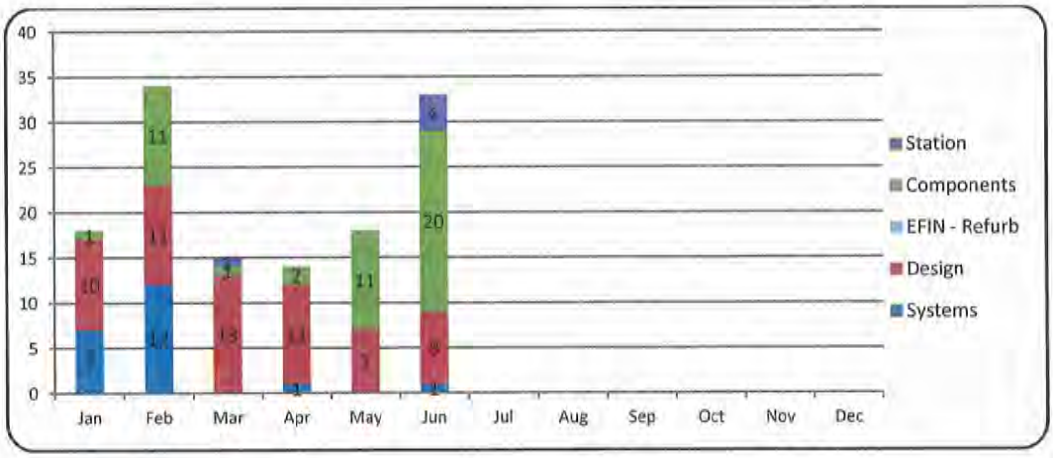
- Status remains at [redacted], due to current criteria: 5 EFDRs in the last 3 months and less than 59 days since the last EFDR.

Box 2 – Open RFIs and Engineering Holds Summary

A. **Requests for Information** – for details, please see Appendix 1 – RFI Tracking List.

B. **Engineering Holds:**

- Station Engineering holds associated with D1621 will be shown on the Refurbishment Holds Metric. These holds are associated with systems which will remain under the ownership of the station as documented in NK38-CORR-09701-0509687.
- Summary of the number of Holds released monthly in 2015, with the current month showing the monthly to-date amount:



- Total Active Holds – this week vs. previous week
  - Station: 23 now vs. 21 previous week
  - Components: 20 now vs. 20 previous week

- EFIN – Refurb: 97 now vs. 97 previous week
- Design: 42 now vs. 42 previous week
- Systems: 169 now vs. 128 previous week

Table 1: Hold Overdue or Duue Within Two Weeks

W/O #	Task #	Task Assign Hold Title	Department	Target Engineer	TCD
02960214	02	Design NICR	PDDM	CHOWDHUM	7/31/2015

Box 3 – Engineering Qualifications – OPG and Partners

- To increase SL's training score from "Yellow" to "White", the following actions are required:
  - To respond to feedback from the review of the draft Training Plan, and to implement additional actions:
    - Establish role documents – TCD: May 15, 2015;
    - Complete documentation of training and qualification of existing project personnel – TCD: May 29, 2015;
    - Update the Quality Plan – TCD: June 15, 2015.

- Work Groups for OPG QCI metrics are filtered on Nuclear Refurbishment and Project Support Division staff only and include temporary staff, contractors, and students. Work groups are further assigned as per the following codes: Design (WG # 1061, 1033, 1062), System Reliability (WG # 1039, 1038), Nuclear Safety (WG # 1032, 1036, 1037), Project Engineering (WG # 1066, 2077).

- System Reliability QCI revised to accurately reflect the current qualification completion status with the addition of newly hired staff, reference AR 28172846.

Boxes 4 & 5 – MEC/EC Revision and Field Initiated Change (FIC) Summary

- Data is based on only reporting ECs from Lindsay Wright's list. Note that the Total # of EC Revisions includes the 33 MEC Revisions.

Table 2: EC Revision and FIC Summary by Design Agent and by Bundle

Design Agent	# of ECs	# of EC Rev	# of FICs
Algal	6	8	7
AMEC	58	4	0
BWC	3	1	0
BWC / CEI	1	0	0
GEH	12	4	0
GHD	40	113	2
HSL	156	89	130
OPG	69	19	1
RCMT	197	188	160
RCMT / AMEC	8	13	0
Rolls Royce	2	0	0
SL	11	4	0
SNC	117	14	0
TETRATECH	33	9	0
WORLEY	6	0	0
Total	719	466	300

Bundles	# of ECs	# of EC Rev	# of FICs
Balance of Plant	52	6	0
BOP/P&M Pre-Refurb	67	51	64
Defueling	12	4	0
Facilities and Infrastructure	374	362	231
Refurb. Control Computers	1	0	0
Refurb. Support Facilities	23	12	0
RFR	67	12	0
SDLU	7	0	0
SDLU/Services	18	2	0
SG	4	1	0
Specialized Projects	17	0	0
Turbine Generator	40	0	0
Unit Islanding	12	5	0
Unit Islanding/Outage	3	0	0
Unit Islanding/Pre-Refurb	22	11	5
Total	719	466	300

- Only unique FICs are used, i.e. duplicates between revisions are not double-counted, and multiple attributes of the same FIC are counted as only one FIC.

- **Field Initiated Changes** – Changes from the previous week:
  - Planning: 258 now vs. 239 previous week

- Execution: 42 now vs. 42 previous week

Table 3: Average FIC/EC of Design Agent and by Bundle (Only for Previously approved ECs)

Design Agent	Total # of ECs Approved	Average FIC/EC
Algal	5	1.40
GHD	41	0.05
HSL	139	0.94
RCMT	182	0.88
OPG	32	0.03
Total for All Agents	**527**	**0.57**

Bundles	Total # of ECs Approved	Average FIC/EC
Facilities and Infrastructure	313	0.74
BOP/P&M Pre-Refurb	66	0.97
Unit Islanding/Pre-Refurb	21	0.24
Total for All Bundles	**527**	**0.57**

Box 6 – Corrective Action and Self Assessment Summary

- **Y2015 CAPs:**
  - Level 3 SCR CAPs
    - D-2014-32249 – CAP completed on 2015-Jan-19 – Action 28172804
    - N-2015-00659 – CAP completed on 2015-Feb-11 – Action 28174505
    - N-2015-03131 – CAP completed on 2015-Mar-04 – Action 28175086
    - N-2015-05665 – CAP completed on 2015-Mar-20 – Action 28175525
    - N-2015-04776 – CAP completed on 2015-Mar-24 – Action 28175676
    - N-2015-05499 – CAP completed on 2015-Mar-27 – Action 28175934
    - N-2015-07258 – CAP completed on 2015-Apr-27 – Action 28176540
    - N-2015-10728 – CAP completed on 2015-May-25 – Action 28177660
    - N-2015-09539 – CAP completed on 2015-May-28 – Action N/A
    - N-2015-11568 – CAP completed on 2015-Jul-06 – Action N/A
    - N-2015-14208 – CAP completed on 2015-Jul-22 – Action 28179512

- **Planned Self Assessments** for 2015, as per N-REP-09701-10007 R000, *NR 2015 Self Assessment Planning and Schedule*:
  - RF15-000058: Product Quality Review / Quality of DCAVRs; (TCD – 2015 Sep 30).
  - RF15-000066: Effectiveness review of Shut-Down and Lay-Up RTMs; (TCD – 2015 Dec 31).
  - RF15-000070: Human Performance in NR Engineering; (TCD – 2016 Jan 22).

- **Approved and Closed Self Assessments** for 2015, (N-REP-09701-10007 R000, *NR 2015 Self Assessment Planning and Schedule*):
  - RF15-000053: Assessment of the Quality and Accuracy of Regulatory Correspondence to CNSC; (Completed – 2015 Jan 15).
  - RF15-000056: Compliance Check of Field Initiated Changes; (Completed – 2015 May 15).
  - RF15-000055: Compliance Check of Detailed Design Packages; (Completed – 2015 Jun 26).
  - RF15-000057: Product Quality Review / MEL & BOM Updates; (Completed – 2015 Jun 30).

Table 4: Overdue AR Assignments and Outstanding CAPs

AR # / CAP (SCR #)	Description / Event Title	Owner / EO Manager	TCD	# of Times Rescheduled
-	-	-	-	-

- **Engineering Directives and Briefing Cards**, (July 2015):
  - May and June 2015 packages: all Departments have responded back.

					Responses by Department									
Type	Title of Eng Directive (ED) or Letter of Expectation (LE) or Briefing Card (BC)	Doc number	Date issued	Due date	Project & Quality Eng.	Systems & Components	Nuclear Safety	Refurbishment Eng.	R&FR	TG	FH	BOP	SD/LU	SG
ED	Management of Modification Issues	NK38-CORR-01901-0552934	16 July 2015	24 July 2015	✓	✓	✓				✓	✓		

Box 7 – Rejections by Approving Authority

- Data used is over a 12 months rolling period.

1. CNSC Rejection of CFVS DEC due to code classification error. (See SCR N-2014-25475, 2014-Sep-09).
2. CNSC Rejection of code review due to omission in the CSA N 289.5-12 code review. (See SCR N-2014-29989, 2014-Oct-27).
3. DSM Rejection of Radiological Hazard Analysis report due to a calculation error. (See SCR N-2014-33969, 2014-Dec-09).
4. DSM Rejection of 85% design package, due to: a) inaccurate Requirements Traceability Matrix and missing the architectural change paper, (See SCR N-2015-13041, 2015-Jun-05), and b) rejection of the civil structural calculation, (See SCR N-2015-13062, 2015-Jun-05).
5. DSM Rejection of DCAVR dry run package, due to procedure compliance issue. (See SCR N-2015-14309, 2015-Jun-19).
6. DSM Rejection of the structural calculation for the cargo elevator modification. (See SCR N-2015-14791, 2015-Jun-25).
7. DSM Rejection of 85% design package, (2nd submission), due to missing architectural change paper. (See SCR N-2015-15749, 2015-Jul-09).

Box 8 – NR Design Engineering Site Modification Index

- See the Dashboard for details.

Box 9 – EC Completion Status

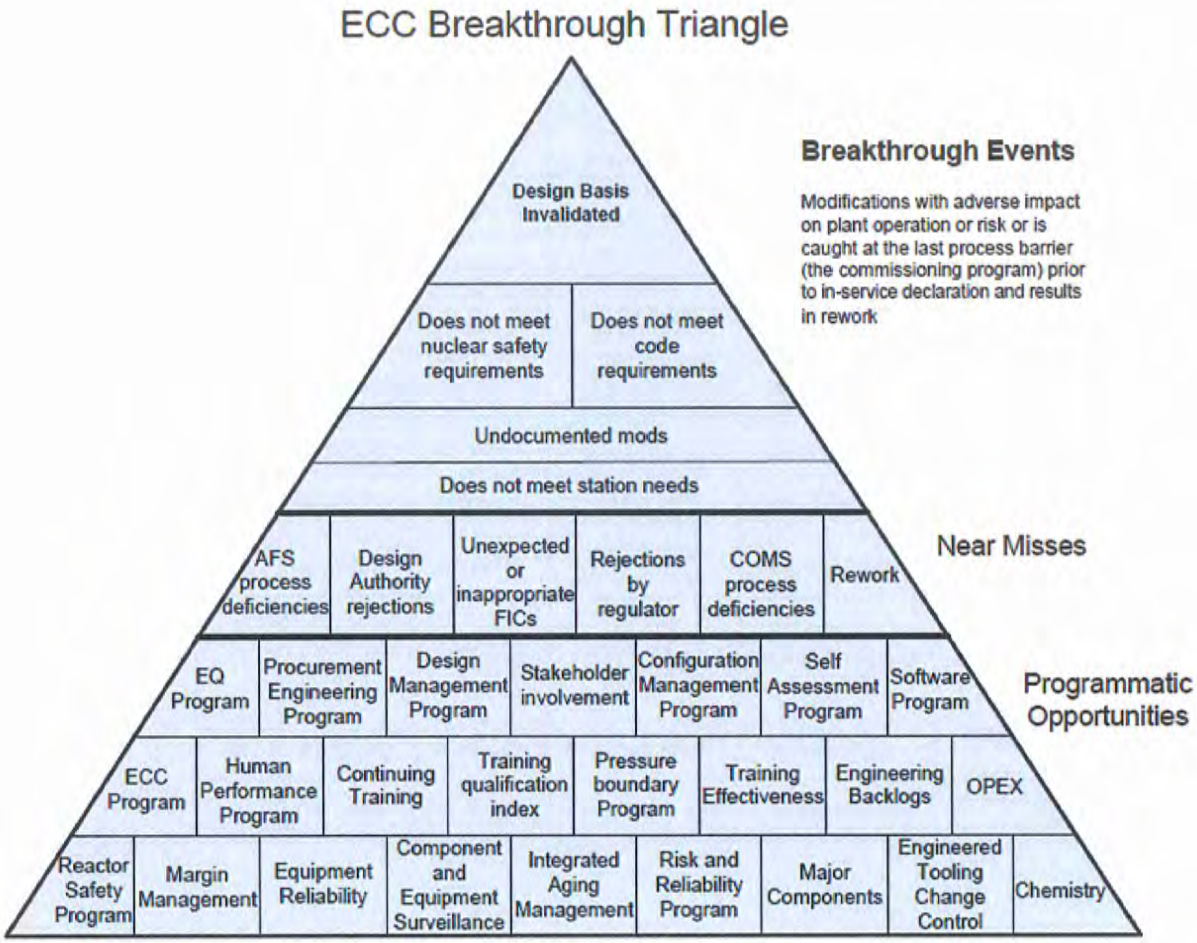
- See the Dashboard for details.

Appendix 1 – RFI Tracking List

RFI #	PM or SPOC	Bundle	Date Sent	Due Date	Days Late	Comments
NR-BM-1-IDC-RFI-00019	Amardeep Gill	Facilities and Infrastructure	27-Feb-15	13-Mar-15	132	-
NR-BM-1-IDC-RFI-00020	Amardeep Gill	Facilities and Infrastructure	4-Mar-15	18-Mar-15	127	-
NR-BM-1-IDC-RFI-00021	Amardeep Gill	Facilities and Infrastructure	4-Mar-15	18-Mar-15	127	-
NR-BM-1-IDC-RFI-00022	Amardeep Gill	Facilities and Infrastructure	4-Mar-15	18-Mar-15	127	-

RFI #	PM or SPOC	Bundle	Date Sent	Due Date	Days Late	Comments
NR-BM-1-IDC-RFI-00023	Amardeep Gill	Facilities and Infrastructure	9-Mar-15	23-Mar-15	122	-
NR-BM-1-IDC-RFI-00024	Amardeep Gill	Facilities and Infrastructure	16-Mar-15	30-Mar-15	115	-
NR-BM-1-IDC-RFI-00025	Amardeep Gill	Facilities and Infrastructure	17-Mar-15	31-Mar-15	114	-
NR-BM-1-IDC-RFI-00026	Amardeep Gill	Facilities and Infrastructure	18-Mar-15	1-Apr-15	113	-
NR-BM-1-IDC-RFI-00027	Amardeep Gill	Facilities and Infrastructure	23-Mar-15	6-Apr-15	108	-
NR-BM-1-IDC-RFI-00028	Amardeep Gill	Facilities and Infrastructure	24-Mar-15	7-Apr-15	107	-
NR-BM-1-IDC-RFI-00029	Amardeep Gill	Facilities and Infrastructure	17-Apr-15	21-Apr-15	93	-
NR-BM-1-IDC-RFI-00030	Amardeep Gill	Facilities and Infrastructure	16-Jun-15	19-Jun-15	34	-
NR-BM-1-IDC-RFI-00031	Amardeep Gill	Facilities and Infrastructure	15-Jul-15	20-Jul-15	3	-
NR-BM-1-IDC-RFI-00032	Amardeep Gill	Facilities and Infrastructure	16-Jul-15	21-Jul-15	2	-
NR-BM-2-IDC-RFI-00014	Michael Taguiam	Facilities and Infrastructure	6-Nov-14	17-Nov-14	247	In Approval
NR-BM-2-IDC-RFI-00036	Michael Taguiam	Facilities and Infrastructure	8-May-15	11-May-15	73	RFI is still pending completion. Projects is actively working with vendors to obtain a path forward.
NR-ESFOX-21-IDC-RFI-00002	Andy Ireland	Shutdown/Layup	13-Jul-15	24-Jul-15	0	-
NR-ESFOX-21-IDC-RFI-00003	Andy Ireland	Shutdown/Layup	16-Jul-15	22-Jul-15	1	-

Appendix E: ECC Breakthough Triangle/ Modification Rework Process



ONTARIO POWER GENERATION

Guideline

Internal Use Only	
Document Number: NK38-PLAN-09701-10223	Usage Classification: N/A
Sheet Number: SHT 0004	Revision: R000

Title: NUCLEAR REFURBISHMENT ENGINEERING FUNCTIONAL MANAGEMENT PLAN

MODIFICATION REWORK PROCESS OVERVIEW

	Definition Phase	Mod Planning	Detailed Design	Design Completion	Planning Phase	Construction Phase	Construction Completion	AFS	Overall Success
Process	MDP pre-requisites MDP, DA & DDM Approval Project Kick off	Collaborative Front End Planning Preliminary Design	Detailed Design CDMS	DCAVR	Comprehensive Work Package (CWP). Work Order Ready	Field Execution, Construction Completion Commissioning	Construction Completion Assurance.	Commissioning AFS	Effectiveness Review
Issue Identification	SCR/ D-EFDR Flash Reports	SCR	SCR	SCR Flash Reports	SCR	SCR	SCR Rapid Response and, or Flash Report	SCR	SCR/Lessons Learned Report
Accountability for raising SCR	MTL/DTL	DTL/Eng Lead	Vendor/DTL/ Eng Lead	Vendor/DTL/ Eng Lead	Eng Lead/ MTL	MTL	MTL	MTL	MTL/DTL
ECC Trend Codes (By SCR Coordinator)	ECC - SCOPE ECC- DA ECC-APPROVER	ECC - SCOPE ECC –PROCS ECC –PROCS-ERRS	ECC –COMS ECC-PROCS ECC-DA	ECC-PROCS ECC-DA	ECC -PRACTICAL	ECC –UNDOC MOD ECC-GUID EXCEPT ECC-COMMISS	ECC –UNDOC MOD ECC-GUID EXCEPT ECC-DA	ECC -AFS	ECC –EFFECTIVE ECC-BREAKTHRU

Note: (i) ECC codes listed above are typical suggestions. Use the ones from ECC trend codes as applicable. In addition, use Vendor related Line Defined Codes as applicable.
(ii) Human Performance Trend Codes to be applied in addition to ECC trend codes, in accordance with N-LIST-01966-10001, Trend Codes applied to Station Condition Records
(iii) Whenever criteria for declaring Department Event Free Day Reset (D-EFDR) are met in accordance with Appendix-D of N-INS-09030-10002, Site and Department Event Free Day Reset (D-EFDR), document the details in the SCR, to enable declaration of D-EFDRs. Any rejection of Design Documents by the Design Authority results in a D-EFDR.
(iv) The above process Flow is based on the Engineering Work Streams identified in N-MAN-00120-10001, Nuclear Refurbishment Earned Value Management

ONTARIO POWER GENERATION

Plan

Internal Use Only	
Document Number: NK38-PLAN-09701-10223	Usage Classification: N/A
Sheet Number: 005	Revision: 000

Title:
FUNCTIONAL MANAGEMENT PLAN FOR NUCLEAR PROJECTS OVERSIGHT

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Functional Management Plan For Nuclear Projects Oversight

NK38-PLAN-09701-10223-005-R000
2015-07-17

Order Number: N/A
Other Reference Number:

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R000	2015-04-09	PAG's FMP was originally issued as NK38-PLAN-09701-10214 in August, 2014. The FMP has been updated to the change the name of the function to NR Nuclear Project Oversight and supports 4D business planning. NK38-PLAN-09701-10214 was superseded by this document (NK38-PLAN-09701-10223 Sheet 0005).

Records Table

The following Records may be generated by use of this document and shall be registered in the appropriate document management system in accordance with the following table:

Record Created	Associated Form or Template Number	QA Record? Y/N	Filing Information/Retention (AIMS Type/Sub-Type)
None	NA	N	Asset Suite

1.0 PURPOSE

This functional management plan defines the mission, scope and strategies for the Nuclear Project Oversight (NPO) Division of the Nuclear Refurbishment (NR) Organization. In addition, this document describes the major deliverables, activities, organization and staffing plans, assumptions, constraints, risks and mitigation plans associated with the execution of the defined work program of the department.

This document takes its authority from NK38-NR-PLAN-09701-10001 Sheet 0010, “Darlington Refurbishment Nuclear Projects Oversight Program Management Plan”.

2.0 MISSION

The mission of the NPO Division is threefold: first is to provide effective performance assurance and oversight of the Darlington Refurbishment Program (DRP) managed systems processes and contractors. Second, provide Contract Management Support for Nuclear Projects and thirdly, manage the On-Boarding process for Nuclear Operations and Nuclear Projects.

3.0 SCOPE AND RESPONSIBILITIES

NPO is comprised of the following Departments:

- Program Assurance Group
- Contract Management

Note: Contract Management functional requirements are specified in NK38-PLAN-09701-10223 Sht. 002.

- On-Boarding

3.1 Program Assurance Group (PAG)

3.1.1 Program Assurance

The Director, PAG, is the program owner for Darlington Refurbishment’s Program Assurance and reports directly to the Vice President NPO. The Director is supported by the Manager PAG and an Administrative Assistant. Three (3) Lead Auditors, and up to three (3) augmented staff Lead Auditors are also reporting directly to the Director. One (1) Lead Auditor, one (1) Senior Performance Improvement Officer, one (1) Senior Report Specialist and one (1) Performance Improvement Officer (CAP Specialist) report to the Manager PAG.

The Program Assurance Program is defined in the Program Assurance Program Management Plan, NK38-NR-PLAN-09701-10001-SHT 11 and procedural guidance is

provided in NK38-GUID-09701-10032, Program Assurance Group. PAG plans, participates, coordinates and administers all horizontal assurance activities for DRP. PAG leads all horizontal assurance activities across the DRP projects. In addition PAG provides an integrated review and analysis of all assurance activities that are ongoing within DRP including the following assurance providers:

- PAG
- Executive Program Assurance Group, (EPAG)
- Project Oversight
- Corrective Action Program Trending
- Board Of Directors Oversight
- Ministry of Energy Oversight
- Nuclear Oversight, (NO)
- Internal Audit, (IA)
- Supply Chain Quality Services, (SCQS)
- Nuclear Safety Review Board, (NSRB)
- Others

3.1.2 Corrective Action Program, (CAP)

The Manager, PAG, is responsible for the implementation of the CAP in DRP.

PAG administers and operates the Corrective Action Program for DRP. This includes managing the Station Condition Record, (SCR) Screening Meeting, the Management Review Meeting, (MRM) and the Corrective Acton Review Board, (CARB). A trend report is produced quarterly.

The CAP is mandatory for DRP as per N-PROG-RA-0003, Corrective Action Program. Procedural guidance for use of the Corrective Action Program is provided through NK38-GUID-09701-10022, Nuclear Refurbishment Use of OPG CAP for Contractor Issues.

The two main processes that make up the Corrective Action Program are:

- Processing Station Condition Records, N-PROC-RA-0022
- Operating Experience Process, N-PROC-RA-0035

A Performance Improvement Officer provides administrative support and oversight activities for Processing Station Condition Records. Management engagement and oversight is achieved through the MRM and CARB.

3.1.3 OPEX and Lessons Learned

The Manager PAG has the accountability for the planning, executing, monitoring and control of OPEX, Lessons Learned processes and IT Systems Management.

A Senior Performance Improvement Officer anticipates, identifies and effectively communicates project lessons learned, recommends solutions, shares information to stakeholders, and works with management to implement solutions and facilitates meetings, including external partners and vendors.

Maintains the process procedures and reports to stakeholders, CARB and projects staff.

3.1.4 Self Assessment

The Manager, PAG, manages the Self Assessment process for DRP. The Self Assessment process is governed by N-PROC-RA-0097, Self Assessment and Benchmarking. A Senior Report Specialist develops a Self Assessment schedule annually, and updates it at the end of each subsequent quarter. The Senior Report Specialist either participates directly or provides oversight to all Divisional Self Assessments to ensure quality and rigor of process.

3.1.5 Management System

The Manager, PAG, is responsible for the definition and documentation of the Management System for the DRP. Development, revision, improvements and additions to the Management System will continue as the DRP evolves. The Management System is defined in D-PCH-09701-10000, Darlington Refurbishment Program Charter, and defined in NK38-NR-PLAN-09701-10001-SHT 0001, Darlington Refurbishment Program Structure. Management System improvements are undertaken through collaboration with stakeholders and all impacted areas of the NR organization and implemented through governance and process support documents.

PAG provides assurance that all aspects of the NR program will be conducted in accordance with the requirements of:

- CSA N286, Management System Requirements for Nuclear Power Plants;
- CNSC Regulatory Document RD-360, Life Extension of Nuclear Power Plants;
- N-CHAR-AS-0002, Nuclear Management System; and
- OPG Corporate Governance

3.1.5.1 Process Support Documentation

The Manager, PAG, controls the creation, revision, review and communication of NR process support controlled documents documented in NK38-MAN-09701-10006, Nuclear Refurbishment - Requirements For Process Support Controlled Documents.

Process support documents are meant to supplement existing Nuclear and/or Corporate Governance used by the NR organization but which define specific processes or requirements for NR staff to adhere to when conducting work on the DRP.

PAG plays an active role in reviewing new/revised process support documents and conducting oversight to ensure the NR organization is adhering to the process and that the process is continuously improved.

3.1.6 Project Management Oversight Program

NR Project Managers are responsible for the creation and implementation of Project Oversight Plans. The Director, PAG, provides Lead Auditors from PAG to assist Project Managers in the development and execution of their Oversight Plans.

Standards for the Oversight plans are documented in N-STD-AS-0030, Project Oversight Standard and in N-MAN-09701-10002, “Nuclear Refurbishment Project Oversight".

3.1.7 External Assurance Audit Coordination and Administration

There are multiple External Assurance and Oversight Agencies evaluating DRP, they are:

- Executive Program Assurance Group, (EPAG)
- Board Of Directors Oversight
- Independent Oversight Advisor (IOA) for Government of Ontario, Ministry of Energy
- Nuclear Oversight, (Internal OPG)
- Internal Audit, (Internal OPG)
- WANO, NSRB, IAEA, CNSC

There is a need to coordinate the assurance provider’s efforts to ensure they are not over lapping each other, scope of works are clearly defined, logistical support for office and meeting space and coordination of actions and recommendations. A dedicated MP6 Lead Auditor is responsible to manage this interface for the DRP team. Contract Administration for the EPAG is performed by the PAG Department.

3.1.7.1 EPAG

By Q4 2015 the Executive Program Assurance Group (EPAG) reporting directly to the CEO and CNO will be operational. The EPAG will be responsible for making impartial assessments to ensure that the project team's actions are meeting expectations, commitments and are following industry proven project management practices. The EPAG may also be requested to suggest potential solutions if they identify any weaknesses or gaps.

3.1.7.2 Board of Directors Oversight

The Board of Directors Oversight is an independent external organization secured to assist the SVP, Nuclear Projects and the Nuclear Oversight Comittee, (NOC) of the Board of Directors in fulfilling their mandate. They provide independent assessments on the overall performance of the DRP as well as targeted independent assessments in specific areas of activity in accordance with the Project Assurance Plan prepared by OPG Internal Audit.

Overall assessments will be completed quarterly and the results reported to the SVP Nuclear Projects and the NOC.

PAG administers all External Oversight Actions in the RMO (Risk Management and Oversight) and conducts a monthly senior management meeting to address External Oversight Issues.

The Independent Oversight Advisor to the Minister of Energy reports directly to the Ministry of Energy and has full access to the DRP.

The purpose of the IOA is to advise the Minister of Energy on the effectiveness of execution of the DRP with respect to risks associated with budget, schedule, safety and quality. In order to effectively execute this scope of services, OPG provides the IOA with access to information related to the DRP. The IOA may also be provided with certain information by or on behalf of the Ministry of Energy during the conduct of their advisory duties.

PAG provides the same level of support to the IOA as for all oversight agencies.

3.1.7.3 Nuclear Oversight

Nuclear Oversight (NO) conducts audits on DR processes and products and is governed by N-PROG-RA-0010, Independent Assessment. NO provides independent insight on areas of performance strength and opportunities for improvement to line management.

The Independent Assessment Program, N-PROG-RA-0010, ensures the management system under N-CHAR-AS-0002, Nuclear Management System, is reviewed with sufficient frequency to confirm its continuing effectiveness. This program provides independent assessment processes to perform comprehensive and critical evaluations

of activities affecting Ontario Power Generation Nuclear facilities, including Nuclear Waste Management facilities.

PAG provides the same level of support to NO as for all oversight agencies.

3.1.7.4 Internal Audit

The Internal Audit (IA) organization reports directly to the Chief Executive Officer. OPG internal audits are identified though the Integrated Annual Audit Plan for OPG that is approved by the Finance and Risk Committee of the Board of Directors.

IA assists the Board in fulfilling its strategic oversight responsibilities by providing the Finance and Risk Committee with independent, objective assurance and consulting activities designed to add value and improve the organization's operations. IA helps OPG accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of the organization's risk management, control, and governance processes.

PAG provides the same level of support to IA as for all oversight agencies.

3.2 On-Boarding

An Individual Contributor Band G Manager reports directly to the Vice President NPO, and is supported by an Administrator and a Business Process Specialist. The On-Boarding Manager will perform the following for Nuclear Projects Oversight:

- Supervise Matrix staff performing On-Boarding activities:
  - Training
  - Security Clearance
  - Radiation Protection set-up and administration
  - Reactor Physics
  - Staffing
- Support, integrate and collaborate with contract partners conducting On-Boarding and Off-Boarding of supplemental staff for OPG Nuclear
- Administer and manage the On-Boarding/Off-Boarding process
- Continuous improvement of On-Boarding/Off-Boarding process

4.0 ASSUMPTIONS AND CONSTRAINTS

In addition to the assumptions and constraints identified in the Darlington Refurbishment Program Charter, the following assumptions are specific to the PAG activities and work programs.

(a) Project Managers will be accountable for direct oversight of the effectiveness of the vendor's quality programs and performance over the life of the project.

(b) Process Support Documents will be authored by the appropriate functional groups.

(c) Contractors will use their own CAP to manage their adverse conditions and not OPG's CAP. This decision is documented in DRAS 379.

(d) Board of Directors Oversight and the Ministry of Energy Oversight providers are funded and contract administered through the Corporate Office for the lifecycle of DRP.

(e) PAG will be supported by Functional groups to conduct PAG surveillances. Each functional group will be required to provide between 70-900 hours per year of subject matter expert support for the surveillances

(f) EPAG is funded and contract administered by NPO Division.

(g) Security, Radiation Protection, Reactor Physics, Staffing and Training will provide matrix support for the On-Boarding process.

(h) Opportunities for MSO to obtain 3 FTE's of the 43 Construction Services Contractors and 3 FTE's from Nuclear Oversight have been explored with Director, Refurbishment Construction and Director, Nuclear Oversight respectively.

(i) Conduct fewer surveillances as this would require less staff. This is likely to negatively impact output and effectiveness.

5.0 STRATEGY / INITIATIVES

5.1 Program Assurance Group

The Director, PAG, provides support to the Project Teams and functional leads in the area of oversight, corrective action and program assurance. These resources will be secured through various avenues including internal vacancy postings for regular and/or rotational positions.

PAG acts as a catalyst for continuous improvement by constantly challenging the DRP organization to improve its performance

Initiatives for 2015 include the establishment and operation of PAG and EPAG. A study on engineering costs will also be conducted in 2015.

5.2 On-Boarding Department

In 2015 Nuclear Projects Oversight Division will assume responsibilities of On-Boarding. It is expected the On-Boarding Department will be fully responsible for the On-Boarding of contract staff for Nuclear Projects and Nuclear Operations by Q3 2015.

6.0 MILESTONES AND KEYDATES

Below is a listing of the Milestones and Key Dates for Nuclear Project Oversight:

Milestone Name	Key Date	Accountable	Description	Completion Criteria
2016 Divisional Self Assessment Schedule (milestone)	Dec 15, 2015	PAG	Develop Self Assessment Schedule	Document Issued
Nuclear Projects Oversight Functional Management Plan	Aug 31, 2015	PAG	R001 of the NPO Functional Mgmt Plan	Document Issued
DR Program Assurance Program Management Plan	Aug 31, 2015	PAG	R001 of the NR Program Assurance Program Mgmt Plan	Document Issued
PAG Integration of Audit Findings	August 31, 2015	PAG	Integrate all audit findings into a comprehensive document	Issue 2015 initial Quarterly Program Assurance Report
Dashboard/scorecard Development	December 31, 2015	PAG	Develop Dashboard or scorecard to show results of PAG integration report.	Issue Dashboard/Scorecard
EPAG Implementation	Dec 31, 2015	PAG	EPAG operational	Executive Advisor contract signed Executive Advisory Board Q4 report issued
2016 Audit Schedule	Dec 15, 2015	PAG	Audit coordination between MOE, CNSC, External Oversight, Internal Audit and Nuclear Oversight	Schedule Issued
On-Boarding process established and effective within NPO	Dec 15, 2015	OB	On-Boarding process established and effective within NPO	On-Boarding metrics in place

7.0 MAJOR WORK SUMMARIES

For all phases of the DRP, PAG is accountable to establish and provide oversight of the Management System. This will consist of the standards and processes by which each part of the organization fulfills their requirements to meet the requirements of

CSA N286, as outlined in the Nuclear Charter and Project Management program documents.

The task of monitoring and oversight will be a shared accountability between the functional groups, Project Managers and PAG. Supply Chain representatives will provide initial review and acceptance of vendor QA programs through the pre-qualification process. Project Managers will provide vendor oversight during execution of their assigned project work. PAG provides oversight of NR's compliance with the Management System.

Major work activities for PAG include developing and implementing the processes supporting Oversight, managing the DR Program Oversight Plan, providing administrative oversight of the Corrective Action Program and overseeing the development and implementation of the divisional level Self Assessment plan. Additional work will include coordination of ad hoc reviews and assessments by both internal and external parties.

7.1 Level of Effort Activities

NPO has many level of effort activities that are necessary to support the NR Program, they are:

Level of Effort Activities	Accountable	Activities
MRM Support	PAG	Agenda, Meeting, Actions, communications
CARB Support	PAG	Agenda, Meeting, Actions, communications, review of other Audits and self assessments
SCR Coordinator Support	PAG	Organize, mentor SCR coordinators in NR, Screening meeting
Review Oversight Plans	PAG	Review of Oversight Plans
Perform Surveillances	PAG	Lead Program Assurance Activities. Plan and execute Oversight Surveillances
Perform OPEX and Lessons Learned	PAG	Anticipates, identifies and effectively communicates project lessons learned, including OPEX
Observe and Coach Project Management Teams	PAG	Attend Project Team Meetings, Attend Vendors workplace
Review Oversight Logs	PAG	Review Oversight Logs, Trend, Analyze
Support Self Assessments	PAG	Participate in Team, ensure they follow governance requirements
Contract Administration for EPAG	PAG	Contract Administration for EPAG. Review charges compared to work plan
Document Retrieval	PAG	Provide administrative and logistical support for the 3 external oversight bodies
Document Screening	PAG	Prepare agenda, facilitate meeting
Governance	PAG	Maintain NR governance framework. Act as a SPOC for all new governance and controlled documents
Program Oversight	PAG	Cross reviews of all projects and functions. Develop metrics with P&C to measure NR program effectiveness for quality
Liaise within Nuclear Fleet	On-Boarding	Administer the On-Boarding process for NR, and the rest of the Nuclear fleet

Level of Effort Activities	Accountable	Activities
Manage the On-Boarding	On-Boarding	Perform the On-Boarding function of scheduling, resourcing and implementing the On-Boarding process.

8.0 RISK AND MITIGATION STRATIGIES

PAG carries one (1) risk, #764, in RMO, Vendor or OPG Poor Performance requiring additional oversight resources. Increased number of SCRs requiring additional OBU Resources from CACG

This risk is actively updated in the RMO database.

On-Boarding – no risks currently identified.

9.0 PERFORMANCE MEASUREMENT AND REPORTING

9.1 PAG Performance Measures

Currently PAG measures CAP performance that is reviewed at the monthly CARB. Project Oversight Plan performance is measured monthly and discussed at the monthly Oversight Steering Committee meeting.

In 2015 a scorecard/dashboard that integrates many of the Program Assurance elements will be implemented with the PAG. Its initial focus will be on quality and safety as cost and schedule have mature reporting infrastructure.

9.2 On-Boarding

On-Boarding will have a suite of metrics developed by the end of 2015.

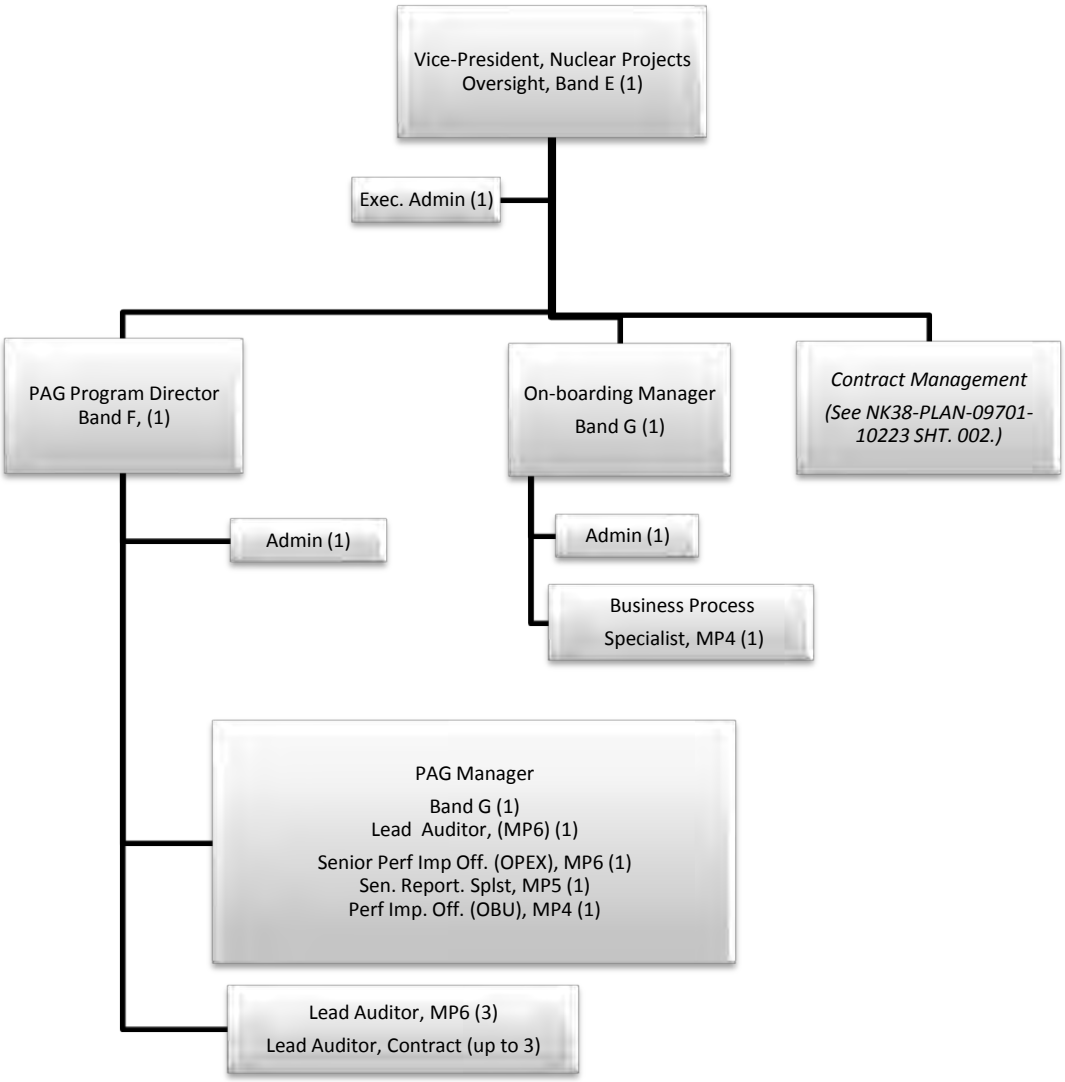
10.0 RESOURCE PLAN

PAG's business plan staffing level is ten (10) FTE positions (increasing to thirteen (13) in 2017) with funding for one (1) FTE of Other Business Unit (OBU) staff. The department's primary role is one of oversight with the bulk of these resources allocated to support NR Project Teams within the matrix organization or dedicated to management systems self assessment and oversight work.

On-Boarding business plan staffing level is three (3) FTE positions.

Total staffing level for NPO is fifteen (15) FTE's increasing up to eighteen (18) FTE's in 2017 until the end of the project.

NPO Organization Chart



Yearly Staff Requirement

Position Title	Job Family	Employee Type	2015	2016	2017-2025
Vice President	Band E (VP)	Regular	1	1	1
Exec Admin	Executive Assistant (Admin)	Regular	1	1	1
PAG		**Sub-total**	**2**	**2**	**2**
Director(PAG)	Band F (Director)	Regular	1	1	1
Admin	Manager Assistant (Admin)	Regular	1	1	1
Manager (PAG)	Band G (Manager)	Regular	1	1	1

Lead Auditor	MP6, (Sr. Advisor, Technical Specialist)	Regular	4	4	4
Lead Auditor, PAG	MP6, “Industry experts”	Augmented	0	1	Up to 3
Senior Performance Improvement Officer	MP6, Senior Performance Improvement Officer		1	1	1
Senior Report Specialist.	MP5, Senior Reporting Specialist	Regular	1	1	1
CAP Specialist	MP4, Performance Improvement Officer	OBU	1	1	1
On-Boarding		**Sub-total**	**10**	**11**	**Up to 13**
Dept Manager (On-Boarding)	Band G (Manager)	Regular	1	1	1
Admin	Manager Assistant (Admin)	Regular	1	1	1
On-Boarding support	MP4, Business Process Specialist	Regular	1	1	1
		Sub-total	**3**	**3**	**3**
Totals			**15**	**16**	**Up to 18**

10.1 Human Resource Strategy

Most of the positions will be staffed with Regular status positions via the advertised vacancy process drawing from applicants within OPG. For positions requiring “industry experts”, PA will use augmented staff agencies.

10.2 Contract List (excluding the major refurbishment contracts)

No.	Contract Name	Time
1	External Oversight *	2014-2024
2	Independent Oversight *	2014-2024
3	Executive Program Assurance Group	2015-2024

* Owner - Corporate Executive Operations

10.3 Other Business Unit Support

Support will be required for the implementation of the Oversight Training program. These needs have been identified to the DR Operations and Maintenance Training Manager for inclusion in their business plans.

A Performance Improvement Officer has been matrixed to support NR administration of the corrective action program. This person will be funded through OBU funding.

10.4 Augmented Staff

Starting in 2016, PAG will acquire up to three (3) Industry Experts to perform surveillance and oversight of project activities.

10.5 Training

Training is conducted informally on the job. The hiring strategy for PAG is to hire experienced OPG staff with appropriate skills and experience. This strategy will be re-evaluated over time as the DRP moves into the implementation phase.

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Plan

Internal Use Only General Business	
Document Number: N-PLAN-09701-10232	Usage Classification: Reference
Sheet Number:	Revision: R000

Title:
NR WORK MANAGEMENT FUNCTIONAL MANAGEMENT PLAN

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NR Work Management Functional Management Plan

N-PLAN-09701-10232-R000
2014-11-14

Order Number: N/A
Other Reference Number:

Internal Use Only
General Business

Prepared by: 2014-11-27.
Dennis Curley – Senior Outage Manager NR Work Management — Date

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Revision Summary

Revision Number	Date	Comments
R000	2014-11-14	Initial issue.

1.0 PURPOSE

This document describes the responsibilities and staffing requirements for the Work Management organization in Nuclear Refurbishment and supports the revenue requirements documented in the WM 4D business plan submission.

2.0 MISSION

The mission of the NR Work Managemnt organization is to plan and coordinate all of the activities leading up to, throughout and closing out assigned unit outages. This includes safety, cost, quality and schedules while completing the assigned scope of work. In this task, Work Management must integrate and coordinate the effort of individual project teams with cyclic maintenance, operation and layup requirements.

3.0 SCOPE AND RESPONSIBILITIES

The Work Management function owns the individual unit outage execution schedules and will provide key input to the overall program schedule. While each project and contractor is responsible to produce a valid and executable schedule the Work Management function must validate that schedule and integrate it into the overall schedule, identifying contractor schedule modifications as required.

The direction and oversight requirements of any individual project are the accountability of that project. The principle task of the Work Management function is to provide an integrating force and establish cross-cutting processes and metrics to ensure that the integrated set of projects is first prepared and then executed to a jointly developed schedule.

Specific tasks include:

Pre-Outage

- Ensure all operating work and outage needed before the start of the refurbishment outage is scoped, planned, and scheduled according to refurbishment standards and in a manner that will achieve the overall business strategies and goals.
- Manages outage scope of work program.
- Ensures that risk reviews are completed, and actions required to monitor and/or mitigate the risk are tracked through to completion using the risk register.
- Ensure all pre and post requisites are planned, coordinated, and executed for assigned refurbishment outages.
- Ensure integration of contractors, refurbishment, and station activities.
- Ensures logistics required during a refurbishment outage including space, services, resources, permits, and radiation protection are planned, coordinated, and executed.
- Manage schedule contingency in the Coordination and Control Level 2 (C&C) schedule

During execution phase

- Ensure work activities are properly planned, prepared, coordinated, and monitored during the actual execution phase through the planning controls systems including making sure parts and tools are readily available.

- Ensure logistics required during a refurbishment outage including space, services, resources, permits, and radiation protection are planned, coordinated, and executed.

- Ensure execution and integration of the unit shutdown and restart activities, including layup, islanding and defuel activities. In particular, ensure Canadian Nuclear Safety Commission (CNSC) commitments related to assigned outage are coordinated and executed.

- Monitors work processes, identifies opportunities for efficiency improvements and works with operations and maintenance as well as other groups to realize these improvements.

- Coordinate the execution of inspection and maintenance work by external contractors including that required for fuel channels, steam generators, feeders, turbine generator, islanding, shutdown and/or layup, and balance of plant. Produce a detailed work execution schedule at a frequency required to ensure effective execution of the planned work.

- Perform critical reviews of upcoming work to ensure projects are aligned and challenged to meet the execution window. Optimize outage critical path with due consideration to the impact on individual project costs.
- to manage schedule contingency in the Coordination and Control Level 2 (C&C) schedule

- Ensure that actual performance is monitored against established performance criteria. Provide timely and credible explanations of year-to-date and year-end project variances in outage performance. Produce appropriate metrics to describe status of the execution of planned work.

- Ensure that problem solving and analysis is conducted when unacceptable performance deviations occur and that corrective actions are initiated and tracked to resolution.

- To provide and operate a Project Control Centre to manage work priorities and issue resolution on a 24/7 basis.

4.0 ASSUMPTIONS AND CONSTRAINTS

1) This plan addresses the staffing requirements for outage preparation and execution for all four refurbishment units. Planning and execution phases were overlapped per the schedule and staffed to a consistent model to arrive at a staffing prediction.
2) This plan assumes that there is one Work Management organization accountable for the planning and scheduling of all four unit outages. This is necessary to ensure that when overlapping outages place conflicting demands on resources, there is one office accountable for resolving the conflicts and establishing priorities. A single Director is shown. This represents a reduction from the 4C assumptions.
3) With minor variations the plan assumes that after the first unit, the planning requirements for subsequent units will be handled by 1 Outage Manager, 1 Section Manager, 6 Work Control Team Leaders (WCTLs), 2 Cost and Schedule Analysts (CSAs) and 1 Master Scheduler. This staffing is required to establish the P6 networks that support the issuance of RevA/RevB/RevC schedules, follow up on lessons learned from the executing unit, code all work packages, and identify and schedule all outage pre-requisites in the stations IPG schedule.
4) The planning level required for the first unit is considerably more involved. It must perform the transactional tasks described in 3) above, but in addition the planning team must establish first of a kind logic and problem resolution for the execution of all the projects, assist with the tracking and scheduling of all infrastructure pre-requisites which will be required for the first unit, and coordinate the F&IP work execution with the stations IPG plan.
5) The plan assumes the addition of a Scheduling Manager, Scheduling Section Manager and direct support scheduling staff which were not shown in the 4C model. These personnel are transferred from Planning Controls and are a direct result of a recent decision to centralize the scheduling function. A significant staff reduction is shown over the years 2015 to 2017 reflecting a developing maturity of the vendor schedules.
6) The plan assumes 4 X 36 month outages completing in December 2025.
7) The Plan assumes the establishment of a Project Control Centre (PCC) to be staffed 24/7 for the full duration of each outage. The staffing, similar to unit outages, is to be established as 1 Duty Outage Manager (DOM), with a SPOC from each of Operations, maintenance and Engineering. There may be periods when the PCC is not required and can be stood down, but for purposes of staff planning, a full time PCC is recommended. Ongoing requirements for station support to the projects, OPEX from prior refurbishments, and the degree of overlap in the final three unit outages all argue for the presence of a dedicated PCC charged with ensuring the timely execution of the schedule.

5.0 STRATEGIES / INITIATIVES

The key strategy for the Nuclear Refurbishment project is the development of an Engineer/Procure/Construct (EPC) model for the execution of major refurbishment work required for the extension of unit design life. In that model, each contractor is accountable for the planning and scheduling of their own work. In integrating those vendor schedules, the Work Management function must constantly assess two things:

- Is the vendor schedule valid and credible? and
- Is the vendor schedule, as a subset of the Outage (OPG) schedule predicting success?

To assist with the ongoing assessment process, the Scheduling team is/will be reviewing vendor schedules and integrating them into the overall schedule as part of an integrated Schedule Control Centre. The SCC was physically established in 2014 and will be staffed with OPG and vendor schedulers in late 2014 and 2015.

Pre-breaker schedule metrics addressing schedule validity include counts of long float items and ratio of L3 to L2 activities. The health of the project schedule is monitored by monitoring the fraction of activities completed as scheduled in each month, and by monitoring the critical and bear critical streams in each project.

Scheduling standards and the process by which schedules are integrated are detailed in the Schedule Management Plan (N-MAN-00120-10001 SCH-11).

6.0 MILESTONE AND KEY DATES

Outage Integration milestones are documented in NK38-MAN-09701-10005 and will not be reproduced here.

7.0 MAJOR WORK SUMMARIES

See section 3.

8.0 RISK AND MITIGATION MEASURES

Risks and Opportunities

Work Management has identified planning and scheduling risks in the Program Radar. Risks specific to the 4D staff planning model are:

- To maintain lower staff numbers, a 4 crew rotation for PCC coverage is described, with no provision for SAVH coverage. In the context of a 3 year outage (or a 9 year integrated overlapping outage program) this may prove inadequate. On a positive note, there may be periods during execution phase where only a single entity (R&FR) is not working a straight days schedule, and there may be times when we can stand down the PCC. For business planning purposes, dedicated staffing is shown.

- The number of Work Control Team Leaders (WCTL's) is reduced from 12 to 8 in outages following the execution of the first unit. This reduction credits a increase in ease of implementation of the following units. This may be overly optimistic.

9.0 PERFORMANCE MEASUREMENT AND REPORTING

The program reporting for the Work Management function is largely managed as the successful completion of milestones leading to outage readiness in the pre-outage phase. These milestones are documented in NK38-MAN-09701-10005. Pre-outage metrics and reports monitor the completion rate for work scheduled to be executed in the stations IPG or outage schedules.

10.0 RESOURCE PLAN

The resource plan for this program has been submitted as the input sheet to release 4D business plan. The work sheet which was used to derive the staffing requirements as a function of the summation of overlapping unit planning and execution phases has been attached as an additional spreadsheet in the 4D submission and is available on the Sharepoint drive.

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Controlled Document Request

COMPLETE AND FORWARD TO THE CONTROLLED DOCUMENTS UNIT

Submitted by: Dennis Curley Location: DEC2A5 Phone: 2975 Date: 2014-11-13 (YYYY-MM-DD)

Document Owner: Arthur Despres Review Cycle: Alert Code: Date Required: (YYYY-MM-DD)

Document requires Canadian Nuclear Safety Commission (CNSC) approval or notification? ☐ Yes
(Refer to N-LIST-00531-10002, OPG Documents Referenced in Licence Condition Handbook, or applicable Licence Condition Handbook.)

Document is related to Pressure Boundary: ☐ Yes

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☐ **Reserve New** – Complete Section A
☒ **Issue/Revise** – Complete Sections A and D
☐ **Obsolete/History** – Complete Sections A and C (Document Custodian to file completed form with document)
☐ **Supersede** – Complete Sections A, B and C (Document Custodian to file completed form with document)
☐ **Cancel** – Complete Section A (and Section C, if associated EC is to be revised)

SECTION A (Continue on page 3 if additional space is required to list document numbers or Vendor information)

Document Number: NK38-PLAN-09701-10232 Sheet and Section Numbers:

Document Title: NR Work Management Functional Management Plan

Document Type:	Sub-Type (if applicable):	Units:	System (SCI/USI):	Project ID (if applicable):
PLAN				10-73000

Security Classification: ☒ Internal Use Only/OPG Proprietary ☐ Confidential ☐ Confidential Security Protected

Vendor Name (in accordance with approved Vendor list):

Vendor Document Number: Revision:

SECTION B

Superseded Document Number (document that is being replaced):

Superseding Document Number (document that is active):

SECTION C

Document Owner Approval:
(Signature or attach approval email)

Document Owner Name and Title:

Revise EC: ☐ Yes EC Number(s):

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Cancel (History) Minor Revision: ☐ Yes	Alpha/Revision Number:

Controlled Document Request

SECTION A (Continued)

Facility	Doc Type	Sub-Type	Units	SCI/USI	Document Title	OPG Doc No.	Sheet No.	Rev No.	Vendor Name	Vendor Doc No.	Vendor Rev No.	EC/DCR No.

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Document Number: NK38-PLAN-09701-10223		Usage Classification:
Sheet Number: 002	Revision Number: 001	Page: 1 of 20

Title: FUNCTIONAL MANAGEMENT PLAN – CONTRACT MANAGEMENT

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FUNCTIONAL MANAGEMENT PLAN - CONTRACT MANAGEMENT

NK38-PLAN-09701-10223-R001
2015-10-08

Order Number: N/A
Other Reference Number: N/A

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R001	2015-07-24	Contract Management's FMP was originally issued in August 2014 to support 4D business planning. This FMP has been revised to reflect the RQE business planning.
R002	2015-10-08	This FMP has been revised to reflect the RQE Functional Risk Management decision.

Records Table

The following Records may be generated by use of this document and shall be registered in the appropriate document management system in accordance with the following table:

Record Created	Associated Form or Template Number	QA Record? Y/N	Filing Information/Retention (AIMS Type/Sub-Type)
None	NA	N	Asset Suite

1.0 PURPOSE

This Functional Management Plan (FMP) plan defines the vision, mission, scope and responsibilities for the Contract Management function of the Nuclear Refurbishment (NR) Organization. This document describes the major milestones and work, organization and staffing plans, assumptions, constraints, strategies and risks associated with execution of this defined work program.

The FMP takes its authority from the Darlington Refurbishment Program Management Plan, NK38-NR-PLAN-09701-10001.

2.0 MISSION

Contract Management's mission is to function as a leader and integrator in the development and documentation of commercial contracting strategies for the key strategic NR Program commercial agreements. These strategies will lead to the formation of effective contractual relationships with key suppliers. Contract management shall be carried out at the appropriate level of commercial rigor and prudence from agreement initiation through to close-out.

3.0 SCOPE AND RESPONSIBILITIES

3.1 Scope

Contract Management supports strategic and major NR contracts in the various stages of the contracting process. The number of Managers and support resources assigned to each contract are allocated by Contract Management and Refurbishment Execution based on the level of complexity and commercial risks associated with the contract and the expected level of support required by the project teams (e.g. project changes, disputes, etc). The scope and responsibilities of the Contract Management organization include:

Definition/Execution Planning Phase Activities:

- **Commercial Strategy** - Defining, developing and documenting an overall commercial strategy for the effective delivery of the Darlington Refurbishment Program.

- **Contracting Strategies** – Defining, developing and documenting individual contracting strategies for the effective delivery of the individual projects within Refurbishment. In doing so, Contract Management will:

  - Work with the project teams to identify, analyse and document the contracting alternatives, considerations and recommended contracting strategy which includes incorporating the objectives and principles outlined in the NR Program Commercial Strategy, relevant OPEX and marketplace intelligence, etc.

  - Obtain and incorporate cross functional perspectives into each of the contracting strategies by working closely with key stakeholders across OPG.

- **Procurement Activities** – Engaged in the development of project procurement documents, proposal evaluations, contract negotiations, OPG stakeholdering and facilitation of the Refurbishment Program Contracting Steering Committee

Execution Phase Activities:

- **Contract Management Activities** – Providing commercial support in the administration of contracts, and leading and demonstrating rigor and prudence in the management of OPG's commercial relationships. This will include:

  - Implementation of a contract management framework to ensure consistency in execution of agreements across projects.

- Providing interpretation of contract terms & conditions
- Development of contract management plans
- Facilitating change management - contract change notices, change directives and contract amendments
- Provide inputs to support invoice reviews
- Contract compliance monitoring
- Performance monitoring and reporting for master contracts
- Identification of commercial issues through participation in project meetings, OPG/Vendor Steering Committees and OPG/Vendor Executive Steering Committees.
- Provide support in dispute resolutions

- **Process Changes** – Facilitate process changes for improved efficiencies related to contractual obligations
- **Contract Audits** – Development of the NR Contract Audit Program, coordination and execution of contract audits.

Closeout Phase Activities:

- **Contract Close Out** – Address all outstanding disputes, for those that cannot be resolved supply background information to support any potential future claims. Ensure all final charges are submitted by the vendor and that no further charges will be submitted. Also, ensure that all ONCORE charges are approved or negated, that all commercial obligations have been met and that commercial documentation is filed accordingly. Participate and support any claims or audits.

Contract Management Overall Program:

- **Governance Reviews** – Review of Refurbishment governance, manuals, guides & procedures to assess potential impacts to contracts
- **Freedom of Information Requests** – Address Freedom of Information (FOI) Requests on Refurbishment contracts
- **OEB Reporting/Prudence/External Reviews** – Coordinate with Law, Regulatory Affairs and other key stakeholders to support information requirements

- **Board Reporting** – Coordinate assessment of commercial risk and reporting to OPG's Enterprise Risk Management - Credit Risk organization

- **Contract Management Training** – Coordinate on-going contract training program for Refurbishment staff

3.2 Responsibilities

Contract Management's responsibilities are:

- To establish an overall commercial framework with guiding principles for establishing and maintaining commercial relationships with third parties to support the NR program objectives.

- To establish and document effective and appropriate contracting strategies for the projects to demonstrate prudence to the Ontario Energy Board (OEB) and ratepayers.

- To establish an appropriate contract management framework to ensure consistency of approach and logic across the implementation and execution of agreements.

- To provide effective commercial management support to the Project teams to ensure OPG's interests are protected.

4.0 BASIS, ASSUMPTIONS AND CONSTRAINTS

4.1 Basis and Assumptions

- Contract Management will function within the governance structure and expectations set out in N-PROG-AS-0007, Project Management.

  This includes:

  - Contract Management Standard (N-STD-AS-0029) provides minimum standards required in managing third party relationships.

  - Nuclear Contract Management Manual (N-MAN-09701-10003) provides guidance on how Contracts within Nuclear Projects will be defined, managed and controlled, with templates for implementation.

  - Darlington Refurbishment Contract Management Plan (NK38-NR-PLAN-09701-10001-0013) to define how the major *Contracts* within Nuclear Refurbishment (NR) will be defined, managed, and controlled.

  - Darlington Refurbishment Program Commercial Strategy (NK38-REP-00150-10001) to set out OPG's overall guiding principles for effectively

engaging and maintaining commercial relationships with third parties in the NR Program.

Assumption ID: 526

- Supply Chain has the accountability for managing the procurement activities and the Project Manager has the accountability for the implementation and compliance to the executed agreements. The Project Manager is accountable for all aspects of the project including contract and contractor management.

  Contract Management supports the project organization in development of contracting strategies, contract oversight and integration. This includes; interpretation of contract terms and conditions, contract management plans, facilitate change management - notice/change directives, advise on invoice reviews, contract oversight and compliance, dispute resolution, commercial records, performance monitoring and reporting for master contracts, driving efficiencies in contractor processes, addressing FOI and OEB contract related requests. Contract Management also has the accountability for administering the Contract Audit Program. Contract Management's oversight accountabilities also extend to ensuring OPG internally is meeting its contractual obligations and is in compliance with the contract.

  It was agreed by senior management during the Release Quality Estimate (RQE) process that contract management will be funded by Contract Management under Nuclear Project Oversight while the contract administration function will be funded by the Refurbishment Execution organization.

Assumption ID: 527

Note: Contract Management will utilise existing partnership agreement between Supply Chain and Nuclear Projects. Contract Management is not accountable to support contracts for material procurement (this is with Supply Chain).

Contract Management will track and manage issues, disputes and potential claims prior to formal submission. Contract Management is to supply background information to support any formal claims, and will support Supply Chain and Law with the formal claim process.

Assumption ID: 528

- The NR program is sub-divided into 7 major projects. The NR program model is to contract the work scope for each of the major sub-projects to a qualified Engineering, Procurement and/or Construction contractor. The Contract Management organization is divided into 2 organizations that support NR.

  - Contract Management - Refurbishment is resourced to support the strategic and major NR contracts for projects i.e., Retube and Feeder Replacement (RFR), Turbine/Generators (TG), Steam Generators, Fuel

Handling and other significant NR contracts. This organization also supports/oversights the OSS MSA contract on behalf of all of NR.

- Contract Management – Projects and Modifications (Prods n Mods) is resourced to support ES MSA. No ES MSA support has been added to the Balance of Plant or Contract Management Refurbishment budget.

Assumption ID: 538

Note: Contract Management supports strategic contracts greater than $5 million and major contracts greater than $40 million. Accountabilities for Contract Management exclude Contractor on-boarding and Contractor management and oversight in the field.

Assumption ID: 539

- Contract Management is accountable to:
  - Document contracting strategies for major contracts in DNGS Refurbishment.
  - Integrate themselves in the Project teams to provide oversight, guidance and direction.
  - Ensure accountabilities for contractual obligations and compliance are clearly assigned.

Assumption ID: 540

- Contract Management assumes the current organization will have sufficient (and fully qualified) resources to support the major contracts throughout the execution phase. However, due to staff departure and internal movement there have been difficulties experienced in maintaining the current level of resources. Contract Management staff up with full time employees, temporary employees and contract staff. Contract Management utilises Augment Staff MSA (e.g. CPUS, Ian Martin, CTS) and the Faithful+Gould (F+G) MSA for contract staff to supplement resource needs. Due to the specialized nature of Contract Management it has been difficult to obtain qualified/experienced contract management individuals. As such, staffing changes for Contract Management require sufficient notice to obtain qualified resources for replacements and to implement an adequate transition plan to maintain the service levels to NR.

Assumption ID: 541

- Legal costs are embedded in the Contract Management Budgets but estimates, cost management and forecasting are directly managed by OPG Law Division and Refurbishment Regulatory Affairs.

Assumption ID: 542

4.2 Constraints

Contract management personnel must:

- Adhere to the terms and conditions of the contract and all legal requirements.
- Obtain value for money in the delivery of goods and services in contracts.
- Ensure goods and services are per the terms and conditions of the contract.
- Be fair to suppliers while protecting OPG interests.
- Engage internal and external stakeholders to ensure alignment and use of best practices, contracts, rates, and terms and conditions. Contract Management's work program places heavy reliance on support from non-Refurbishment Centre of Excellence functional organizations (e.g. Finance, Law and Supply Chain, etc.) to provide required inputs and progress activities in a timely manner.
- Strive for continuous improvement in the creation and lifecycle management of a contract.
- Foster trust and improved supplier relationships including:
  - Being open and transparent
  - Proactively communicating with suppliers and stakeholders
  - Striving for mutual success
  - Sharing of risks and rewards
  - Driving opportunities for cost reduction and efficiency improvements
- Leverage the existing and potential future relationships and contracts between OPG and the supplier across multiple contracts and/or projects.
- Manage commercial relationships between multiple suppliers in large projects and programs.
- Provide feedback to contractors promoting continuous improvement in their performance.

5.0 STRATEGIES/INITIATIVES

Contract Management will employ the following strategies in the execution of the work scope described in Section 3.

- Staff the Contract Management organization with experienced Contract Managers that will form a Centre of Excellence providing support to the project teams where needed; VP, Execution and Project Managers have agreed that due to the nature of the role, the Contract Management staff will be integrated as Project Team Members.

- Contract Managers will have a direct functional reporting relationship to the Director, Contract Management with a high degree of communication to ensure consistency of strategy, implementation and logic.

- Utilize common templates to document individual contracting strategies and contract management plans.

- Utilize a decision records database to capture key contract activities and changes.

- Establish a standardize structure for retention of commercial documentation in project sharepoint sites.

- On-going communications with Project Manager, Supply Chain, other NR functional areas and OPG stakeholders such as Law, Treasury and Finance to ensure alignment and that strategies, process and contractual changes will meet OPG's business interests.

- Weekly Contract Management Meeting to facilitate integration and sharing of information and contract management activities/practices across projects/contracts.

- Bring commercial focus to project related RFP development, contract negotiations and contracts.

- Provide contract management guidance and support to the projects in the administration and execution of contracts.

- Contract Management has engaged the services of Deloitte LLP to provide Contract Audit and Advisory support on the major contracts. KPMG has also been engaged to provide Contract Audit support if Deloitte LLP has a conflict of interest or lacks the necessary resources to support.

6.0 MILESTONES AND KEY DATES

Contract Management deliverables and due dates are identified by the Project Teams to support their Gate Progression timelines.

Upon contract execution, contract management deliverables are defined as needed based on requirements of the Project Team and the vendor.

The NR Program Commercial Strategy (NK38-REP-00150-10001), NR Contract Management Plan (NK38-NR-PLAN-09701-10001 Sheet 0013) and individual Contract Management Plans have an annual review cycle.

7.0 MAJOR WORK SUMMARIES

Major work activities for Contract Management include support of commercial aspects of setting up, ensuring oversight/integration and appropriate contract close out (this includes documentation) for each strategic and major contract in Refurbishment along with managing the overall Contract Management program. For more information on the scope of this during the different project phases (i.e., definition, execution planning, execution and closeout) or to manage the Contract Management Program see Section 3.1 Scope.

8.0 RISK, MITIGATION MEASURES AND OPPORTUNITIES

8.1 Risk

- Timelines for implementation of changes in execution may be aggressive – effective stakeholdering and support from non-Refurbishment Centre of Excellence functional organizations to ensure required inputs and activities are progressed in a timely manner. Volume of work for Contract Management may vary depending on the number of changes in the project/contract and disputes – Resourcing may be supplemented with the use of contractors as need arises.

  Risk ID: 705/714

8.2 Mitigation Measures

OPG transforming itself into an oversight organization; roles and accountabilities for all stakeholder groups may not be clearly defined or understood – Contract Management will work with the Project team and other stakeholder groups to clearly define OPG and vendor commercial obligations in the contract and ensure accountabilities are assigned for oversight and execution in the Contract Management Plans.

- To prevent conflict of interest in relationships with vendors, Contract Managers will be rotated through the various contracts every 3-5 years. This will also allow the team to develop the familiarity with the major Refurbishment contracts to ensure the team has a qualified resource pool for back-ups and succession planning.

8.3 Opportunities

Utilizing Contract Management OPEX/Best Practices related to major projects to ensure effectiveness, improve efficiencies and obtain value for money.

9.0 PERFORMANCE MEASUREMENT AND REPORTING

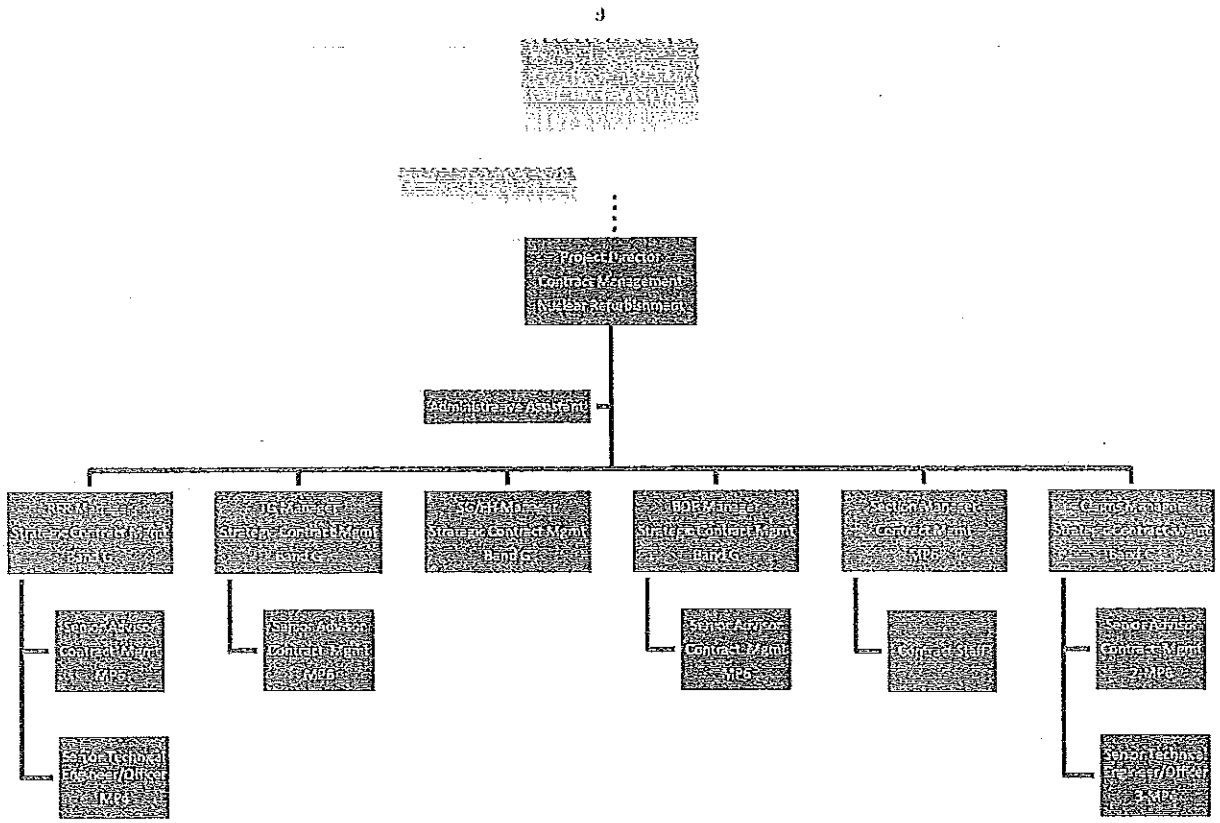
- NR Program Contract Steering Committee meetings are held to communicate procurement status of major contracts and to obtain direction from senior management.
- Performance measures are used to assess the extent to which the terms and conditions within major contracts are being achieved. This is performed via compliance tables. If terms and conditions are assessed to be at risk of not being met, corrective action is taken.
- Scorecards developed by Contract Management are rolled up and presented at the OSS MSA Vendor Quarterly Steering Committee Meetings held with both OSS MSA vendors. These meetings are held to report contract status and issues to Senior Management.

10.0 RESOURCE PLAN

10.1 Labour

This section describes the organization and staffing plan of the Contract Management organization necessary to support the Project Teams in the completion of the work scope for the NR Program.

10.1.1 Organization Chart



10.1.2 Yearly Staff Requirement

A significant portion of the Contract Management resources are currently staffed with temporary resources via rotations and contractors. Resources will be scaled as demands change with the use of OPG staff and/or contractors in the execution phase.

There are limited internal OPG resources with the appropriate commercial experience. Contract Management has also experienced challenges attracting experienced full time resources externally due to labour relations constraints and compensation/benefits constraints for management positions. The yearly staff requirement is contained in the Contract Management RQE Budget (see table below).

Position Title	Job Family	Employee Type	2015	2016	2017	2018	2019-2025	2026
Director	Band F (Director)	Regular	1	1	1	1	1	0.5
Admin	Manager Assistant (Admin)	Regular	0.5	1	1	1	1	0.5
Dept Manager	Band G (Manager)	Regular	4	4.5	5	5	5	2
Section Manager	MP6 (Section Manager)	Regular	1	1	1	1	1	0.5
Senior Advisor (Note 1)	MP6 (Sr. Advisor, Technical Specialist)	Regular	2	4.5	5	5	5 (until 2024 then 4)	2
Senior Officer	MP 4 (Senior Technical Engineer/Officer)	Regular	1	3.25	3	3	3	1.5
Supplemental Staff	MP6 (Sr. Advisor, Technical Specialist)	Augmented	4	4	2.5	1	0	0
		Totals (Note 2)	13.5	19.25	18.5	17	16 (until 2024 then 15)	7

Note 1: RQE decision was made by Senior Management that as of 2016 Contract Management will be funded from the Contract Management budget while the Contract Administration Function in the field will be funded from the Project Execution budget.

Note 2: Contract Management budget also includes one 1-Band F of other business unit staff, for legal support from 2015-2018 after which non-dedicated legal support, if required, is to come from Internal Legal Support. This is not included in above totals.

Further work details are provided in Appendix A – Detailed Hours of Work, which identifies a breakdown of approximate hours to be worked by Admin within the year.

10.1.3 Other Business Unit Support

In order to complete the scope of work within Contract Management, support resources are needed from the other divisions outlined below:

- Finance – Investment Planning, Treasury, Insurance and Controllership
- Law
- Supply Chain
- Enterprise Risk Management – Credit Risk

10.1.4 Human Resource Strategy

Contract Management staff resources are recruited internally from the operations and support functions within OPG. A significant portion of the Contract Management resources are currently staffed up with temporary resources via rotations and contractors. Resources will be scaled as demands change with the use of OPG staff and/or contractors in the execution phase. There are limited internal OPG resources with the appropriate commercial experience. Contract Management has also experienced challenges attracting experienced full time resources externally due to labour relations and compensation/benefits constraints for management positions.

Contract Management supports the successful delivery of the NR Program through the establishment of effective commercial relationships with third parties. Assigned staff is expected to be self experienced motivated leaders with good business acumen and commercial skills who can work directly with project teams, key stakeholders across OPG and third parties. They must have the ability to deal effectively with all levels of management and possess strong presentation and communication skills, including effective conflict management, negotiations and influencing abilities. A key role for individuals in the Contract Management organization involves incorporating technical, commercial and other uncertainties into business decision making. As the role of staff in the Contract Management organization will evolve as the project moves through the various stages from procurement and contracting, to execution, and finally close-out, the organization structure and reporting lines will be reassessed and may change based on support requirements.

The hiring strategy for Contract Management is to hire experienced OPG staff with appropriate skills and experience (as available). As such, training should mainly be conducted informally on the job however specialized training if required will be approved on a case by case basis. This strategy will be re-evaluated over time as NR moves into the execution phase. The training requirements for NR are documented in N-TQD-901-00001, Nuclear Refurbishment Training and Qualification Description.

10.2 Purchased Services

10.2.1 Contract List (excluding the major refurbishment contracts)

Contract Management leverages the Faithful+Gould (F+G) master contract and the OPG master contracts (e.g. CPUS, Ian Martin, CTS) for contract staff to supplement its resource needs. To date these resources have mainly supported MSA contract management function. Contract resources are identified as supplemental staff in the yearly staff requirement table. Contract Management has engaged the services of Deloitte LLP for a 3-year contract to provide Contract Audit and Advisory support. Contract Management has also engaged the services of KPMG for a 10-year contract to provide contract audit support where Deloitte LLP is unable due to a conflict of interest (they are auditor of SNC-Lavalin Nuclear which is one of the JV partners in RFR and TG EPC agreements) or resource constraints.

Contracts	2015-2016 ($k)	2017 ($k)	2018 ($k)	2019-2022 ($k)	2023-2025 ($k)	2026 ($k)
Technical Contract Support – F+G (Note 1)	750	500	250	0	0	0
Technical Site Representatives (Note 1)	600	300	150	0	0	0
Contract Audits & Consulting (Note 2)	800	750	750	850	1050	525
Totals (Note 3)	2150	1550	1150	850	1050	525

Note 1: No budget has been set-aside for the OSS MSA replacement contract(s) for contract management function type of support or for the vendor site representatives.

Note 2: Contract audit amounts increase as the Refurbishment project nears its end as audits need to be performed for all major contracts prior to contract close out.

Note 3: Legal contract funding is also being carried in the Contract Management budget for $400 k (2015), $200k (2016) and $100k (2017). As this work will be emergent in nature additional funding, if required, will be requested from contingency funding.

10.3 Non-Labour Resources

Non-labour resources required include Information Technology Systems IT tools:

- P6
- Proliance
- ONCORE
- ISN
- Vendor Document Management (VenDM)
- SharePoint

Appendix A: Detailed Hours of Work

Dept	Person	Activities	Hrs/Activity	No /Year	Hours
Contract Management	Admin	Manage calendars Director/Managers	1	250	250
		Schedule/Organize Meetings	0.5	250	125
		Prepare Meeting folders	0.5	250	125
		Set up IT Requests for Network Access	1	4	4
		Proofread documents	1	125	125
		Update AIDA database	1	60	60
		TEMPUS Approvals	0.5	52	26
		Update Main Contract Management Sharepoint Sites (incl'd OSS public and internal Sharepoint Sites)	0.5	48	24
		Prepare memo/documentation as required	1	50	50
		Order supplies etc. as needed	0.25	24	6
		Manage Director's/Managers actions	1	52	52
		Action Tracking - Asset Suite	0.5	52	26
		Vacation Tracking	1	12	12
		Space Planning/Telephones	1	12	12
		New Staff Onboarding	1	4	4
		Expense Reports - prepare, review, process	2	12	24
		Building Access Requests	1	4	4
		Department meeting - Organize, actions	1	12	12
		Training Contact	1	12	12
		Prepare Mthly/Qtrly Meeting Materials Steering Committee Meetings	2	12	24
		Invoice Payment - External Contracts	1	52	52
		Conference Room Bookings	0.5	100	50
		Support Dept Staff - preparing materials for special mtgs	3	75	225
		Sending Documents to Records	2	12	24
		Manage OSS Activity List	2.5	52	130
		Update OSS Metrics Tables	4	52	208
		Update Vendor Gang Oversight Info	4	12	48
		Sub Total			1714

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Plan

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Document Number: NK38-PLAN-09701-10235	Usage Classification: N/A
Sheet Number: N/A	Revision: R000

Title:
NUCLEAR REFURBISHMENT PROJECT RQE COST ESTIMATE PLAN

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Nuclear Refurbishment Project RQE Cost Estimate Plan

NK38-PLAN-09701-10235-R000
2015-03-09

Order Number: N/A
Other Reference Number: N/A

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R000	2015-03-09	Initial issue.

1.0 INTRODUCTION

The Project RQE Cost Estimate Plan provides the outline of the activities required to generate a total program cost estimate utilized for the sanctioning of the Darlington Nuclear Refurbishment Program (DNRP). The sanctioning of the program will be accomplished through the development of a Release Quality Estimate (RQE) submission, comprising a detailed cost estimate for Unit 2 execution and a life cycle estimate for the remainder of the program.

This plan defines the estimating activities to develop the total program cost as part of the "The Road to RQE". The Road to RQE is segmented into four groups: Estimating & RQE, Functions, U2 Outage and Projects:

Projects	Each project is progressing to Gate 3 to achieve the program milestone RP300 by June 30th, signifying the completion of project definition and readiness to begin the execution phase. Each project manager is responsible to submit a class 3 estimate, schedule and risk analysis for Unit 2 and a life cycle estimate for the remainder of the units. Based on the contracting strategy of the projects, the projects have engaged an EPC vendor to perform the project work and submit a class 3 estimate and schedule for Unit 2 execution which will be utilized as the basis for the RQE submission and the four unit life cycle cost of the project.
Functions	Each functional estimate owner is responsible to update their respective functional management plan and estimate for incorporation into the RQE.
U2 Outage	The refurbishment operations and maintenance organization is responsible to develop the Unit 2 cyclical estimate and schedule for incorporation into the RQE.
Estimating and RQE Team	The RQE project team is responsible to coordinate the estimate submissions by the organizations above, integrate the submissions into a total program cost estimate forming the RQE, review and validate the RQE, conduct risk and financial analyses, and produce the RQE Report and Memo for submission to the Board.

2.0 BACKGROUND

DNRP receives funding from the OPG Board of Directors (BoD) for defined phases of program work. As part of the submission for release of funds, NR must prepare a detailed cost estimate for the release period, as well as a life cycle estimate for the remainder of the program.

DNRP has committed to continuously updating the basis of the program's estimate in phases, and those updates reflect the progressive increase in maturity of the underlying cost estimates. Prior cost estimates, in support of DRNP funding releases,

have been based on assumptions regarding the future state of the program's execution approach and growing maturity.

The most recent program funding approved, Release 4D November 2014, will initiate the next cost estimate cycle and program gate milestone; RL030 Board Approval of Release Quality Estimate (RQE).

RL030 RQE Milestone represents an OPG decision gate for the Darlington Nuclear Refurbishment Program (DNRP) that signifies the completion of the definition phase detailed planning and the readiness of the program to transition into the execution phase. The RQE establishes a program baseline level scope, cost, and schedule for the DNRP (all four units).

The cost estimate to support the full RQE submission in accordance the RQE Management Plan [R-1], is developed incorporating the cumulative refinement of each project bundle towards a Gate 3 submission; and, integrates with Release 4D to become the program's Release 5 funding. DNRP has committed to utilizing the RQE estimate as the program's control budget for each of the four units.

The RQE, as a progression from 4D, will be a Class 3 Estimate characterized as follows:

1. Estimate details will be quantified based upon defined scopes of work and detailed engineering outputs,

2. Estimates will be based on the way in which work will be executed and scheduled,

3. Support required by others, in order to execute the work according to the plan and schedule, will be documented in the execution approach and estimate basis,

4. Assumptions made within previous estimates will be transformed into plans and the assumptions closed out accordingly, and

5. Estimate basis and remaining assumptions recorded within the Assumptions & Basis Log (previously solely the Assumptions Log).

3.0 ESTIMATE PLAN ORGANIZATION

The RQE Cost Estimate Plan is organized as follows:

1. Document of plan with number: NK38-PLAN-09701-10235;

2. Appendix A, providing the end-to-end estimating process flow of activities to support the Road to RQE and RQE Cost Estimate Development Roadmap, [R-2]. The roadmap provides the scope of estimating activities submitted by project EPC vendors, OPG functions, and Unit 2 Outage that integrate into the overall RQE Cost Estimate.

3. Appendix B, providing specific estimating activities details in order to ensure enough details around the estimating activities to meet estimating planning standards, and

4. Appendix C, providing the legend to the process map and details presented within previous appendices.

The activities of the process map are uniquely identified in order to ensure unique references can be made within this document. The process details presents further information on key activities and the various inputs, outputs (artifacts), forms or templates needed for the performance of the activity. As a working document details are anticipated to evolve and be added within the applicable appendix. In order to ensure any references made to items within this plan can be done so uniquely, the following shows the key to the reference from activity to the specific details:

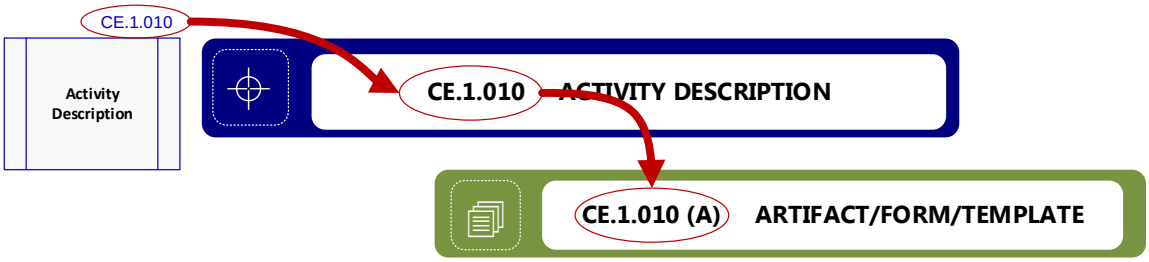


Figure 1: Key to references made to estimating process activities

References made will be utilizing the activity ID and/or reference to the activity detailed item as follows: **CE.01.010**, **CE.01.010 (B).**

4.0 ESTIMATE PLANNING AND DEVELOPMENT PROCESS

The RQE development process is organized as presented above, comprising the:

- written plan,
- RQE Cost Estimate Development Roadmap, referred as the “roadmap”, and
- Estimating process diagram and supporting details attached within the appendices.

The estimating process provides an end-to-end process flow to achieve RQE progressing each bundle from definition phase, and documenting estimates in a manner verifiable for senior management’s vetting of the underlying information.

The implementing details of the estimating process form the basis of estimate (BOE) that evolves during the development process and is finalized upon completion of the final estimate report.

The approval and sponsorship of this plan is achieved through reviews with team members and stakeholders, alignment with the overall “The Road to RQE” and formal approval of the document.

If conditions change through implementation of the estimate development activities, updates of the plan will be incorporated and processed with a review and approval cycle.

5.0 PURPOSE OF THE ESTIMATE

The cost estimate, in support of the RQE RL030 Program milestone, is developed to seek full approval from the Board to execute the DNRP, and specifically, the Unit 2 Execution of refurbishment scope.

The cost estimate will form the first cost control baseline from which actual costs will be collected and resources monitored to establish performance measurement against the program execution plan.

The target classification of the RQE cost submission is AACE Class 3 with an expected 50% level of confidence on the point estimate and accuracy range, exclusive of applying escalation, interest and management reserve, within:

Class 3	10% to 40%	Budget authorization or control	L: -10% to -20% H: +10% to +30%

An assessment of the class of estimate achieved by each project bundle will be performed by the NR Estimating Team based upon AACE Recommended Practices and the nature of the project scope of work. The intent of AACE will be applied “fit-for-purpose” to the nature of a refurbishment program whereby standard outage work management practices and OPEX are leveraged in the execution planning of the work.

6.0 REFERENCES

Document Number	Document Description
[R-1] NK38-NR-PLAN-09701-10004	RQE Management Plan
[R-2] NK38-PLAN-09701-10235-001	RQE Cost Estimate Development Roadmap
[R-3] N-MAN-00120-10001 SCH-05	Nuclear Refurbishment Program/Project WBS Manual
[R-4] N-MAN-00120-10001-EST	Nuclear Projects Cost Estimating

[R-5] N-MAN-00120-10001-SCH-09	Nuclear Projects Scheduling Requirements From EPC Contractors
[R-6] NK38-REF-09701-RL030	Board of Directors Approval of Release Quality Estimate
[R-7] N-PROC-MA-0013	Planned Outage Management
[R-8] NK38-MAN-09701-10005	NR Planned Outage Management
[R-9] 509407-0000-00000-30IM-0001	DGNS RFR Project – Estimate Plan
[R-10] 617391-0002-00000-30IM-0004	DGNS TGR Project – Estimate Plan

7.0 KEY ESTIMATE DEVELOPMENT MILESTONES

The milestone progression of the overall RQE cost estimate is aligned to the Road to RQE and roadmaps with milestones defined as follows.

Table 1: Key Estimate Development Milestones

Deliverable	Description	Pre-Requisite	Related Program Milestone
Cost Estimate Plan Baseline	Detailed plan to achieve compilation, review, validation and issuance of the RQE	• Review and acceptance of plan • Roadmap approved	
RQE Basis Inputs Defined	All data items used to form Release 4D and required as input to developing the RQE	• 4D Proliance Integration • 4D Basis of Estimate finalized	OP2015
Scope & Assumptions Review: All Units	Final Basis review of U2 scope and assumptions. Review of remaining units scope and assumptions to confirm variances from U2	• U2 Initial Work Assessment • Assumptions updated and plan for disposition finalized	OP2075
Program Estimate Data Freeze	All data submissions for estimates and schedules completed. Gate Package data complete	• All estimates submitted • CCF's incorporated	
First Manpower and Cashflow Reports	Integrated estimate and schedule at the work package level (Level 3 for U2 and L2 for remaining units) to produce manpower and cashflow histogram reports	• Estimate/Schedule Integration Complete	
All Projects Gate 3	All projects successfully completed Gate 3 Review Board	• GRB complete for each project	RP300
Total Cost Estimate Snapshot #1	Draft total cost estimate report for use in management reviews First draft contingency analysis performed	• Estimate review and validations complete • Draft Program Integrated Schedule	

Deliverable	Description	Pre-Requisite	Related Program Milestone
Total Cost Estimate Snapshot #2	Final draft total cost estimate report with final contingency analysis and incorporate of review comments/changes	• Senior Mgt reviews complete • Assumptions, gaps, issues closure • Final Program Integrated Schedule	
Final RQE Cost Estimate Report	Final Report issuance for executive management approvals Financial review complete	• Final contingency • Finance review	
Total Cost Estimate File & Integrated Data Set Complete	Integrated data set resides in estimate systems and folders with verifications performed	• Database and electronic files submission • Benchmark analysis complete	RL030

The milestones above are described in further detail below and within milestone definition forms provided for tracking of milestone completion.

8.0 ESTIMATE SCOPE & REQUIREMENT

8.1 RQE Progression

RQE, referred as Release 5, will establish a progression from prior releases to a program class 3 cost estimate and level 3 execution schedule that will be utilized as the program control budget. The estimate progression is defined below within the estimate requirements and summarized in the enclosed process details, Appendix B **CE.1.010 (A)**.

8.2 Program Scope & Schedule

The estimate in support of RQE is developed to the full program scope and all units composed of project bundles and program functions according to the program scope breakdown enclosed, Appendix B **CE.1.010 (B)**.

The bundles' costs are coded following an approved structure that specifies the control account and work package levels, as per the program WBS manual [R-3], to reflect each project and function within the scope of the program and unitized for each Darlington Station Unit of work, Appendix B **CE.1.010 (C)**.

The program WBS is currently set by scheduling and the specific numbering of projects is maintained by Finance. The WBS for each project bundle will require revision as the work progresses from the Definition Phase to the Execution Phase, in accordance with the framework provided in Appendix B **CE.1.010 (D)** and consistent with the program's WBS manual. The cost accounts utilized for the estimate and

project schedules must match and all quantities expressed in the WBS must be equivalent.

As the input to the estimate basis, the program summary schedule is enclosed, Appendix B **CE.1.010 (E)**. Key cost considerations include unit sequencing, extent of overlap in both execution phases and subsequent unit definition phases that require ramp up of activities and resources.

8.3 Estimate Requirements: Class 3 and Class 2

In order to achieve the required RQE target estimate classification, the project deliverables forming the basis of individual project estimates require a level of completion in accordance with the nuclear estimating manual, [R-4], and aligned with the AACE International Recommended Practices (No's 17R-97 and 18R-97). The characterization of the maturity of the deliverables is "enough to achieve execution readiness", whereby:

1. Engineering completion is greater than 60% detailed design to support commodity based cost estimation which equates to engineering approximately 40% earned value according to the earning rules within the engineering change process;

2. Procurement of all long lead materials is complete with purchase orders issued and delivery dates confirmed to meet execution schedule;

3. Procurement of all non-long lead materials is in progress with pricing established through committed bids, or in-house pricing and escalation to base year dollars;

4. Project management plans and/or execution plans are defined, including contracting plans implemented and a defined list of outputs/deliverables,

5. Infrastructure and support services are defined;

6. Construction work planning for direct work scope execution, pre-requisites, and support requirements is complete to a discipline level with resources and man hours defined;

7. Estimate inputs are defined using quantity and commodity based information per design outputs as applicable to the engineering change process,

8. Vendor project schedule is defined in accordance with contractual obligations and in conformance with the program's scheduling requirements, [R-5]. Minimum requirements include work defined at a project level 3 with defined discipline work packages, integrated with resources & cost estimates and with critical path identified in order to produce manpower and cash flow histograms;

9. Non modification work is defined with required work orders, tasks, resourcing, material, specifications, instructions, and support requirements identified;

10. Non modification work is scheduled into the integrated program schedule and integrated with resources & cost estimates;

11. Contingency analysis is performed against integrated resource & cost loaded schedule with specific risks identified to determine cost and schedule variability and estimate accuracy, achieving a 50% level of confidence.

12. Documentation is collated for the above items were used to develop the estimate and ensure the BOEs are verifiable.

9.0 ESTIMATE RESPONSIBILITY FRAMEWORK

9.1 RQE Release 5 Responsibilities

The Director Planning & Controls is accountable for the release planning process and the preparation of the program level cost estimates in support of the BoD submission.

The Manager of Estimating will serve as the Director Planning and Control's SPOC and responsible for the planning and development of Release 5: RQE total cost estimate.

Release 5 is an integral part of RQE planning, and as such falls under the overall coordination of the Project Manager, RQE.

The Manager of Project Cost Management is accountable for supporting the development of Release 5 and the provision of cost data to integrate cost actuals with estimates-to-complete in order to establish the RQE total cost.

The Manager of Risk and Infrastructure is accountable for the preparation of the program contingency and management reserve cost elements of the release.

The NR Controller is accountable for support the development of Release 5 and the provision of interest and escalation calculations to be integrated into the overall RQE Total Cost

The NR Controller provides specialized financial support as requested by the Director Planning & Controls, as well as providing an independent review of the cost estimates prior to submission to the NR SVP. The NR Controller is also the SPOC interface to the corporate Business Planning process.

The Senior Vice President, Nuclear Refurbishment (NR SVP), is responsible for recommending the final Release 5 cost estimate to the OPG Board of Directors via the RQE submission package.

Line functional and project managers, including the VP Execution, are accountable for the cost estimates and populating the risk registers included in the final release submission for their respective areas.

As part of the estimate submissions, functional and project managers, as estimate owners, are accountable for the review and vetting/validation of estimates to ensure completeness, quality and reasonability. The NR Estimating Manager is responsible to assess estimates for quality, coordinate the review process to ensure completeness and reasonability is achieved, and provide the assignment of the estimate classification achieved.

9.2 Cost Estimating Responsibilities/Accountability

The following provides the overall responsibility framework for the development, review, validation, documentation and approval of estimates within the program towards the compilation of the RQE total cost estimate.

On behalf of the SVP Nuclear Refurbishment and in accordance with the Tier Structure of program milestones, the Director, Planning and Controls is the RQE RL030 milestone owner, [R-6].

The sponsorship for the development and final RQE product is provided by the following Key Positions:

1. SVP, Nuclear Refurbishment
2. VP, Nuclear Refurbishment Execution
3. Director, Project Controls
4. Director, Execution
5. Project Directors and Managers
6. Functional Managers
7. Business Unit Managers
8. Manager, Finance
9. NR Controller

In performing the tasks required to produce, review, vet/validate, document and integrate the estimates, the responsibility framework, Appendix B **CE.1.010 (F)**, applies.

9.3 Communications, Coordination and Updates

The roll-out of The Road to RQE, as well as, this plan with supporting roadmap, process and details will establish the kick-off of the RQE development effort.

For the purposes of estimate progression, regular communications and interfacing will be performed within the following venues already established within the program:

1. RFR and TGR OPG/JV Steering Committee meetings,
2. SVP NR and VP Execution Direct Reports meetings,
3. Program bundle and project interface meetings,
4. Engineering schedule review meetings,
5. Estimating and P&C Leads interface meetings, and
6. SNC/Aecon JV and EPC interface meetings.

Bi-Weekly to weekly review meetings will be held to update the status of estimate submissions and development by each bundle prior to the Estimate Submission Freeze date.

The ongoing charter for the review meetings is to meet the estimating milestones and objectives in the Roadmap and include review of the status of EPC estimate deliverables, review of issues and actions, and outlook & coordination of activities and deliverables.

As part of the RQE project, participation in weekly RQE Leadership meetings will be maintained to communicate the status of estimate deliverables, review of issues and actions, and early identification of risks and opportunities related to achieving the RQE.

“The Road to RQE” roadmap includes sufficient check points and milestones necessary to foster early identification of risks and opportunities related to achieving a viable Unit 2 and Life Cycle program cost estimate for the RQE submission.

9.4 Estimating Team

The estimating team is comprised of a core estimating team, estimating support team, and an estimating review team.

Current estimating resources deployed within the definition phase supported project contracting strategies and independent estimate reviews required by procurement governance.

The estimating team structure will be maintained to support the RQE estimating activities, change process and other functions outlined in the roadmap. Areas of focus for accomplishing RQE include reviewing & vetting EPC submissions, developing owner costs, integrating all estimates, and coordinating program level reviews.

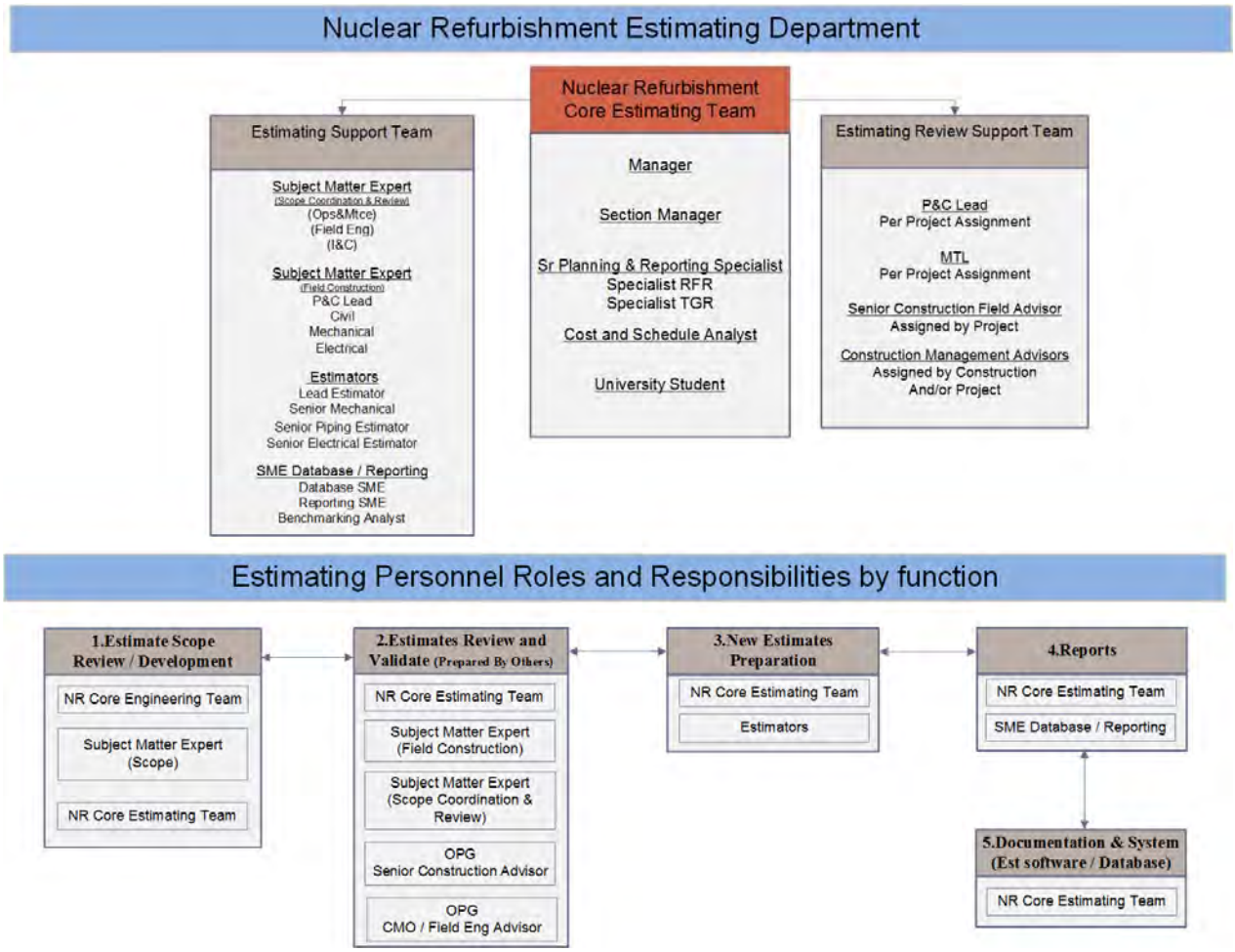


Figure 2: NR Estimating Team & Responsibilities

10.0 ESTIMATING METHODOLOGY

The estimating methodology utilized to achieve the target class of estimate accuracy is based on the nature and scope of the DNRP activities within each bundle and include:

- New Facilities and modifications – work derived from engineering change process and outputs,
- Non-Modifications, cyclical and routine maintenance tasks – work comprising like-for-like component replacements, preventive and corrective maintenance tasks and routine maintenance (preservation) tasks based upon the shutdown and layup of the unit,
- Program Support and Indirect Costs – comprising work required to support the direct scope of refurbishment work and includes management and support staff, and

- Contingent Work – based upon results of required inspection activities.

As the estimates for each of the project bundles progress, the work types and methodology utilized to develop each estimate will be confirmed and documented as part of the BOE.

11.0 THE ROAD TO RQE & COST ESTIMATE ROADMAP

The NR Program is progressing from the definition phase to the execution phase, initiated by the completion of the Release Quality Estimate (RQE) milestone RL030.

Aligned with the key milestones above, the RQE progresses in accordance with the roadmap and process enclosed within the appendices. The following section describes the estimate progression in line with the various activities of the estimating process.

Each bundle progresses in accordance with the contracting strategy and project timelines to reach the required scope maturity to support the development of the class 3 estimate, inclusive of cost, schedule and risk.

Unit 2 Cyclical work progresses in accordance with the planned outage management processes, [R-7][R-8], and identified Unit 2 preparation milestones.

The following sections provide the description of the activity within the estimating process flow provided within the appendix.

11.1 NR RQE Cost Estimate Plan Baseline

The estimate plan baseline, embodied by approval of this document, is achieved through the high level roadmaps and detailed schedule for the estimate development for each bundle, Appendix B **CE.1.010**.

In line with the Road to RQE, each project bundle has a playbook outlining the milestones and dates required for the progression of the estimates and schedules. Each milestone has a completed milestone definition form in order to track completion of the milestones.

11.2 RQE Basis Inputs Defined

The starting point for the preparation of the cost estimate is the determination of the program and project level basis derived from Release 4D; even though, the basis of the estimate will evolve and change through the course of the estimate preparation based on actual status of information or refined inputs obtained.

The planning inputs for RQE will comprise the following:

1. Design status of each bundle and subsequent design outputs (detailed design at ≥ 60% completion) forming the basis of scope and detailed estimate quantification;

2. Planning status of the program and development of detailed execution plans, including:
   - 4D Release, basis, and assumptions,
   - Updated program and functional management plans,
   - Project execution plans and schedules, and
   - Outage execution plans and schedules;
3. Pricing data, sources, and methods forming the BOE costing, including wage rates, material pricing, adjustments, productivity factors, freight, taxes, duties, indices utilized for escalation, forex rates, interest rates, allowances, cost categorization, and calculations;
4. 4D Estimate Classification Assignment;
5. Variances in scope, assumptions and cost basis items identified within 4D with plan for reconciliation, and
6. Estimate structures and coding defined, inclusive of construction work packages and cost categories.

Details of RQE basis inputs are provided within Appendix B **CE.1.020 (A to D)** enclosed.

11.3 Owner Estimate Development

Estimates prepared by the owner comprise all functions and Unit 2 Outage work. Project Management and functions performing work directly within project bundles will be estimated by the Project.

Owner costs for functional support will be conducted through functional planning, outputs and manpower estimates consistent with updated/approved functional management plans.

Owner costs for work performed within the plant, i.e. non-functional management, including cyclical maintenance, operations & maintenance support to others, routine maintenance tasks, radiation protection, as examples, will be estimated through assessed hours per work order & task and quantified using OPG crew and labour rates.

Material estimates, by vendors and OPG, will be defined from purchase orders, material requisitions and/or past material requirements (historical data or back-grounded work orders) with specific quotes or the most recent material pricing escalated to base year dollars.

Outsourced work to specialty contractors will be estimated according to submitted estimates and pricing and/or issued purchase orders.

Program support items or shared cost items will be estimated loaded within the estimating system based on requirements defined by projects or the program level. The scope and assumptions review process with each of the project and functions will serve as the kick-off to defining these items.

11.3.1 Estimate Roll-up and Owner Costs

Estimate will roll up to the program level in accordance with the structure provided within Appendix B **CE.1.030 (A & B)** based on Release 4D. Changes to the roll-up and reporting structure will be incorporated as the estimate progresses and feedback is obtained.

11.4 Scope & Assumptions Review: All Units

A formal program scope and assumptions review is performed upon completion of bundle estimates, review, validation and collation of assumptions incorporated within project files. The review provides both project level and program level scope baseline based on U2 detailed execution planning and the identification of differences from unit-top-unit.

The review achieves a validation of full scope capture into the estimate and requires the participation of:

1. Engineering,
2. Project Management,
3. Execution, including Outage and Construction, and
4. Estimating.

The output is a scope description incorporated into the program BOE, a validation report that traces the scope reports through to the estimated work, and a baseline assumptions log incorporated into the program BOE.

11.5 Estimate Integration

The RQE total cost estimate will consist of the following:

1. Project Bundle EPC estimate submissions,
2. Project Bundle project management costs,
3. Functional and program costs, and
4. U2 Outage station work.

Release 4D results will be loaded into the estimating system according to the approved work breakdown structure and coding to the control account level. The 4D

Release will be held as a point estimate within the estimating database and used to provide comparisons and identify variances for reconciliation with RQE.

As estimates submissions occur, the estimate will be loaded into the estimate database and compared, where available, to previous estimates to provide comparisons and identify variances for reconciliation to RQE.

Estimates will be organized and common coding will be utilized, as per Appendix B **CE.1.050 (A to D)**, to collate estimates and integrate with the program schedule at work package level to perform manpower and cashflow analysis, develop estimating metrics and benchmarking analysis, and to support estimate refinements and shared services analysis.

11.6 Program Estimate Review Plan

The review process for both bundles and costs captured at the program level will be planned and documented to ensure alignment with the review requirements and program and stakeholder goals and objectives.

A formalized review cycle, which is implemented in a progressive manner from estimate details to compiled bundle estimates and, finally, the collated total cost estimate for RQE, provides quality checking upfront to minimize surprise gaps or errors at the last minute. The progressive nature of verifying estimate quality allows the building of confidence and awareness in both the strengths and weaknesses of the estimate.

The review plan, Appendix B **CE.3.060 (A)**, will address the approach to conducting formal reviews at the project and functions level and the senior management level.

11.7 EPC Estimate Development

SNC Lavalin Nuclear Aecon Joint Venture estimates for RFR and TGR bundles are prepared according to contractual and approved estimate plans [R-9][R-10].

Contractors performing works as EPC with OPG as either owner or constructor under the Extended Services Master Services Agreement (ES MSA) will prepare estimates according to OPG's estimating requirements as provided within the estimating manual and templates provided to contractors, indicating required data within estimate details and requirements for BOE documentation.

Projects for which full releases have been provided will have the estimated cost taken from the contract price and structured according to required execution work packages. Cost and schedule integration to produce manpower and cash loadings will be performed utilizing the work packages and execution schedules. Contingency analysis will be conducted through a review and refresh, as required, by the contract deliverable submissions.

11.8 Progressive EPC Estimate Reviews and Validations

EPC estimate deliverables will be progressively reviewed and vetted by the OPG project and estimating teams to ensure the opportunity for a timely collaborative "review and fix" approach.

Progressive reviews are implemented as an opportunity to manage the volume of data incrementally versus on an "all at once" basis that would be prone to late surprises.

The results of the progressive reviews, however, will require validation upon the vendor's providing final submissions; and, while positive results are not guaranteed, the review of final submissions will be more effectively conducted based on the knowledge gained in the progressive reviews.

Additionally, reviews will be focussed more in-depth for key items identified as a critical cost driver of the estimate value or encompasses higher risk/critical path items.

The progressive review process will be applied to all bundles as per the timing of deliverables development and project schedule priorities in the following stages:

1. Identification of key deliverables and cost drivers and development of a review plan,

2. Scope and COMS (constructability, operability, maintainability & safety) review to ensure completeness and ability to execute while identifying potential errors and omissions.

3. Estimate quality review, including basis (cost, schedule, risk) items, methodology, application of rates & productivity factors, identification & quantification of primary and support work, completeness and consistency of documentation, and correctness in cost quantification, generally, per Appendix B CE.6.080 (A) process details.

4. Review of assumptions, exclusions and process of comments and disposition.

5. Estimate comparison against prior estimate submissions, key metrics and benchmark ratios as applicable to the nature of the scope of work.

Estimate vetting and validations are performed independently to compare the estimate to objective data that can be used to determine if the estimate is accurate, reasonable and competitive to the desired AACE classification; as well as, identifying any gaps in the documentation or methodology that may negatively impact the quality of the final estimate. The validation process presented builds upon the reviews conducted as described above.

As a requisite to conducting estimate validations, the estimate documentation should be fully examined, including prior review results as assurance that

1. the scope of the work has been verified as complete and properly characterized to the desired AACE classification;

2. estimate is presented in an understandable manner (clear, concise, repeatable, traceable and defendable) and submitted in the native file formats used for the preparation;

3. costs have been quantified correctly and consistently,

4. quality checks have been performed to identify and resolve errors & omissions; and,

5. the team conducting the validation has a full understanding of how the estimate was prepared, reviewed/challenged, checked and sanctioned.

Methods by which the estimate validation is performed is presented in Appendix B **CE.6.080 (B).** The selection and application of the validation method is dependent upon the stage and purpose of the estimate concurrent to the value-for-money of the effort that is spent.

11.9 Estimate Validations & Reviews: Bundles

For each bundle, a formalized review process, building upon (rather than duplicating) the progressive reviews, will be implemented to:

1. Report upon the collate results of progressive reviews,

2. Perform an overall estimate review with the project team to ensure collation of the full estimate is correct with validations performed, and

3. Achieve a “cold eyes” review of the full estimate, establish feedback & improvements, and ensure the project team attains a full understanding of the estimate.

The review process, Appendix B **CE.6.090,** will be triggered upon the formal submission of the full estimate and documentation by the EPC and kicked-off with a vendor presentation and include the following stages:

1. Estimate presentation,

2. Technical review,

3. Estimating team review, and

4. Project team review with estimate validations

11.10 First Manpower and Cashflow Reports

The estimate data freeze will initiate the integration of all bundle estimates into a single estimate data set and integration of manpower data with scheduling with required validations.

The output of the data integration will be a first cut of the program manpower and cashflow reports, and a verification report by work package to identify and correct any variances in data between sources.

All Projects Gate 3 Complete

Project bundles proceed to gate 3 progressively through the period up to June 30th 2015 whereby the program gate 3 milestone is achieved. The achievement of the gate review for each of the bundles provides a vetting opportunity for senior management.

11.11 Total Cost Estimate Snapshot #1

The RQE Cost Estimate reporting will include a first program draft timed to follow the Gate 3 approvals for the majority of the refurbishment scopes of work. Gate 3 project approvals include Class 3 cost estimates for the execution phase. In addition, the RFR and TGR Class 2 cost estimates final submissions will be complete.

The first estimate snapshot will be based on the integration of estimates submitted by the projects and functions, as well as, approved OBU Service Level Agreements. This estimate snapshot will include first draft program contingency and management reserve as provided by the Manager Risk and Infrastructure in accordance with N-MAN-00120-100001 RISK-04, Nuclear Refurbishment Risk Management and Contingency Development Guide.

The estimate snapshot and reports will initiate a formal review process and include detailed estimate comparisons against prior estimates, standardized objective metrics, key performance indicators and/or benchmarks ratios or factors, including:

- program life cycle costs comparison to levelized unit electricity cost comparison,
- program and project cost relationships with equipment, cost components (PEPC), project phases, FTE's, program directs and indirects,
- discipline benchmark comparisons to total direct field costs, total field costs, and total installed costs, and
- commodity benchmark comparisons (as available) of quantities to costs, unit rates and direct to indirect costs.

11.12 Senior Management Reviews

Leading up to the first estimate snapshot will be the development of a program estimate review plan drafted and finalized within the second quarter of 2015 for the purpose of outlining the terms of reference of the program estimate review process to include:

1. Program estimate and schedule team reviews,
2. Program management reviews, and
3. Program executive team reviews.

The review process builds upon the progressive EPC deliverables reviews, project and bundle reviews and the program scope & assumptions review in order to achieve management review and full understanding of the estimate, estimate refinement, finalized closure on gaps, assumptions and outstanding issues requiring management attention and disposition, and input into the contingency analysis, and assessment of the management reserve.

11.13 Total Cost Estimate Snapshot #2

The finalization of management reviews and changes will be incorporated into the estimate and basis documentation with a second estimate snapshot for both management and finance review. The second snapshot is considered the final draft of the cost estimate report for review and approvals.

Finance, at this time, will conduct final escalation, forex and interest calculations with a resulting report and result that is incorporated into the final cost estimate file.

11.14 Final RQE Cost Estimate Report

Final report production with finance review results incorporated is circulated to program executives for approval.

11.15 Total Cost Estimate File and Integrated Data Set Complete

The period from the final report approval to the RQE milestone date is utilized for collation of all basis files, data sets, logs and final benchmark analysis data into the estimate file as the single source for traceability and future estimating activities.

12.0 RQE COST COMPONENTS

RQE costs will be rolled up according to the structure provided within enclosed appendix. A detailed list of cost components is provided a planning input with the progression from Release 4D to RQE including expanded details of execution phase work within the EPC costs and the Unit 2 outage work planning.

For EPC cost, the estimating team will integrate estimates based on latest project bundle scope and contract costing information. Each EPC contractor's estimate will be reviewed, challenged, and approved before incorporating into the RQE. The responsible project manager and estimating will concur on acceptance/rejection of the project specific estimate, before it is incorporated into RQE.

The OPG oversight (functional) cost will be associated with overseeing the work done by various contractors. The OPG planned staffing and service contracts cost, etc, approved in 2016 OPG business plan, will be incorporated into RQE.

Contingency will be developed by NR Risk Management, after the estimate for all project bundle specific cost and program oversight cost are prepared. Risk review meetings will be held to calculate contingency for each project bundle, and then at NR program level. The contingency will then be included in RQE.

12.1 EPC Contractor Cost

EPC contractor cost elements will be developed for each DSR/Scope of Work, and organized by WBS and Project Bundle. It will include estimate for EPC Contractor Project Management, EPC Contractor Engineering, Direct Field Cost, and Contractor Construction Indirect costs, captured in the format of BOE documents.

12.1.1 EPC Contractor Project Management

EPC contractor project management cost will be based on the Project Management Team (PMT) organization charts and staffing plan, along with overtime (OT) or shift plan for labour cost estimate. The related travel, office and supplies cost will be included.

The cost categories shall comply with memo NK38-REF-09701-0389661: NR Code of Accounts – EPC Contractor Project Management.

12.1.2 EPC Contractor Engineering

As part of the PMT, the contractor engineering estimate will be based on the organization of engineering/design team and required technical support or field engineering required during execution.

The base working hours are 40hrs/week for engineering and project management office. A set of rate tables (with OT rate, and premiums) for different job families will be defined by NR estimating team. They will be agreed upon by the project managers for preparing RQE.

The cost categories shall comply with memo NK38-REF-09701-0389661: NR Code of Accounts – EPC Contractor Engineering.

12.1.3 Direct Field Cost

The labour, material, equipment, and subcontract cost per the cost categories defined in memo NK38-REF-09701-0389661: NR Code of Accounts - Direct Field Cost (Procurement and Construction).

The trades labour below general foreman, including (foreman, sub foreman, Journeyman, Apprentice) shall be counted as direct field labour cost.

Shift premium and allowance will be applied per shift schedule as laid out in trade EPSCA agreements.

12.1.4 Construction Indirect Cost

It will be developed based on Construction Management Team organization and associated activities. Temporary construction facilities, construction services and utilities are estimated based on quotes or PO, or based on historical cost. It will be specifically estimated with the concurrence from each project bundles and NR construction management.

The cost categories for construction indirect cost shall comply with memo NK38-REF-09701-0389661: NR Code of Accounts – Contractor Construction Indirects.

12.2 OPG Project Oversight Cost

OPG project oversight cost will be developed in Release 5. It will be planned and implemented via the annual business planning processes, as defined in overall RQE plan.

12.3 Escalation and Interest

Escalation and interest will be developed by Nuclear Refurbishment Finance, after the base estimate is prepared and before the contingency or management reserve are applied.

12.4 Contingency

Contingency for DNRP will be prepared by NR Risk Management team, through qualitative or quantitative methods as required per N-MAN-00120-10001-Risk 05-R001.

The contingency will be added to the base estimate for each NR project and NR program, and be an integral part of RQE.

12.5 Management Reserve

Management Reserve constituents, preparation and its management are defined, per N-MAN-00120-10001-Risk 05-R001. It will be reviewed and decided by NR senior management team after the base estimate, escalation, interest, and its contingency are prepared. It is also an important component to the RQE.

13.0 ESTIMATE ORGANIZATION, FORMAT AND CODING

The RQE estimate will be prepared by project bundle, then by DSR line, and detailed to Code of Accounts. The cost element of labour, material, equipment, and subcontract will be utilized. The WBS codes will be assigned to estimate by DSR line, when an approved WBS has been issued and used on a particular project bundle.

14.0 ESTIMATE BASIS

The imperial unit of measures is used. Following is a list of unit of measures used in RQE.

Basis Date:	August 31st 2015
Currency:	3nd Quarter 2015 Canadian Dollars
Exchange Rate:	Included based on NR Finance's FOREX calculations.
Incurred Costs	Included in estimate as per project controls directive with cut-off date 30 May 2015
Composite Crew Rate:	Based on latest EPSCA, CUSW, and BACU agreements with OPG and its rate schedule effective as of May 2015, or May 2014 and escalated to 2015.
Unit of Measure:	Imperial
Commissioning & Start Up:	Included
Capital Spares:	No capital spares are included as Nuclear Refurbishment Funded.
Taxes & Duties	Excluded
Contingency:	Calculated based on risk registry and risk analysis done by project bundle.
Escalation:	Included based on calculation done by NR Finance.

15.0 LATE CHANGES

Late changes (after Q2 2015) will not be incorporated in the RQE, and will be evaluated and approved by management among Engineering, Project Execution, and Project Control between the July and September 2015, before inclusion into final estimate.

16.0 INCLUSIONS

Cost for the work executed by Darlington station during Pre-Refurb or Refurb Outage, and funded by Darlington station (ASIC, Capital Funding, etc) is excluded.

Cost for Force Majeure events is not included.

Cost impact due to government change imposed upon NR project execution strategy or plan is not counted.

17.0 ESTIMATE DOCUMENTATION

The CCAs, CDRs, technical reports, drawings or proposals, etc. used in the estimate will be referred to and recorded.

The quotes for material, equipment, etc. used in estimate will be archived or the related document number will be kept on file if an electronic version exists in Asset Suite.

The calculation for quantity, or quantity take-off, etc will be kept as dated hard copies, and archived as estimate backups.

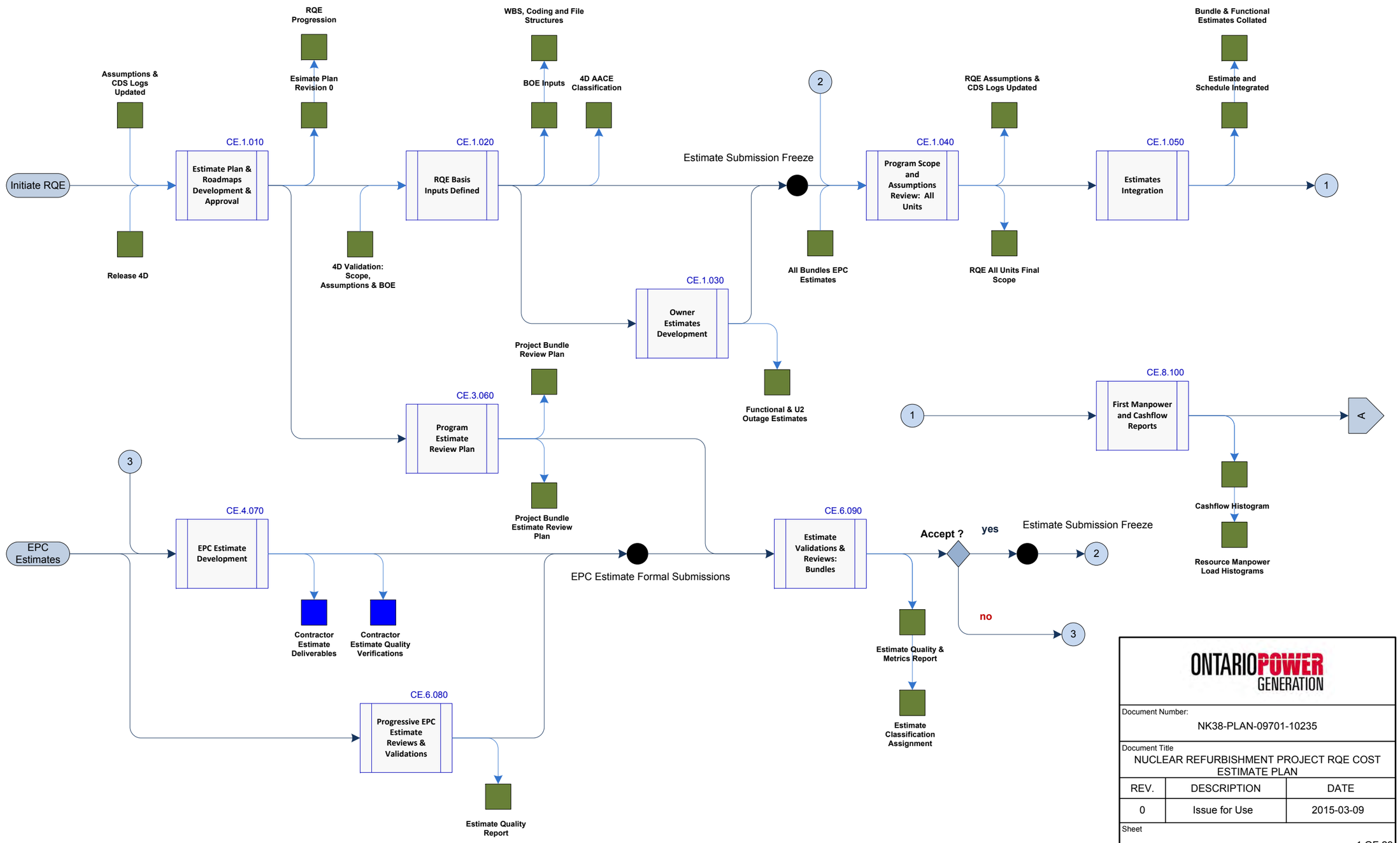
The approved estimate along with BOE documents will be archived electronically in SharePoint team site and Asset Suite, and in hard copies within estimate team.

Appendix A: Cost Estimate Process

Appendix B: RQE Cost Estimate Process Details

Appendix C: RQE Cost Estimate Process Legend Page

(Appendix A) RQE Cost Estimate Process



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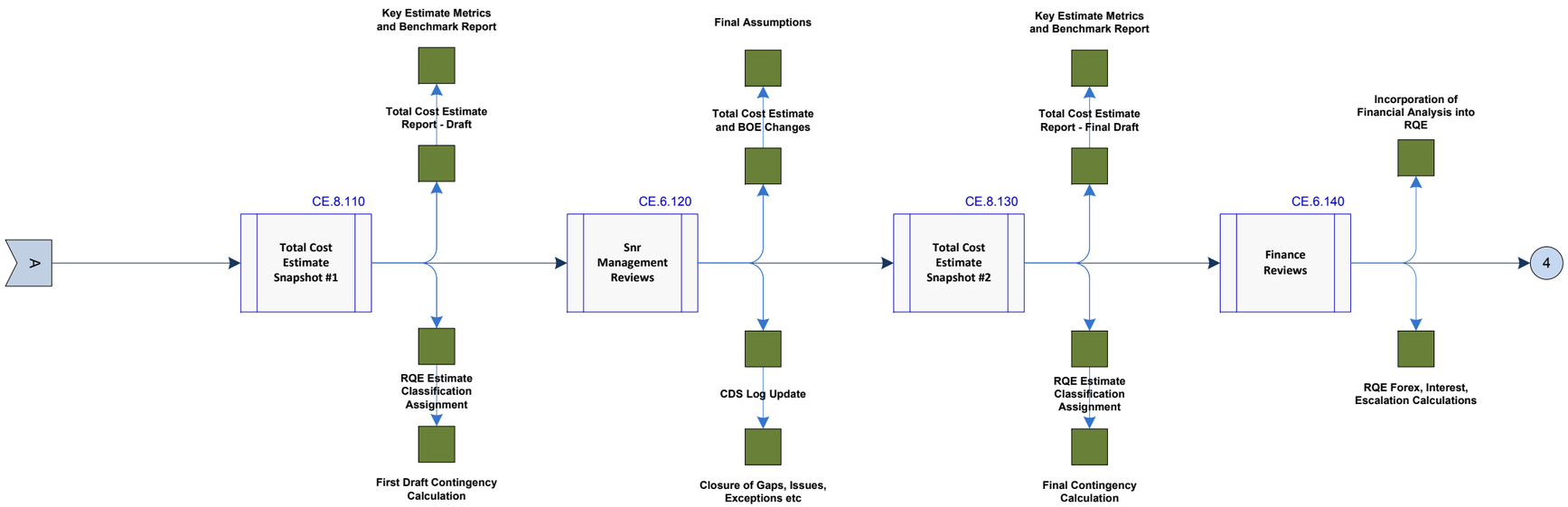
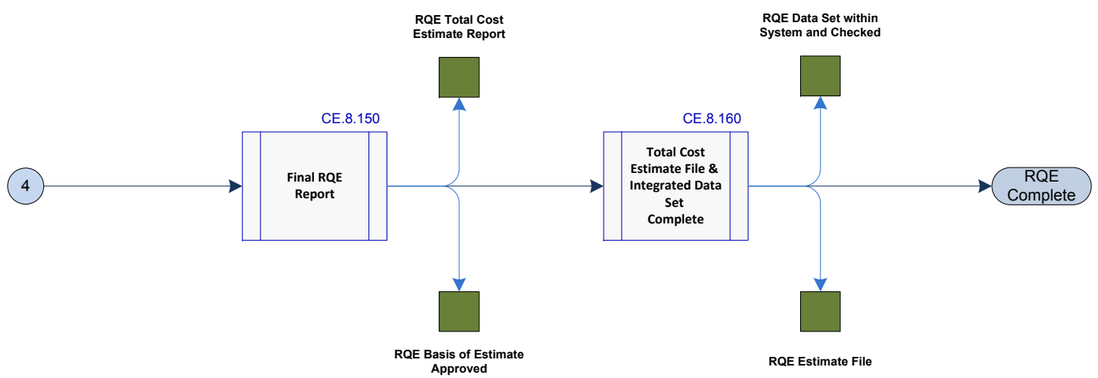
(Appendix A) RQE Cost Estimate Process





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(Appendix B) RQE Cost Estimate Process Details

CE.1.010 ESTIMATE PLAN DEVELOPMENT

- Release Quality Estimate (RQE) purpose
- Estimate Progression and Target Classification
- Estimate Requirements
- Program Scope – Project Bundles
- Contractor Estimate Plans and Review Process
- Program Execution Strategy
- Work Breakdown Structure and Coding
- Program Schedule
- Lessons Learned from Prior Phase
- Program Historical Information
- Estimating Tools

- Consultations with teams (internal and contractor/EPC)
- Documentation Reviews
- Process mapping
- Stakeholder reviews

Draft Plans:
- NK38-PLAN-09701-10235 Nuclear Refurbishment Project Cost Estimate Plan
- NK38-PLAN-09701-10235-001 RQE Cost Estimate Development Roadmap, Process and Details

Key Plan Elements
- Estimating Roadmap/Schedule
- Estimating Process and details
- Program Estimating Responsibilities
- Estimating team structure

CE.1.010 (A) RQE PROGRESSION

- All project bundles progressed through Gate 3 with approved cost estimates, schedules, risks and contingency analyses
- Functional costs defined with functional management plans, organization structure and outputs aligned to release 4D cost estimates
- All assumptions reconciled from 4D to RQE with inclusion to project plans, basis document or disposition of final assumption within Final Log
- Schedules aligned to program level plan and based on approved planning assumptions incorporated into execution plan
- Unit 2 schedule defined to level 3 and construction work package level with remaining units defined to program level 2 control account level
- All estimates achieved to a minimum class 3
- Other Business Units aligned with business transformation phase 2 changes and integrated within OBU plan and signed services level agreements
- Integrated cost, schedule and risk model to support financial analysis

CE.1.010 (B) PROGRAM SCOPE BREAKDOWN: RELEASE 4D

Bundles

Balance of Plant	Adjusters - NS	**RFR**	R&FR Target Cost
	ASME Mod - CV		R&FR Tooling
	Components - SW		RFR Major Retubing
	Condenser Struts - CV		
	Containment - NS	**RSF**	Decontam Shops,Contam Shops and Work areas
	DCC		EWA Wifi
	Electrical Systems - CV		Holt Road Services
	Emergency Heat Sink - NS		Mtce Contract - RSF
	ESW L15 Replacement		RPT
	Fire Protection (Major Mods) - CV		Shops and Work Areas
	Fire Protection (Minor Mods) - CV		TAB Elevator
	Fission Chambers - NS		Vestibules, Storage pad and PB laydown area
	PHT & Aux - NS		Washroom/ Lunchroom
	PHT Pump Motor Overhaul - SW		WCA
	Regulating Flux Detectors - NS		
	SDC HSink - SW	**SG**	SG EPC
	Service Water - CV		
	SHIM - NS	**Shutdown Layup**	Breathing Air
	Valve Rehabilitation - SW		Cranes
			Dry Air Conventional
Defueling			Dry Air Nuclear
			Equipment Layup
Eng Proj Bundle (DSR)			LPSW
			Mod/PHT Dry
F&IP			Mtce Contract - SDLU
			Service Air
Fuel Handling	FH Power Track Refurbishment		SG Primary
	IFB HX Replacement		SG Sec Side/SGECS
	IFB Inspection Faculity & Tooling		TG & Auxiliary
	RA Bridge		
	(blank)	**SIO**	
In Stat Infr	In Stat Infr		
		Specialized Projects	SDS Computer
Islanding	Barriers		Vault Coils
	BH & CI		
	P&M D2O Management Mods	**TG**	TG EPC
	P&M Negative Pressure Containment Mods		TG ESES
	P&M Pre-Req Mods		TG IMS

Functions

Adv Rel 4
Contract Management
Engineering Services
Execution OH
Managed System Oversight
Nuclear Safety
Ops & Mtce
Planning and Controls
Program Support
Reactor Engineering
Rel 3
Supply Chain
U2 Outage
Waste Disposal (OM&A)

New Fuel

P&M executed BOP

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(Appendix B) RQE Cost Estimate Process Details

CE.1.01 (C) PROGRAM WBS CODING

For Project Bundles

Project + PEPC Project Phase + Control Account + Work Packages, altogether will be of 10 digits, as follows

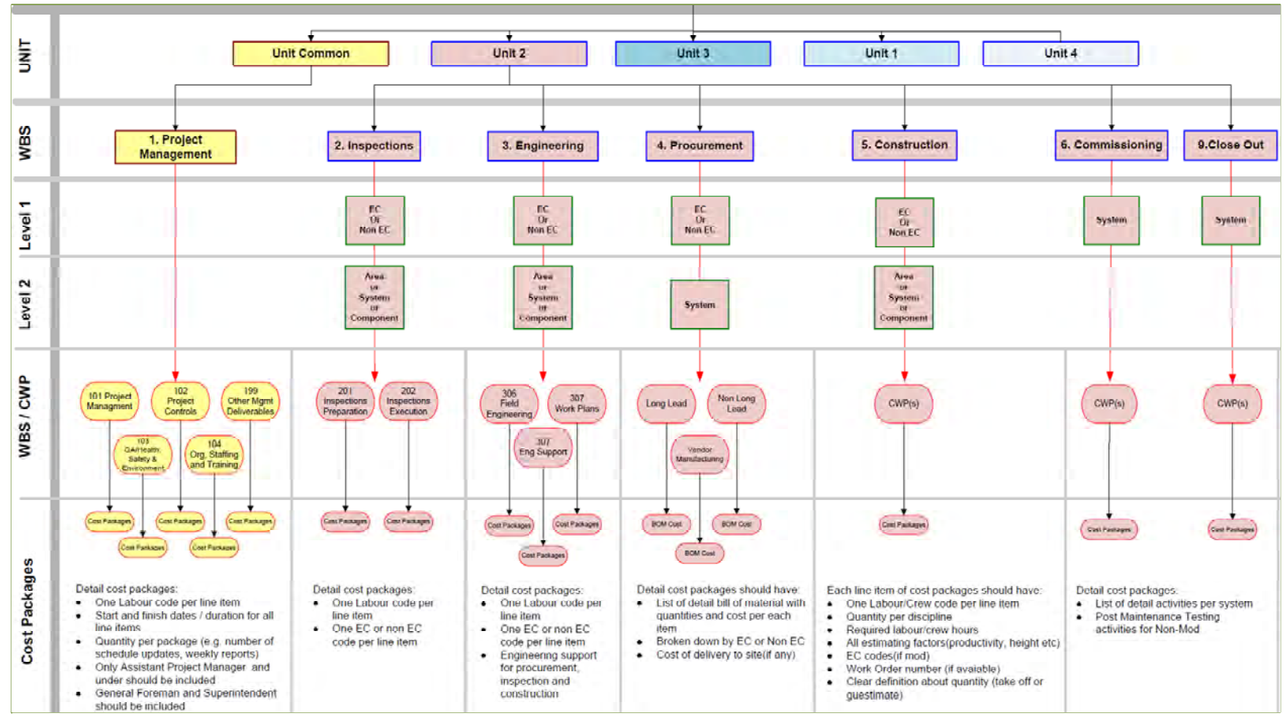
	1st – 5th Digit	6th Digit	7th – 8th Digit	9th – 10th Digit
Indication	Project No.	PEPC Project Phase No.	Control Account No.	Work Package No.
Range	XXXXX	1-9	01-99	00-99
Values	A number is assigned to a Project (unitized)	1. Project Management 2. Pre-Outage Inspection 3. Engineering 4. Procurement 5. Construction 6. Test & Commissioning 7. Closeout	Numeric order	00 is for Control Account 01-99 are for the Work Packages under the Control Account

For Functional Divisions

Project + Function + Control Account + Work Packages, altogether will be of 10 digits as follows

	1st – 5th Digit	6th Digit	7th – 8th Digit	9th – 10th Digit
Indication	Project No.	Function No.	Control Account No.	Work Package No.
Range	XXXXX	1-9	01-99	00-99
Values	A Number is assigned to a Project (unitized)	1. Common 2. Function A 3. Function B 4. Function C	• Numeric order of the Management Programs by the function • 01 is for Level of Effort	• 00 is for Control Account • 01-99 are for the Work Packages under the Control Account

CE.1.01 (D) WBS AND CODING FRAMEWORK FOR ESTIMATING



The term cost package is utilitized and defined as the collection of estimate details within:

1. CWP's defined by EPC organizations and broken out by discipline/crew. CWP's relate to one work order by one or more tasks
2.

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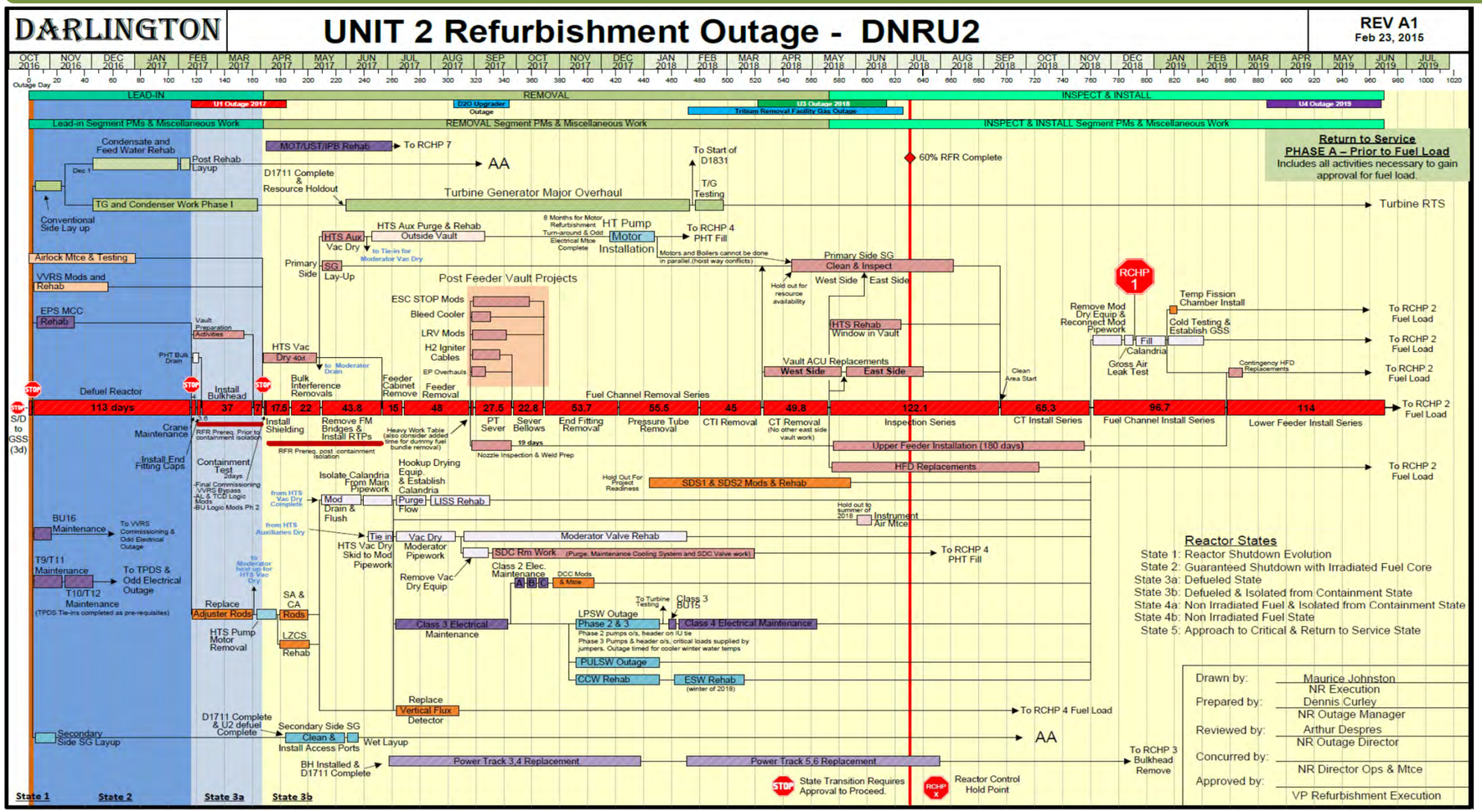
(Appendix B) RQE Cost Estimate Process Details

CE.1.01 (E) PROGRAM SCHEDULE AS INPUT FOR ESTIMATING



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(Appendix B) RQE Cost Estimate Process Details

CE.1.01 (F) PROGRAM ESTIMATING RESPONSIBILITY FRAMEWORK

Table 1: Program Estimate Responsibilities

	R Responsible	A Accountable	C Consult	I Inform
Project EPC Estimates	JV/EPC Vendor	Project Manager	VP Execution	Director, Project Controls
Project Owner Estimates	Project Manager	VP Execution	SVP, NR	Director, Project Controls
Functional Management Estimates	Functional Manager	SVP, NR	VP Execution	Director, Project Controls
Other Business Units Estimates	BU Manager	SVP, NR	VP Execution	Director, Project Controls
Estimate Purpose and Target Classification	Director, Project Controls	SVP, NR	VP Execution	Manager, Estimating
Program Allowances	Director, Project Controls	SVP, NR	VP Execution	NR Controller
Total Cost Estimate	Director, Project Controls	SVP, NR	VP Execution	NR Controller
Program Integrated Schedule	Director, Project Controls	SVP, NR	VP Execution	
Program Cash flow	Director, Project Controls	SVP, NR	VP Execution	Manager, Finance
Program Contingency Costs	Director, Project Controls	SVP, NR	VP Execution	NR Controller
Program Management Reserve	Director, Project Controls	SVP, NR	VP Execution	NR Controller
Interest & Escalation Costs	Manager, Finance	SVP, NR	VP Execution	NR Controller

***R = Responsible**: Those who do the work to achieve the task.*
***A = Accountable/Approval**: Those who are ultimately accountable for the correct and thorough completion of the deliverables or task and the one whom Responsible is accountable to; Approves the deliverable.*
***C = Consulted:** Those whose opinions are sought; and with whom there is two-way communications. Those who participate in the decision-making process.*
***I = Informed:** Those who are kept up to date on progress; those who are aware of decisions and rationale*

Table 2: Estimate Activity Responsibilities

	R Responsible	A Accountable	C Consult	I Inform
Estimate Planning & Inputs	P&C Lead Estimators	Project Manager	Manager, Estimating	Director Execution
Estimate Reviews and Validations	Estimators Project Team	Project/ Functional Managers	Manager, Estimating	Director Execution
Estimate Contingency Calculation	Risk Lead	Manager, Risk	Manager, Estimating	Project/ Functional Managers
Estimate Schedule Integration	Lead Estimator Lead Scheduler	Manager, Scheduling	Manager, Estimating	Project/ Functional Managers
Estimate Forex, Interest & Escalation Calculation	Finance Lead	Manager, Finance	Manager, Estimating	Project/ Functional Managers
Document, Report and Issuance of Estimate	P&C Lead Lead Estimator	Project/ Functional Managers	Manager, Estimating	Director, Execution
Estimate Tools, File and Dataset	P&C Lead Lead Estimator	Manager, Estimating	Project/ Functional Managers	

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(Appendix B) RQE Cost Estimate Process Details

CE.1.01 (G) TYPES OF WORK AND ESTIMATING METHODOLOGY

Refurbishment Work Type

		New Facility	Mod	T-Mod	Non Mod	Cyclical	Program Indirect ±	Program Support	Contingent Work
Bundles									
	Balance of Plant		✓	✓	✓	✓			✓
	Defueling		✓				✓		
	Eng Proj Bundle (DSR)							✓	
	F&IP	✓	✓			✓			
	Fuel Handling			✓	✓				
	In Station Infrastructure	✓	✓	✓		✓			
	Islanding		✓	✓					
	New Fuel								
	P&M executed BOP		✓	✓	✓		✓		
	RFR	✓	✓	✓	✓				
	RSF	✓	✓	✓			✓		
	SG			✓	✓				
	Shutdown Layup			✓		✓	✓		
	SIO		✓	✓	✓				
	Specialized Projects		✓	✓	✓				
	TG		✓	✓	✓	✓			
Functions									
	Adv Rel 4								
	Contract Management							✓	
	Engineering Services							✓	
	Execution OH							✓	
	Managed System Oversight							✓	
	Nuclear Safety							✓	
	Ops & Mtce							✓	
	Planning and Controls							✓	
	Program Support							✓	
	Reactor Engineering							✓	
	Rel 3								
	Supply Chain							✓	
	U2 Outage							✓	
	Waste Disposal (OM&A)						✓		

± Indirect cost is defined for construction as: " all costs not attributable directly to the completion of work, but required for orderly completion of the work ie. Temporary facilities, services, equipment, tools & consumables, non-productive time, management and support staff

Target Estimate Methodology per Work Type

WORK TYPE	ESTIMATING METHOD
New Facilities	Direct Field Labour calculated based on discipline crew rate, commodity production unit rate, quantity of commodity (derived from design drawings & bill of materials) and work face factors. Support services and equipment activities estimated directly for installation of permanent plant equipment & materials, or as a percentage of the direct field labour for applicable construction package and supported by a level 3 execution network logic schedule.
Modifications	Direct Field Labour calculated based on discipline crew rate, commodity production unit rate, quantity of commodity (derived from design drawings & bill of materials) and work face factors. Support services and equipment activities assessed directly for installation of permanent plant equipment & materials within the modification scope and supported by a level 3 execution network logic schedule.
Routine Maintenance Tasks	Work order and task assessing in accordance with OPG's planned outage management processes, procedures and historical data (OPEX). Requires maintenance procedure, discipline crew hours, materials, and assessment of support tasks with crew hours, material as applicable, and supported by a level 3 execution network logic schedule.
Non-Modifications	Direct Field Labour calculated based on discipline crew rate, commodity production unit rate, quantity of commodity (derived from OPEX and material specifications within AS7 for specific component) and work face factors. Support services and equipment activities assessed directly for installation of equipment & materials within the non-modification scope and supported by a level 3 execution network logic schedule.
Program Indirect	Temporary facilities, pre-requisite work or other works strictly to support the execution of the refurbishment scope and planned outage are estimated in accordance with the applicable work type and contract/purchasing strategy. Tasks required to support other work groups are estimated as per work order and task assessing in accordance with OPG's planned outage management processes, procedures and historical data (OPEX). Requires integration of support tasks to the primary refurbishment work order tasks and assessed to include discipline crew hours, materials, and supported by a level 3 execution network logic schedule.
Program Support	Organizational structure, position roles & responsibilities, deliverables listing and shift plan.
Contingent Work	Based on the work type, commodity, unit rates and work face factors. Quantities or likeliness of the contingent work having to be performed would be based upon a most likely case established from OPEX.

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(Appendix B) RQE Cost Estimate Process Details

CE.1.01 (G) TYPES OF WORK AND ESTIMATING METHODOLOGY

Target Estimate Methodology Common EPC Elements

Common EPC elements:	
Supervision, PMT	Organizational structure, position roles & responsibilities, deliverables listing and shift plan
Training	Training Plan, crewed
Onboarding	Hours per employee, crewed
LOA(travel & subsistence)/Expenses	OPEX, labour surveys
SS&E	OPEX, LOE per construction package and required SS&E
Mobilization & Demobilization	Per Contract, Estimated once for Project and incrementally from unit-to-unit based on integrated schedule
Allowances(rework, MTO)	OPEX
Fees	Per Contract terms & conditions
Schedule Basis	Based upon Outage Level 1 and 2 schedules further detailed to work package level comprising estimated crews, hours, and materials/commodities associated at the control account level. PMT as LOE and engineering & procurement as separate packages.
Material & Equipment Pricing	Equipment and material pricing based on: 1. purchase orders to support Class 2, 2. quotations to support Class 3, 3. OPEX (recent material pricing ≤3yrs) for Class 3, or 4. OPEX (material pricing≥3yrs and escalated to estimate basis date) for Class 4.

(Appendix B) RQE Cost Estimate Process Details

CE.1.020 RQE BASIS INPUTS DEFINED

- Project Scope and DSR Database
- MEC's and ECC's for each Bundle
- U2 Cyclical Scope and Work Orders
- 4D Release documentation and BOE
- 4D Assumptions and CDS Logs
- Current design status of each ECC
- ECC Schedule and milestones to achieve 60% detailed design completion
- Project Bundles work package listing
- Program planning inputs
- Cost items and sources

- 4D Validations: Scope and Assumptions Reviews per Bundle
- Assessment of 4D Classification IAW manual
- Record of costing basis details

- 4D Assignment of AACE Classification
- Design Basis inputs
- Planning Basis inputs
- Cost Basis inputs
- Initiation of 4D loading into estimating system
- Estimate Coding:
  1. WBS
  2. Cost Categories
  3. Resource Codes
  4. Commodity Codes (MASTER FORMAT)

CE.1.020 (A) DESIGN BASIS ITEMS

- Breakdown of work scopes and types (Mod, TMod, Like-for-Like, RMT...),
- Status of the definition of each scope of work,
- Number of assumed master ECs,
- Number of design ECs per the master ECs,
- Bill of Materials associated to each scope,
- List of any major engineering deliverables/drawings,
- List of Long Lead Items,
- Staff Qualification/Training plan, and
  - i. Required engineering effort for:
  - ii. Functional engineering,
  - iii. Procurement engineering, and
  - iv. Field engineering.

CE.1.020 (B) COST BASIS ITEMS

- Pricing sources for all major equipment (vendor quotes, historical data, etc,).
- Bulk material and commodity pricing sources, including any discount strategies.
- The pricing source for all labor hours, and all labor productivity adjustments. Provide appropriate detail if productivities vary by trade and/or location within the project (plant, etc.).
- All wage rates used (including crew/craft rates, craft mix, etc.). Identify all items included in all-in rates (if used).
- Overtime rule per assumed shift pattern
- Pricing source and methodology for construction indirects.
- Pricing source for all start-up costs.
- Pricing source and methodology for all home office costs (project management, engineering, design, etc.). Document the basis for any contractor fee costs.
- Pricing source and methodology for costs such as freight, taxes, duties, etc.
- Pricing source for any owner's costs included in the estimate.
- Currency exchange rates if applicable, as well as the stability and/or volatility of rates.
- Escalation indices used, and the method of calculation (including duration).
- Estimate (Specific) Contingency development and basis.
- Basis for all factors used in estimate (difficulty, congestion, heat, height, Location etc) .
- Influence of local market conditions.
- Capital costs vs. expense costs, or other categorization as necessary.
- Any other pricing factors or external influences that may have a significant impact on project cost should be identified.
- List of Special Tools/Equipment
- Additional items specifically addressed based on nature of refurbishment work and contracting model in place:
  - i. DFL Methodology,
  - ii. LOA,
  - iii. travel & expenses
  - iv. productivity factors
  - v. SS&E/EPSCA/Prof Rates
  - vi. PMT
  - vii. Support Services
  - viii. Subcontractors
  - ix. Materials per WMS
  - x. Training

CE.1.020 (C) PLANNING BASIS ITEMS

- Coding structures (WBS, cost codes, resource & crew codes, BOM/commodity codes, etc),
- Program management and functional management plans,
- Project execution plans inclusive of project management, engineering, procurement, constructability, construction execution, contracting & subcontracting, and commissioning plans, and
- Assumptions and disposition of exclusions, exceptions and previous comments.

CE.1.020 (D) PROGRAM BASIS ITEMS

- RQE Estimate Report – overall program summary and detailed
- Program estimate classification achieved
- Program risk and contingency analysis results and basis
- Program cashflow, interest, escalation, & forex calculations, and basis
- Management Reserve and basis
- Program schedule to Level 3, schedule basis, and resource loading histograms
- Program final assumptions
- Allowances utilized
- Program management and execution plans
- U2 scope breakdown and unit over unit differences
- Summarization of design basis and achieved classification for each project
- Summarization of estimating methodology utilized
- Summarization of pricing sources
- Summarization of cost basis and differences within bundles
- Program benchmarks
- Reference to bundle BOE's and gate 3 results
- Reference to project electronic files forming estimate file

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(Appendix B) RQE Cost Estimate Process Details

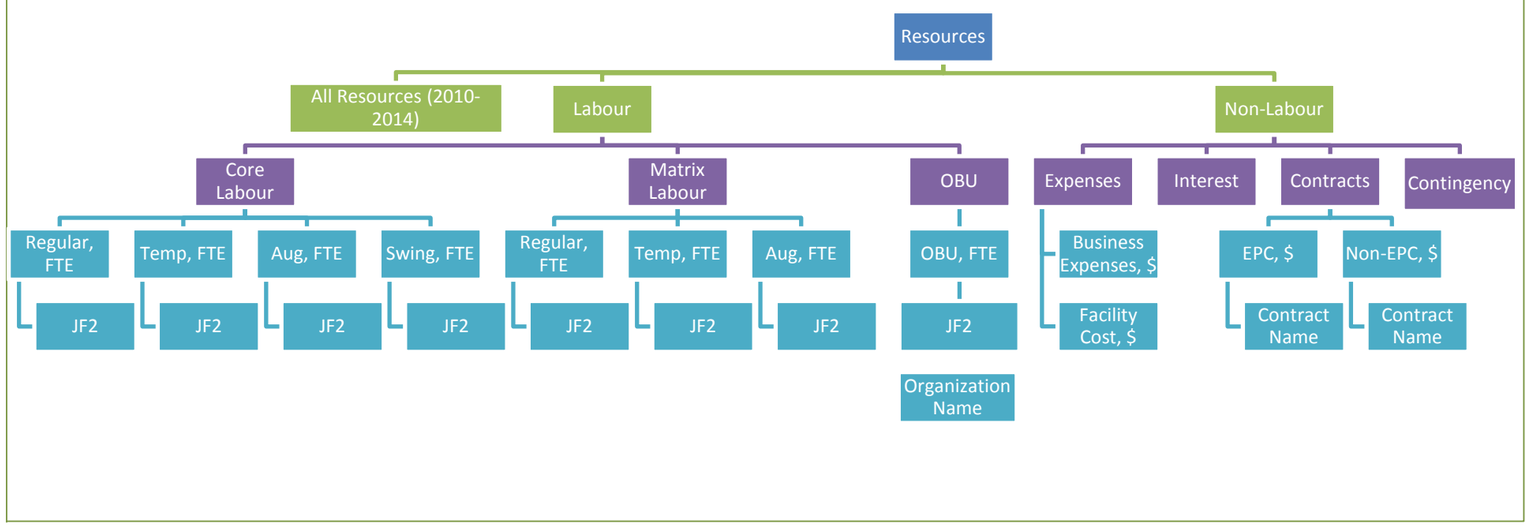
CE.1.030 OWNER ESTIMATE DEVELOPMENT

- Owner Scope
- U2 Outage Scope
- 4D Basis of Estimate and Planning Instructions
- Work Packages (List) and Coding Structure
- Cost Categories
- 4D Estimate Files
- Initial Assessing and Identified Work Orders
- Material Requisitions,
- Issued Purchase Orders or Vendor Quotes
- Latest Material Pricing

- 4D Validations: Owner Scope and Assumptions Reviews
- Change tracking to basis items and assumptions for RQE
- Load Estimating System (4D estimates, rates, codes)
- 4D Estimate files refresh and updating

- Owner Cost Estimate
- Program Basis of Estimate developed for Owner Costs
- Estimate data within Estimating System
- Material pricing escalation to base year dollars (on pricing source >3yrs)

CE.1.020 (B) RESOURCE BREAKDOWN STRUCTURE 4D



CE.1.020 (A) 4D BOE INSTRUCTIONS

1	Contingency – Bundles should include contingency. Functions do not need to include contingency, it will be planned by the program;
2	Interest – Bundles should include interest. Functions do not need to include interest, it will be planned by the program;
3	Escalation – Both Bundles and Functions should not include escalation. It will be planned at the program level;
4	Overtime – For the purpose of planning overtime, the labour rates have already been increased by 2% (or 1 week / year) for the Definition phase (2015), for every represented full time equivalent (FTE). For the Execution phase (2016-2026), the rates are increased by 4% (or about 2 weeks per year) for each represented FTE;
5	Labour rates for 2015 and 2016 are OPG standard rates (in the 2014 Business Plan). Labour rates for 2017 onwards are 2013 rates;
6	Rates for Augmented Staff is OPG standard rates + 30% for the corresponding Job Family;
7	In Resource Type L1, "All_Resources" is a blended resource used for historical costs for the years 2010-2014;
8	Resource Type L1, L2, L3, L4 are defined in the Resource Breakdown Structure (RBS tab)
9	2015 and 2016 are to be estimated on a monthly basis, 2017+ is estimated annually;
10	Labour resources from centre-led organizaition are to be planned as OBU. Decisions from recent business transformation should be taken into consideration;
11	For functions – assume any 2014 budget variances will not be available in 2015.

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(Appendix B) RQE Cost Estimate Process Details

CE.1.040 SCOPE & ASSUMPTIONS REVIEWS

- Program Scope finalized
- PSRB Final Dispositions and DSR Database refresh
- Final Assumptions Log – Program and per Bundle
- Known Unit-over-Unit Scope differences
- Schedule and Risk Basis documents final drafts
- All estimate data file submissions complete

- Table top session for Program Assumptions
- Table top session for each Bundle – assumptions
- Table top session for each Bundle – Unit specific scopes

- Final Assumptions disposition for Program
- Unit 2 baseline scope
- Unit-over-Unit scope differences and estimate disposition
- Identified gaps and recovery actions
- Basis of Estimate Updates

CE.1.020 (A) REVIEW CHARTER

Charter to be developed:

- Review Objectives
- Required Inputs
- Required Participants
- Review Package
- Standard Agenda
- Timings
- Minutes and Actions

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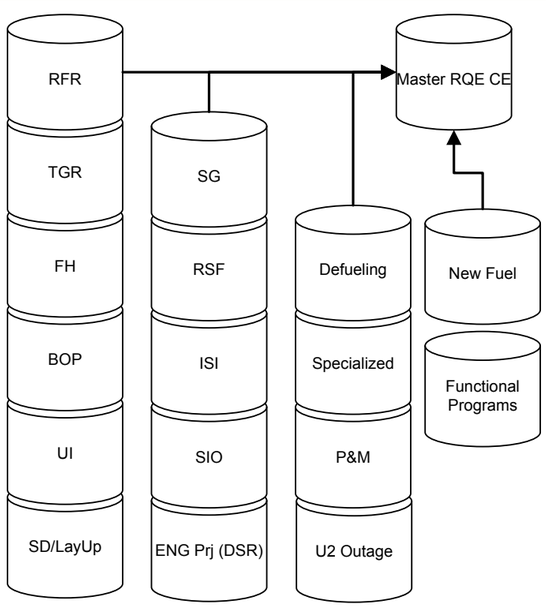
CE.1.050 ESTIMATE INTEGRATION

- 4D loaded into estimating system
- All estimate data file submissions complete
- Rate Tables, Resource Codes, Commodity Codes loaded
- Labour, location and productivity factors loaded
- Materials and Equipment tables loaded
- Estimate reviews and validations complete for EPC submissions

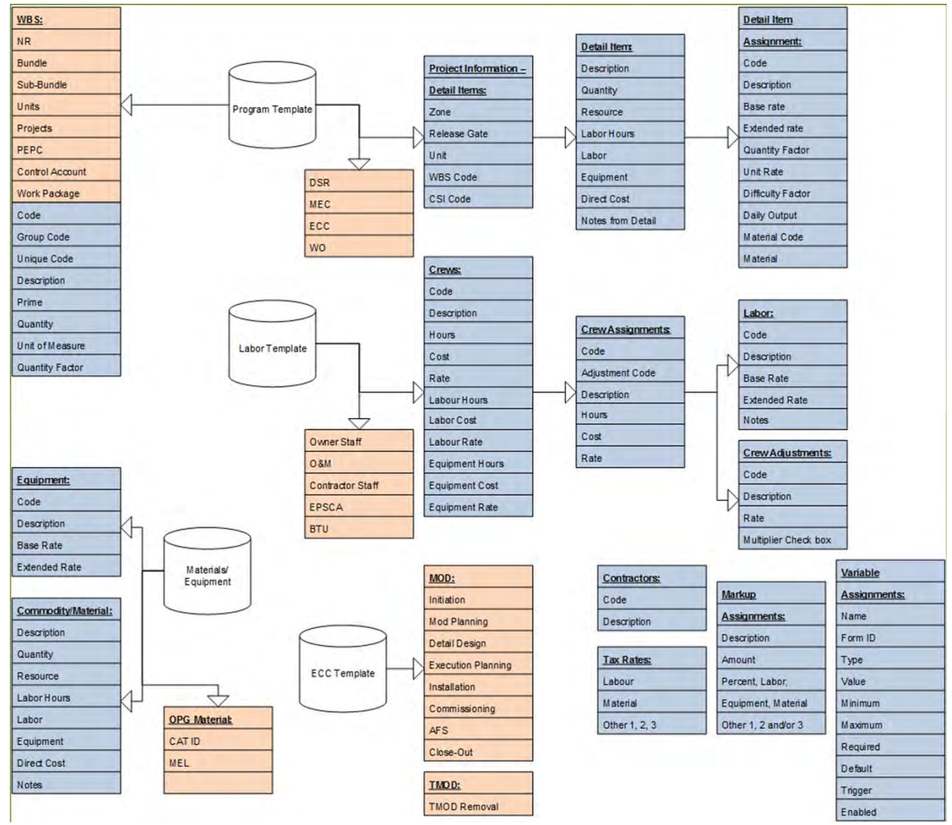
- Dynamic data exchange
- Receipt of electronic estimate & schedule files
-

- Estimate database files
- Collated Master RQE cost estimate file
- Coding dictionary

CE.1.050 (A) ESTIMATE DATA BASE FILE



CE.1.050 (B) ESTIMATE DATA CODING SCHEME



CE.1.050 (C) INTEGRATED CODE ITEMS

Level 1: Control Accounts
Level 2: Work Packages
Level 3: Work Orders
Level 3: Vendor Activities

Work Package

- Unit
- System Number (USI)
- Project Number
- Work Package ID
- Earning Rules
- Scope ID
- Vendor
- EC/MEC
- WO/CWP Number
- Outage Segment
- DSR Line Item
- Total Work Hours
- Crew/Staff Code

Work Order Tasks

- Unit
- System Number (USI)
- Equipment Number
- Commodity Code
- Project Number
- Work Package ID
- DSR Line Item
- Scope ID
- Location
- FOG
- Resource Code
- Resource Hours

Project 1-∞ EC 1-1 Work Order 1-∞ CWP's
1-∞ Tasks

CE.1.050 (D) COST TYPE CODES

To be defined:
- Labour
- Material, Equipement
- Commodity iaw MASTER FORMAT,
- Direct vs Indirect (support services)

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(Appendix B) RQE Cost Estimate Process Details

CE.3.060 ESTIMATE REVIEW PLAN

- Scope and Technical review charter
- Estimate review charter and criteria
- Management review charter
- Key metrics and benchmarks
- Integrated estimate/schedule/risk model
- Assumptions log
- Stakeholder inputs and objectives

- Table top discussion on review charters, goals, objectives
- Review plan template
- Plan document with review and comment cycle

- Draft Review Plan: Bundles
- Draft Review Plan: Snr Management

CE.3.060 (A) REVIEW PLAN TEMPLATE

Review Plan to address, for each type of review, the following

- Review goals
- Background of rationale for review
- Objectives
- Scope of review
- Expected results
- Review Team
- Review schedule and agenda
- Review methodology
- Review package and distribution timing
- Outcome and Deliverables
- Success criteria

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CE.6.080 EPC ESTIMATE REVIEW & VALIDATION

- EPC deliverables schedule
- Scope documentation
- Review criteria
- Estimate deliverable submission
- Estimate quality verifications

- Full or partial check estimate
- Assessment and challenge review
- Detailed estimate comparison
- Estimate review checklist and/or validation plan

- Review and validation reports
- Scope and assumptions validations
- Benchmarking and metrics report
- Assignment of AACE classification to estimate
- Estimate quality report
- Estimate acceptance/rejection

CE.6.080 (A) SAMPLE BENCHMARKING

EXAMPLE ONLY

COST RELATIONSHIP		--- COMPANY HISTORY --- LOW	AVG	HIGH	EST	VAR	INDUSTRY DATA AVG	VAR
TOTAL PROJECT $	/ EQUIPMENT $	2.38	4.97	6.98	**4.77**	-4%	4.86	-2%
TFC $	/ EQUIPMENT $	1.65	3.45	4.79	**3.20**	-7%	3.59	-11%
TOC $	/ EQUIPMENT $	0.51	1.21	1.72	**1.15**	-5%	1.18	-3%
TFL $	/ EQUIPMENT $	1.09	1.99	2.41	**1.80**	-10%	1.89	-5%
PROJ MGMT $	/ TOTAL PROJ $	0.022	0.043	0.065	**0.037**	-14%	0.046	-20%
PROJ MGMT $	/ TFC $	0.009	0.063	0.099	**0.054**	-14%	0.064	-16%
PROJ MGMT $	/ TOC $	0.152	0.233	0.320	**0.210**	-10%	0.212	-1%
PROJ MGMT $	/ EQUIPMENT $	0.190	0.295	0.452	**0.260**	-12%	0.241	8%
ENGR+DESIGN $	/ TOTAL PROJ $	0.122	0.168	0.272	**0.198**	18%	0.189	5%
ENGR+DESIGN $	/ TFC $	0.141	0.243	0.342	**0.291**	22%	0.262	11%
ENGR+DESIGN $	/ TOC $	0.420	0.690	0.880	**0.872**	26%	0.779	12%
ENGR+DESIGN $	/ EQUIPMENT $	0.810	1.020	2.000	**1.173**	15%	1.020	15%
TOC $	/ TOTAL PROJ $	0.162	0.231	0.292	**0.245**	6%	0.229	7%
TOC $	/ TFC $	0.190	0.310	0.550	**0.341**	10%	0.319	7%
TFC $	/ TOTAL PROJ $	0.560	0.710	0.888	**0.682**	-4%	0.783	-13%
TFL $	/ TOTAL PROJ $	0.272	0.362	0.523	**0.341**	-6%	0.362	-6%
TFM $	/ TOTAL PROJ $	0.302	0.481	0.691	**0.419**	-13%	0.419	0%
TFL $	/ TFC $	0.282	0.485	0.590	**0.457**	-6%	0.466	-2%
TFM $	/ TFC $	0.291	0.550	0.817	**0.598**	9%	0.534	12%
TFL $	/ TFM $	0.510	1.125	1.721	**0.902**	-20%	0.980	-8%
EQUIPMENT $	/ TOTAL PROJ $	0.096	0.223	0.572	**0.241**	8%	0.251	-4%
EQUIPMENT $	/ TFC $	0.125	0.304	0.632	**0.334**	10%	0.304	10%
START-UP $	/ TOTAL PROJ $	0.000	0.034	0.158	**0.041**	21%	0.033	24%
START-UP $	/ TFC $	0.000	0.051	0.111	**0.066**	29%	0.047	40%
START-UP $	/ EQUIPMENT $	0.000	0.171	0.362	**0.235**	37%	0.169	39%
CONSTR IFC $	/ TOTAL PROJ $	0.059	0.085	0.110	**0.079**	-7%	0.088	-10%
OWNER COST $	/ TOTAL PROJ $	0.105	0.175	0.219	**0.155**	-11%	0.186	-17%
ENGR+DESIGN HRS	/ EQUIP COUNT	841	990	1287	**1120**	13%	1039	8%
TOT FIELD HRS	/ EQUIP COUNT	3087	4117	4734	**3884**	-6%	4089	-5%
CONCRETE CY	/ EQUIP COUNT	16	20	33	**16**	-20%	22	-27%
PIPING LF	/ EQUIP COUNT	392	474	687	**484**	2%	470	3%
CONCRETE HRS	/ CY CONCRETE	12.1	13.4	19.2	**12.4**	-7%	13.8	-10%
PIPING HRS	/ LF PIPE	2.7	3.2	3.4	**3.3**	3%	3.2	3%
CONCRETE MATL $	/ CY CONCRETE	219	243	306	**224**	-8%	255	-12%
PIPING MATL $	/ LF PIPE	88	103	113	**104**	1%	102	2%

CE.6.080 (B) ESTIMATING VALIDATION METHODS

1. preparation of full or partial check/review estimates for comparison purposes:
   a. prepare an estimate (of an equal or less level of detail or class as original) to the selected scope by using either:
      i. parametric techniques based on historical estimate models,
      ii. reproducing detailed cost estimates on the key cost drivers and using the remaining original estimate for total cost comparison, or
      iii. full bottoms up estimate preparation,
   b. review of background data and conditions,
   c. confirmation estimate parameters and requirements,
   d. evaluation of estimate methodology,
   e. identification and confirmation of all estimate productivity factors used and uncertainties,
   f. comparison of original estimate and check estimate against standardized objective metrics, key performance indicators and/or benchmarks ratios or factors;
2. assessment and challenge review for reasonability:
   a. review all estimate documentation,
   b. conduct estimate briefings and walk-throughs by estimate preparer,
   c. assess and analyze estimate build-ups and methods,
   d. assess and analyze integration with schedule,
   e. assess constructability results (walk-downs, factors applied, and construction means and methods as a basis of the estimate),
   f. assess density of trades persons per estimate location and hours,
   g. assess allowances, assumptions and confirm validity, and
   h. validate completeness of estimate;
3. detailed estimate comparison against standardized objective metrics, key performance indicators and/or benchmarks ratios or factors, including:
   a. project cost relationships with equipment, cost components (PEPC), project phases, FTE's, project directs and indirects,
   b. discipline benchmark comparisons to total direct field costs, total field costs, and total installed costs, and
   c. commodity benchmark comparisons of quantities to costs, unit rates and direct to indirects

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CE.6.080 (B) ESTIMATING VALIDATION SCOPE & APPROACH

Scope		Approach
Project Plans (Estimate, PM, CM, Execution Plans and Change Page)	Documentation that supports the strategy to execute the project and provides a clear understanding of how the project was estimated and scheduled aligned to the execution.	Full documentation review, commenting – internal and client Comment disposition and resolution Approvals (internal & client) Project team, estimating, and SME involvement
Basis Documents and Basis Sheet (Adjustment Items)	Basis provides a full and clear description of how the estimate was prepared and quantified	Full documentation review, commenting – internal and client Comment disposition and resolution Approvals (internal & client) Project team, estimating, and SME involvement
Scope Verified	Full scope of package estimation check per design and required procurement, installation and completion/turnover.	Validate vendor verification process and documentation Conduct sampling of critical items and trace scope from DSR through to lowest element of estimate Document validation results

General

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REV.	DESCRIPTION	DATE
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(Appendix B) RQE Cost Estimate Process Details

CE.6.080 (B) ESTIMATING VALIDATION SCOPE & APPROACH

Scope		Approach
Estimate Summary and Details Estimate line item review	Consistency and summations check Assessment of methodology applied and basis for class of estimate.	Validate vendor review & verification process and documentation. Review vendor's assessment of estimate class achieved and verification of compliance to AACE requirements Identify independent reviews conducted by vendor and documentation Perform spot check of prior revisions to estimate and traceability of changes based on review results Perform spot check of calculations for correctness Document validation results Project Team P&C Lead, Estimating, Construction
Labour Rates	Correct table, application and basis wrt rate changes	Validate vendor verification process of labour rates, basis and application. Obtain labour calculation report that validates discipline total costs Perform check of labour rate tables and application within estimate details Validate correct calculations Document validation results P&C Lead, Estimating
Estimate Coding: Resource/Crew	Coding dictionaries, tables, and application check for correctness & consistency	Obtain and review coding dictionaries Obtain estimate report organized by resource/crew code and review line item details for correct coding – can be done by exception Document validation results P&C Lead, Estimating

Estimate

ONTARIO POWER GENERATION

Document Number:
NK38-PLAN-09701-10235

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(Appendix B) RQE Cost Estimate Process Details

CE.6.080 (B) ESTIMATING VALIDATION SCOPE & APPROACH

Scope		Approach
Crew and Blended Rates	Basis of and correctness of calculation per conditions, shift pattern, make-up and	Obtain and review, for each crew rate, build up and calculations Review vendor's verification process and documented results Spot check rates applied within estimate details Document results P&C Lead, Estimating
Hrs/Qty	Unit rates table, basis, coding, application, and calculation check for correctness & consistency	Obtain vendor's unit rate tables and benchmarking metrics report Review unit rate basis and basis for hours assigned/assessed Confirm approach to assignment of unit rates and hours and consistency Conduct a horizontal review of "like" cost items (critical and non-critical) across project and program, benchmarking to common metrics P&C Lead, Estimating, Construction
Productivity Factors	Factors table, basis, description, justification and scope of application, correct application, calculation (additive vs multiplicative), and consistency	Review factors and any adjustments, basis and guidance on application preparers used Review vendor's verification process and documented results of reviews conducted Review application of factors and calculated results for sampling of each of factors applied on estimate detailed line items Document results P&C Lead, Estimating, Construction
Assumptions, inclusions, exclusions, exceptions and clarifications	Tabulation and reconciliation of project, subcontractor and purchase order items. Disposition of basis items versus assumptions and quantification	Collate all items (assumptions etc.) and review for clarity, duplications/overlaps etc Review vendor's verification and review process of scope vs assumptions etc and identify any areas for improvement Identify items for which quantification is required as allowances for indeterminants Project Team P&C Lead, Estimating, Construction

Estimate

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(Appendix B) RQE Cost Estimate Process Details

CE.6.080 (B) ESTIMATING VALIDATION SCOPE & APPROACH

Scope		Approach	
Cost Categories	Clear description and application of categories for directs, indirects, support services & equipment, PMT. Reconciliation of items that are distributable versus package specific.	Review definitions and details of each cost category Assess application of categories and details within estimate are reasonable and consistent P&C Lead, Estimating	Estimate
Estimate Data Integrity	Entry, flow and transition of data from source to destination (ie spreadsheet to database) integrity.	Obtain vendor verification report and review process plus results Obtain a data variance report Conduct a surveillance of data routines Conduct, as required, data input/out variance analysis Document results P&C Lead, Estimating	Data Integrity
Data access security and configuration/traceability controls	Number of points of data storage, accessibility, security and procedural control.	Review vendor procedures Identify data input routines and user access requirements/restrictions Confirm file security, storage and accessibility Review vendor verification process and change controls P&C Lead, Estimating	
P6 Data Integrity	Entry, flow and transition of data from source to destination (ie estimate to database) integrity.	Obtain vendor verification report and review process plus results Obtain a data variance report Conduct a surveillance of data routines Conduct, as required, data input/out variance analysis Document results P&C Lead, Estimating	

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(Appendix B) RQE Cost Estimate Process Details

CE.6.080 (B) ESTIMATING VALIDATION SCOPE & APPROACH

Scope		Approach	
Data access security and configuration/traceability controls	Number of points of data storage, accessibility, security and procedural control.	Review vendor procedures Identify data input routines and user access requirements/restrictions Confirm file security, storage and accessibility Review vendor verification process and change controls P&C Lead, Estimating	Data Integrity
Estimate data integrated	Resource manhours integrated within estimate and schedule. Total, incremental and peak manpower requirements consistent.	Review vendor verification process of estimate data integration the estimate and schedule Review estimate man-hour and schedule man-hour reports (summary, detail and histograms by discipline and totals) for consistency Identify if inconsistencies exists and document results. P&C Lead, Estimating	Estimate Schedule
Control account & work package structure & coding	Defined WBS elements consistent in estimate structure and schedule	Obtain WBS resports from estimate and schedule source data Review vendor verification process and reviews/results on WBS coding and completeness within source systems Conduct, as required, detailed review of sampling of data across source systems Document results P&C Lead, Estimating, Construction	
Manpower and cashflow histograms	Total field labour histogram and cashflows consistency between estimate and schedule	Obtain manpower and cashflow reports and histograms Review vendor's verification process and reviews/results on consistency between labour cost profiles and man power profiles Project Team, P&C Lead, Estimating, Construction	

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(Appendix B) RQE Cost Estimate Process Details

CE.6.080 (B) ESTIMATING VALIDATION SCOPE & APPROACH

Scope		Approach	
Resource coding, calendars/shifts	Resource and crew codes consistent and application of calendar and shifts aligned between estimate and schedule.	Obtain vendor's verification reports and review/results on man hour totals within estimate and schedule Conduct detailed review, as required, across sampling of work packages within estimate and schedule for consistency in man hour totals Project Team, P&C Lead, Estimating, Construction	Estimate Schedule
Contingency methodology and application	Assess use of range estimating, parametric estimating and/or expected value in contingency determination. Assess application of identified critical cost drivers and risks in range estimating. Assess the variable identified and basis for correlation in parametric estimating. Assess the use of systematic versus project specific risks.	Review risk basis documentation and method of estimating risk values Confirm contingency approach to fixed and variable cost items Document observations P&C Lead, Estimating, Risk Management	Risk
Contingency results and basis	Assess 1. basis for use of and application of variability, probabilities, and ranges, 2. completeness and clarity of documentations, 3. consistency applied, and 4. use of discrete risks, register details and estimation of costs.	Review risk register and assigned values and determine consistency to basis Review cost and schedule P&C Lead, Estimating, Risk Management	
Contingency value integration within estimate	Verify results and documentation incorporated into estimate.	Perform a check of values calculated and reported within cost estimate reports P&C Lead, Estimating, Risk Management	

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(Appendix B) RQE Cost Estimate Process Details

CE.6.090 ESTIMATE REVIEWS & VALIDATIONS: BUNDLES

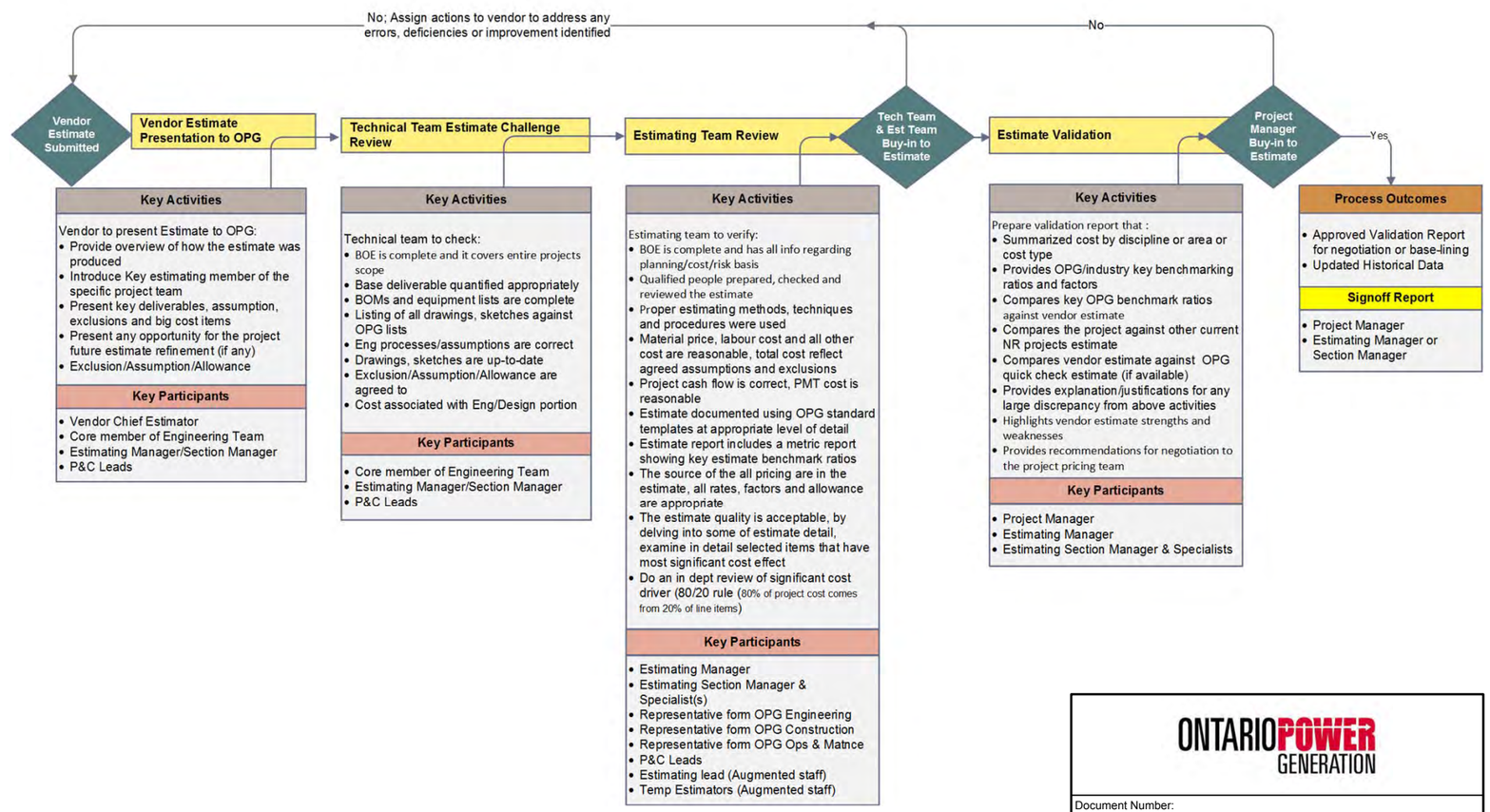
- EPC deliverables schedule
- Scope documentation
- Review criteria
-

- Estimate presentations
- Estimate review checklist and/or validation plan
- Detailed estimate comparison

- Estimate Quality Reports
- Review and validation reports
- Scope and assumptions validations
- Benchmarking and metrics report
- Assignment of AACE classification to estimate
- Estimate report sign-offs

CE.6.090 (A) ESTIMATING REVIEW & VALIDATION FRAMEWORK

Vendor Estimate Validation/Review Process



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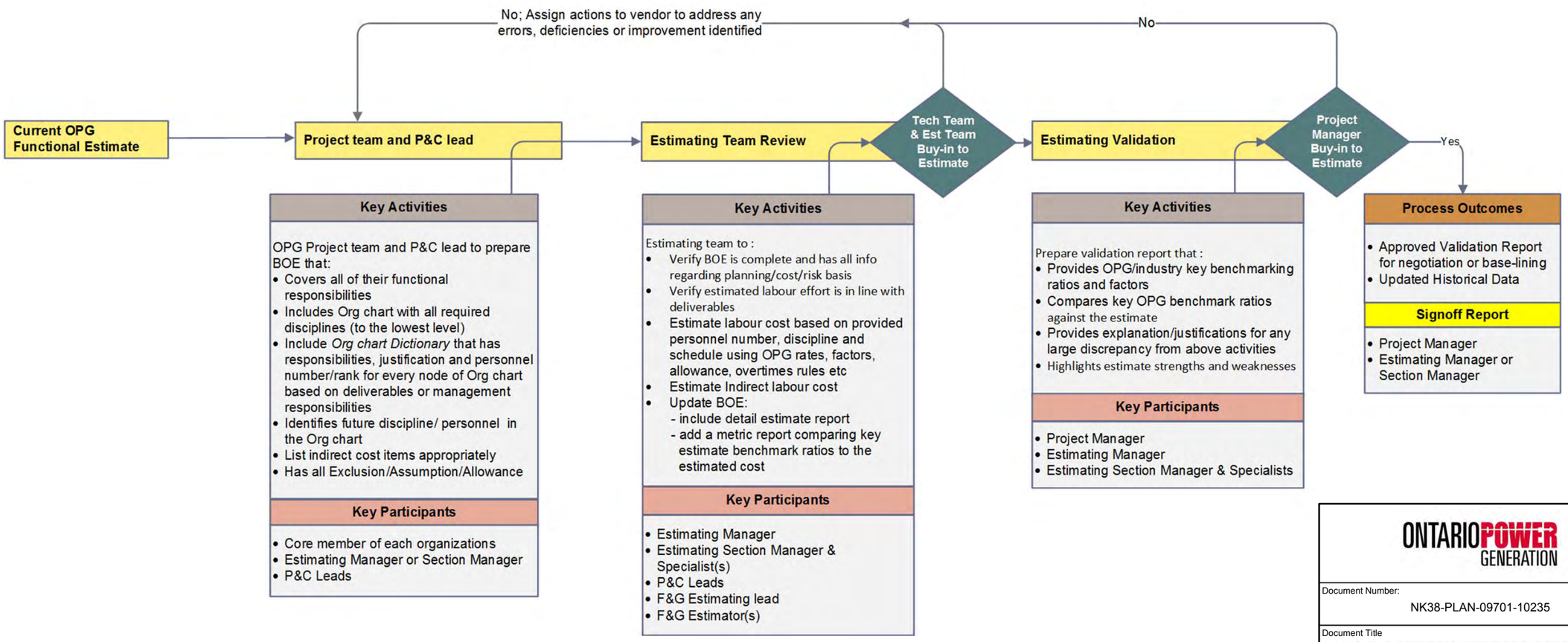
(Appendix B) RQE Cost Estimate Process Details

CE.6.090 (B) ESTIMATING REVIEW & VALIDATION FRAMEWORK: FUNCTIONS

OPG Functional Cost Estimate Review Process



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Document Number:		
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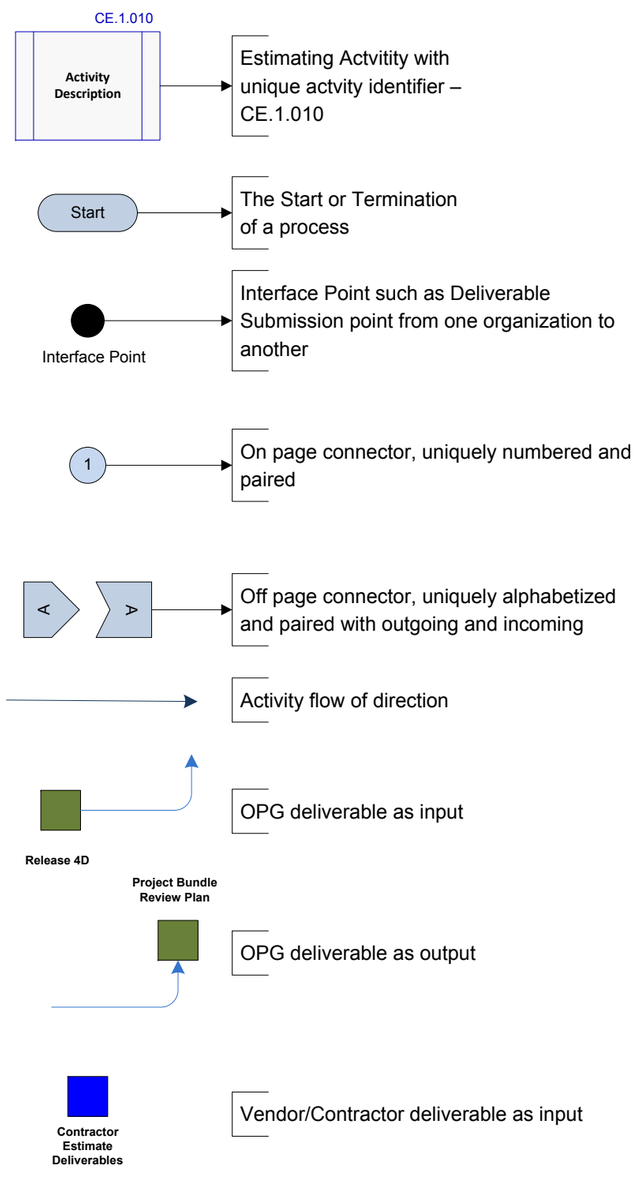
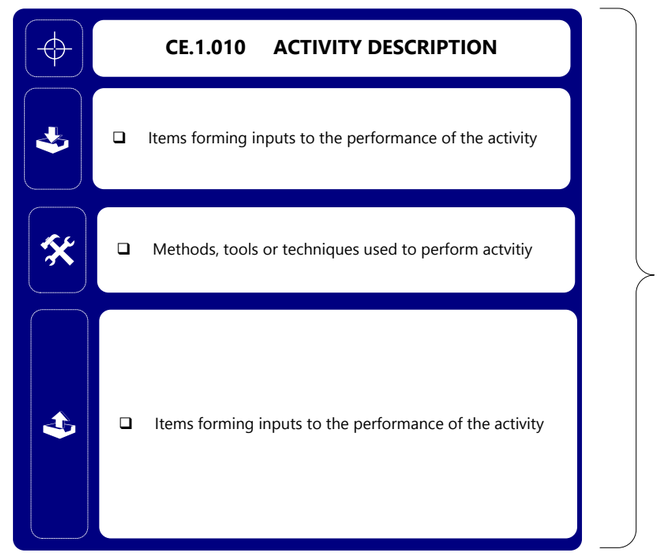
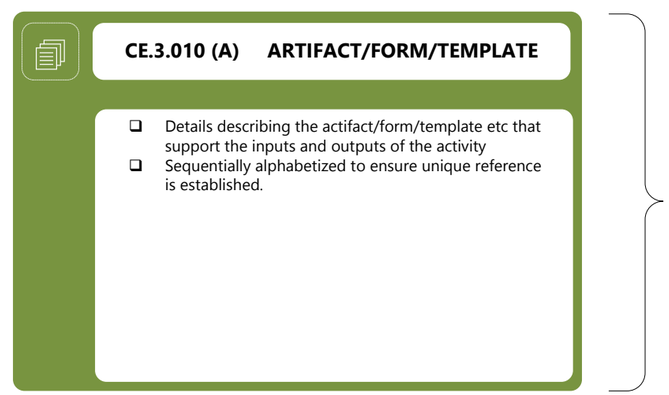
(Appendix C) RQE Cost Estimate Process Legend Page

Appendix A and B (RQE Cost Estimate Process and Details) Legend Page:

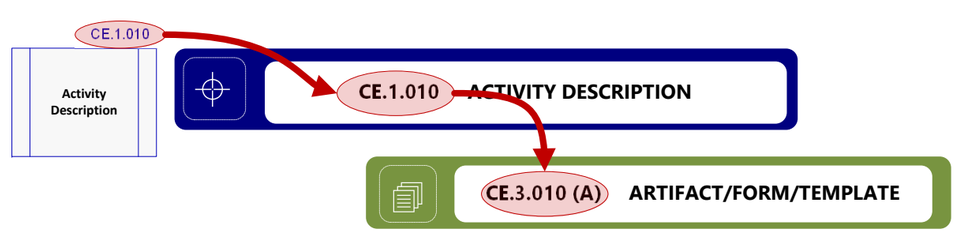




This blue box provides the details of the activity within the process map. The reference to the activity ID and description is provided to ensure that it can be uniquely referenced.



This green box provides the details of the activity inputs or outputs. Each box is sequentially alphabetized with activity ID to ensure unique reference is established.



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November 24, 2015

Mr. Roy Brown
Senior Director,
Retube and Feeder Replacement
Darlington Nuclear Refurbishment
Ontario Power Generation
1855 Energy Drive, Courtice, ON L1E 0E7

Mr. Brian Savage
Project Director,
Retube and Feeder Replacement
SLN-Aecon J.V.
2275 Upper Middle Road East
Oakville, ON L6H 0C3

Dear Mssrs. Brown and Savage:

This letter is sent on behalf of the Third Party Expert Panel (the Panel), commissioned by Ontario Power Generation (OPG) to review the AACE Class 2 Estimate prepared by the SNC-Lavalin AECON Joint Venture (JV) for the Execution Phase of the Darlington Nuclear Generating Station Retube and Feeder Replacement (RFR) Project.

The Panel has completed its independent review of the Class 2 Estimate products, as submitted by the JV and reviewed by OPG and has prepared the attached final report. The Panel unanimously concludes, within our expertise, the JV's submission of R1 of the Class 2 Estimate for their scope of the Darlington RFR Project fully meets the AACE requirements for a Class 2 Estimate,

Submitting our final report completes our planned scope of work according to the agreed Terms of Reference. We can be available to meet or present on our findings if requested. If you have any questions or concerns related to the content of the report or the findings of the Panel, please do not hesitate to contact the undersigned or the most appropriate panel member.

Sincerely yours,

William (Bill) Pilkington
Darlington RFR Third Party Expert Panel

cc: M. Burke
J. Higgs
J. Hopkins

ONTARIO POWER GENERATION

NK38-CORR-09701-0575487

December 10, 2015 **CONFIDENTIAL & COMMERCIALLY SENSITIVE**

PO: 213497

SNC-Lavalin Nuclear Inc.
2275 Upper Middle Road East
Oakville, Ontario L6H 0C3

Attention: Brian Savage
Project Director

Aecon Construction Group Inc.
150 Sheldon Drive
Cambridge, Ontario N1R 7K9

Attention: Aaron Johnson
Deputy Project Director

Dear Sirs:

Re: Engineering, Procurement and Construction Agreement for the Darlington Refurbishment Retube and Feeder Replacement Project (the "RFR Project") between OPG and the contractual joint venture of SNC-Lavalin Nuclear Inc. and Aecon Construction Group Inc. (together, the "Joint Venture") dated as of March 1, 2012 (the "Agreement")

Early Performance of Preapproved Execution Phase Work

Letter re. Execution Phase Amendment of November 09, 2015 (the "November 9th Letter")

Further to the November 9th Letter, a copy of which is attached to this letter for your reference, OPG hereby directs the Joint Venture to commence a preapproved portion of the Execution Phase Work, as set out below, required to support the Execution Phase Target Schedule agreed to by the Parties (the "**Early Works**"). Capitalized terms used but not defined in this letter will have the meanings given to them in the Agreement.

The preapproved Early Works are described in Exhibit 1 attached to this letter, and the scope of such Early Works will not be increased, decreased or varied without the prior written consent of OPG.

The Joint Venture will commence the Early Works on or following December 15, 2015. The Joint Venture will not perform any Early Works after March 31, 2016. The Joint Venture will perform the Early Works as "Work" under and in accordance with the terms and conditions of the Agreement. Any Owner-Specified Materials or Goods that the Joint Venture is authorized by this letter to procure as part of the Early Works will similarly be procured in accordance with the terms and conditions of the Agreement.

The Joint Venture will invoice OPG and OPG will pay the Joint Venture for any Reimbursable Costs due and payable to the Joint Venture for the performance of the Early Works in accordance with the payment provisions set out in the Agreement. The Joint Venture will also invoice OPG and OPG will pay the Joint Venture for the portion of the Fixed Fee that is payable for the Early Works milestones achieved in accordance with the payment provisions set out in the Agreement and Exhibit 2 attached to this letter. Any Owner-Specified Materials or Goods that the Joint Venture is authorized by this letter to procure as part of the Early Works will similarly be invoiced by the Joint Venture and paid for by OPG in accordance with the payment provisions set out in the Agreement. The aggregate value of the authorized Early Works, including any authorized Owner-Specified Materials and Goods, will in no event exceed $21,645,318 without the prior written consent of OPG.

In the event that OPG delivers the Execution Phase Work Notice to Proceed to the Joint Venture as contemplated by section 2.13(c) of the Agreement, the Early Works will automatically be deemed to be part of the Execution Phase Work for all purposes under the Agreement.

If, however, OPG does not deliver the Execution Phase Work Notice to Proceed to the Joint Venture, the Early Works will be deemed to be part of the Definition Phase Work for all purposes under the Agreement without further requirement for a separate Project Change Directive or Amendment, except that any Reimbursable Costs due and payable to the Joint Venture for the performance of the Early Works will not be added to the Definition Phase Target Cost or considered for purposes of determining Definition Phase Reimbursable Cost incentives under section 8.1(b)(2) of the Agreement or Definition Phase Reimbursable Cost disincentives under section 8.1(c)(2) of the Agreement.

In addition, if OPG does not deliver the Execution Phase Work Notice to Proceed to the Joint Venture and directs the Joint Venture to cancel the Early Works prior to March 31, 2015, the Joint Venture will invoice OPG for and OPG will pay in accordance with the Agreement any undisputed amounts owing in respect of: (i) all portions of the Early Works performed in accordance with the terms of the Agreement and this letter on or prior to the date set out in OPG's cancellation notice; and (ii) an equitable portion of the Fixed Fee that would otherwise have been paid to the Joint Venture on the next-following milestone payment date identified in Exhibit 2.

Please sign and return a copy of this letter to OPG to acknowledge your agreement with the above direction.

Yours truly,

ONTARIO POWER GENERATION INC.

Roy Brown
Senior Director Projects

Agreed on this 14th day of December 2015, by:

SNC-LAVALIN NUCLEAR INC.

By:
Name: Brian Savage
Title: Project Director

AECON CONSTRUCTION GROUP INC.

By:
Name: Aaron Johnson
Title: Deputy Project Director

Encl:
- Copy of the November 9th Letter;
- Exhibit 1 (Description and Schedule of Early Works);
- Exhibit 2 (Milestone Payment Schedule for Early Works).

Cc: Mike Allen, VP, Refurbishment
Meg Timberg, VP, Refurbishment Contract Management
Phil Reinert, VP, Supply Services, OPG Projects
Nicole Fabbro, Sr. Manager, Supply Services
David Fennell, Sr. Procurement Specialist
Bill Donovan, Sr. Specialist Strategic Planning
Leo Saagi, Director Finance
Cam MacLeod, Manager, Strategic Contract Management
Evguenia Prokopieva, Sr. Counsel and Director, Law Division/Refurbishment

EXHIBIT 1

Description and Schedule of Early Works

Early Works will comprise all Work activities identified in the attached schedule required to be performed prior to March 31, 2016. For clarity, Early Works will not include any Work scheduled beyond March 31, 2016 or any Work not included in the Work activities identified in the attached schedule.

For more information on the list of the Early Work activities and the Early Work activities' schedule see the Early Work schedule attached below.

Activity ID	Activity Name	Original Duration	Start	Finish
DNG-RFR-L5U2-15	**509407-RFR Level 5 Execution Schedule Unit 2 Rev 0**	1413.00	31-Dec-15	12-Nov-19
DNG-RFR-L5U2-15.73113	**Unit 2 (73113)**	1413.00	31-Dec-15	12-Nov-19
DNG-RFR-L5U2-15.73113.00	**Project Milestones**	90.00	31-Dec-15	30-Mar-16
DNG-RFR-L5U2-15.73113.00.01	**Execution Phase Milestones**	60.00	30-Jan-16	30-Mar-16
73113MS1005	Unit 2 - Execution Phase Schedule Integration	0.00		30-Jan-16*
73113MS1010	Unit 2 - Detailed Execution Phase Target Schedule	0.00		28-Feb-16*
73113MS1015	Unit 2 - Execution Phase Project Management Plans	0.00		30-Mar-16*
DNG-RFR-L5U2-15.73113.00.03	**Submittal Milestones**	90.00	31-Dec-15	30-Mar-16
73113MS3000	Uniit 2 - Execution Phase Schedule Integration Plans Submitted	0.00		31-Dec-15*
73113MS3005	Uniit 2 - Detailed Execution Phase Target Schedule Submitted	0.00		29-Jan-16*
73113MS3010	Uniit 2 - Execution Phase Project Management Plans Submitted	0.00		30-Mar-16*
DNG-RFR-L5U2-15.73113.1	**Unit 2 Project Management**	1412.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.01	**Unit 2 - Project Management Team**	1412.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.01.01	**Project Management Senior Team**	969.00	04-Jan-16	12-Nov-19
73113PMT05	Project Management Senior Team	969.00	04-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.01.02	**Business Services Team**	969.00	04-Jan-16	12-Nov-19
73113PMT07	Business Services Team	969.00	04-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.01.03	**Construction Management Team**	1412.00	01-Jan-16	12-Nov-19
73113PMT09	Construction Management Team	1412.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.02	**Unit 2 - Project Controls and Related Expenses**	969.00	04-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.02.01	**Project Controls Team**	969.00	04-Jan-16	12-Nov-19
73113PMT13	Project Controls Team	969.00	04-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.03	**Unit 2 - Quality Assurance and Health and Safety**	1412.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.03.01	**Quality Assurance and Quality Surveillance**	969.00	04-Jan-16	12-Nov-19
73113PMT15	Quality Assurance and Quality Surveillance	969.00	04-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.03.03	**Health and Safety team**	1412.00	01-Jan-16	12-Nov-19
73113PMT17	Health and Safety team	1412.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.04	**Unit 2 - HR and Training Management**	1411.50	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.04.01	**Human Resources Team**	969.00	04-Jan-16	12-Nov-19
73113PMT19	Human Resources Team	969.00	04-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.1.04.02	**Training Management Team**	706.00	01-Jan-16	12-Nov-19
73113PMT21	Training Management Team	706.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.3	**Unit 2 Engineering**	706.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.3.06	**Unit 2 Engineering - Plant Team**	706.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U2-15.73113.3.06.1	**Unit 2 Plant Engineering Team**	706.00	01-Jan-16	12-Nov-19
73113PMT23	Unit 2 Plant Engineering Team	706.00	01-Jan-16	12-Nov-19
DNG-RFR-L5U3-11	**509407-RFR Level 5 Execution Schedule Unit 3 Rev 0**	1368.50	21-Jun-15 A	13-May-19
DNG-RFR-L5U3-11.73115	**Unit 3 (73115)**	1368.50	21-Jun-1	13-May-19
DNG-RFR-L5U3-11.73115.00	**Project Milestones**	0.00	01-Feb-16	01-Feb-16
73115MS160	Unit 3 Start Engineering Packages	0.00	01-Feb-1	
DNG-RFR-L5U3-11.73115.1	**Unit 3 Project Management**	861.00	01-Dec-15	13-May-19
DNG-RFR-L5U3-11.73115.1.01	**Project Management Senior Team**	861.00	01-Dec-15	13-May-19
DNG-RFR-L5U3-11.73115.1.01.02	**Business Services Team**	861.00	01-Dec-15	13-May-19
73115PC005	Unit 3 -Unit 3 Procurement Subsequent Units	861.00	01-Dec-15	13-May-19
DNG-RFR-L5U3-11.73115.1.03	**Quality Assurance and Quality Surveillance**	861.00	01-Dec-15	13-May-19
DNG-RFR-L5U3-11.73115.1.03.01	**Quality Assurance and Quality Surveillance**	861.00	01-Dec-15	13-May-19
73115QA000	Unit 3 Quality Assurance and Quality Surveillance Subsequent Units	861.00	01-Dec-15	13-May-19

SNC·LAVALIN Nuclear AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort | Critical Remaining Work
Actual Work | ◆ Milestone
Remaining Work

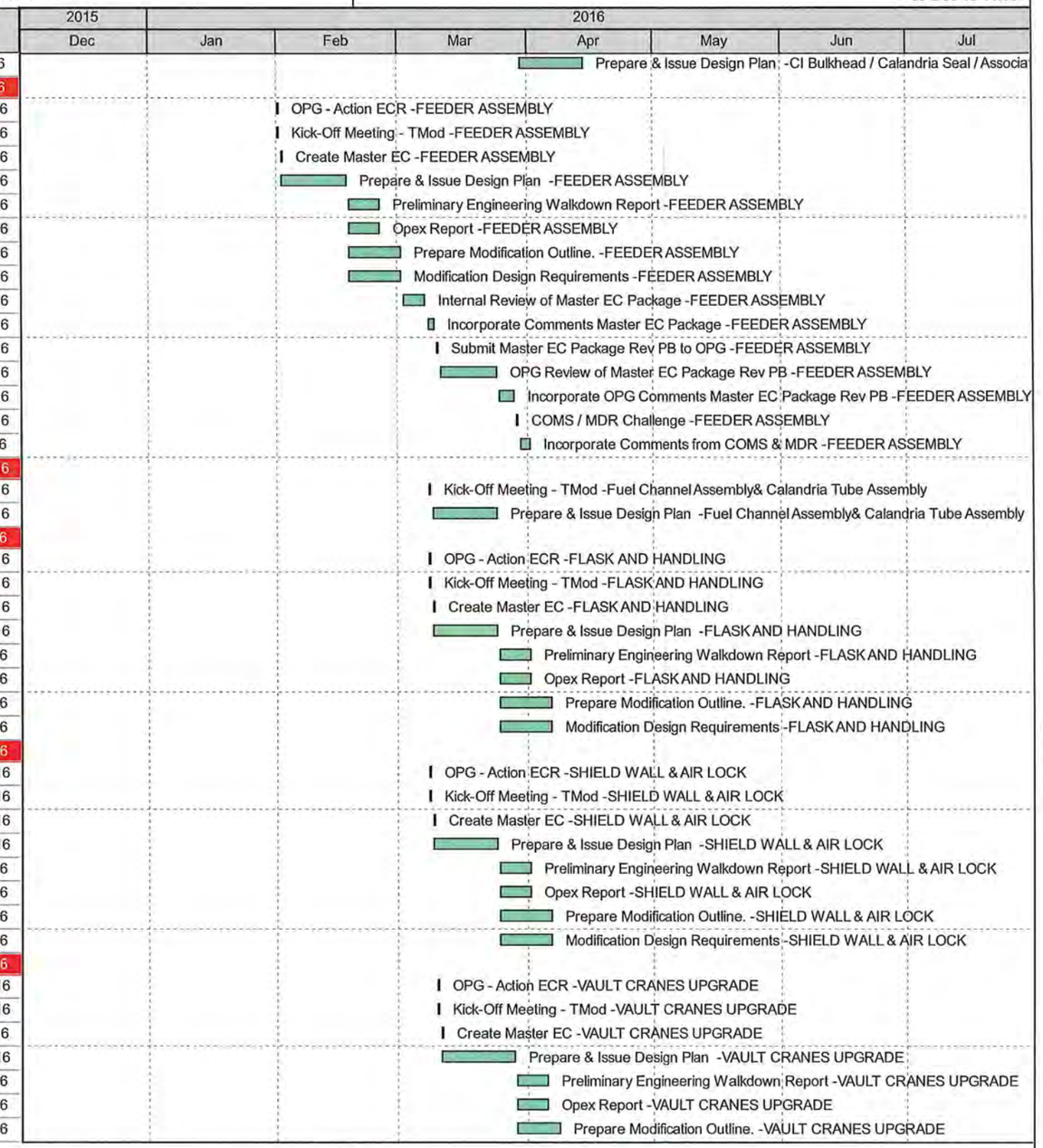
Activity ID	Activity Name	Original Duration	Start	Finish
DNG-RFR-L5U3-11.73115.3	Unit 3 Engineering	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U3-11.73115.3.03	Unit 3 Engineering Preliminary Design MEC Packages	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U3-11.73115.3.03.02	MEC 117317 MECH. Fuel Channel Drain Path	49.10	01-Feb-16	08-Apr-16
73115DD1002	OPG - Action ECR -Fuel Channel Drain Path	1.00	01-Feb-16	01-Feb-16
73115DD1004	Kick-Off Meeting - TMod -Fuel Channel Drain Path	1.00	01-Feb-16	01-Feb-16
73115DD1012	Create Master EC -Fuel Channel Drain Path	1.00	02-Feb-16	02-Feb-16
73115DD1020	Prepare & Issue Design Plan -Fuel Channel Drain Path	12.00	02-Feb-16	17-Feb-16
73115DD1032	Preliminary Engineering Walkdown Report -Fuel Channel Drain Path	6.00	18-Feb-16	25-Feb-16
73115DD1034	Opex Report -Fuel Channel Drain Path	6.00	18-Feb-16	25-Feb-16
73115DD1044	Prepare Modification Outline. -Fuel Channel Drain Path	9.00	18-Feb-16	01-Mar-16
73115DD1046	Modification Design Requirements -Fuel Channel Drain Path	9.00	18-Feb-16	01-Mar-16
73115DD1056	Internal Review of Master EC Package -Fuel Channel Drain Path	4.00	02-Mar-16	07-Mar-16
73115DD1094	Incorporate Comments Master EC Package -Fuel Channel Drain Path	3.10	08-Mar-16	11-Mar-16
73115DD1100	Submit Master EC Package Rev PB to OPG -Fuel Channel Drain Path	1.00	11-Mar-16	14-Mar-16
73115DD1112	OPG Review of Master EC Package Rev PB -Fuel Channel Drain Path	6.00	14-Mar-16	22-Mar-16
73115DD1116	Incorporate OPG Comments Master EC Package Rev PB -Fuel Channel Drain	2.00	22-Mar-16	24-Mar-16
73115DD1132	COMS / MDR Challenge -Fuel Channel Drain Path	1.00	24-Mar-16	25-Mar-16
73115DD1160	Incorporate Comments from COMS & MDR -Fuel Channel Drain Path	3.00	25-Mar-16	30-Mar-16
73115DD1168	Submit Master EC Package Rev 0 & COMS Report -Fuel Channel Drain Path	1.00	30-Mar-16	31-Mar-16
73115DD1220	OPG Review of Master EC Package Rev 0 & COMS Report -Fuel Channel Dra	6.00	31-Mar-16	08-Apr-16
DNG-RFR-L5U3-11.73115.3.03.18	MEC 118506 CIVIL Retube Tooling Platform Installation	22.00	08-Mar-16	06-Apr-16
73115DD1072	OPG - Action ECR -RETUBE PLATFORM & JIB CRANE	1.00	08-Mar-16	08-Mar-16
73115DD1074	Kick-Off Meeting - TMod -RETUBE PLATFORM & JIB CRANE	1.00	08-Mar-16	08-Mar-16
73115DD1082	Create Master EC -RETUBE PLATFORM & JIB CRANE	1.00	09-Mar-16	09-Mar-16
73115DD1126	Prepare & Issue Design Plan -RETUBE PLATFORM & JIB CRANE	12.00	09-Mar-16	24-Mar-16
73115DD1188	Preliminary Engineering Walkdown Report -RETUBE PLATFORM & JIB CRAN	6.00	25-Mar-16	01-Apr-16
73115DD1190	Opex Report -RETUBE PLATFORM & JIB CRANE	6.00	25-Mar-16	01-Apr-16
73115DD1212	Prepare Modification Outline. -RETUBE PLATFORM & JIB CRANE	9.00	25-Mar-16	06-Apr-16
73115DD1214	Modification Design Requirements -RETUBE PLATFORM & JIB CRANE	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U3-11.73115.3.03.03	MEC 118671 ELECTRICAL Vault Temp. Power Distr. & Penetr. N	35.00	18-Feb-16	06-Apr-16
73115DD1024	OPG - Action ECR -VAULT TEMPORARY POWER DISTRIBUTION & PENETF	1.00	18-Feb-16	18-Feb-16
73115DD1026	Kick-Off Meeting - TMod -VAULT TEMPORARY POWER DISTRIBUTION & PE	1.00	18-Feb-16	18-Feb-16
73115DD1030	Create Master EC -VAULT TEMPORARY POWER DISTRIBUTION & PENETF	1.00	19-Feb-16	19-Feb-16
73115DD1058	Prepare & Issue Design Plan -VAULT TEMPORARY POWER DISTRIBUTION	12.00	19-Feb-16	07-Mar-16
73115DD1102	Preliminary Engineering Walkdown Report -VAULT TEMPORARY POWER DIS	6.00	08-Mar-16	15-Mar-16
73115DD1104	Opex Report -VAULT TEMPORARY POWER DISTRIBUTION & PENETRATIC	6.00	08-Mar-16	15-Mar-16
73115DD1106	Prepare Modification Outline. -VAULT TEMPORARY POWER DISTRIBUTION	9.00	08-Mar-16	18-Mar-16
73115DD1108	Modification Design Requirements -VAULT TEMPORARY POWER DISTRIBUT	9.00	08-Mar-16	18-Mar-16
73115DD1118	Internal Review of Master EC Package -VAULT TEMPORARY POWER DISTR	4.00	21-Mar-16	24-Mar-16
73115DD1138	Incorporate Comments Master EC Package -VAULT TEMPORARY POWER DI	2.00	25-Mar-16	28-Mar-16
73115DD1146	Submit Master EC Package Rev PB to OPG -VAULT TEMPORARY POWER DI	1.00	29-Mar-16	29-Mar-16
73115DD1202	OPG Review of Master EC Package Rev PB -VAULT TEMPORARY POWER D	6.00	30-Mar-16	06-Apr-16
DNG-RFR-L5U3-11.73115.3.03.07	MEC 118769 MECH Containment Isolations	13.00	29-Mar-16	14-Apr-16
73115DD1148	OPG - Action ECR -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	29-Mar-16	29-Mar-16
73115DD1150	Kick-Off Meeting - TMod -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	29-Mar-16	29-Mar-16
73115DD1162	Create Master EC -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	30-Mar-16	30-Mar-16

SNC·LAVALIN Nuclear AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort | Critical Remaining Work
Actual Work | ◆ Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
73115DD1248	Prepare & Issue Design Plan -CI Bulkhead / Calandria Seal / Associated Isolati	12.00	30-Mar-16	14-Apr-16
DNG-RFR-L5U3-11.73115.3.03.20 MEC 118770 MECH.OSM Feeder Assembly		45.00	01-Feb-16	01-Apr-16
73115DD1006	OPG - Action ECR -FEEDER ASSEMBLY	1.00	01-Feb-16	01-Feb-16
73115DD1008	Kick-Off Meeting - TMod -FEEDER ASSEMBLY	1.00	01-Feb-16	01-Feb-16
73115DD1014	Create Master EC -FEEDER ASSEMBLY	1.00	02-Feb-16	02-Feb-16
73115DD1022	Prepare & Issue Design Plan -FEEDER ASSEMBLY	12.00	02-Feb-16	17-Feb-16
73115DD1036	Preliminary Engineering Walkdown Report -FEEDER ASSEMBLY	6.00	18-Feb-16	25-Feb-16
73115DD1038	Opex Report -FEEDER ASSEMBLY	6.00	18-Feb-16	25-Feb-16
73115DD1048	Prepare Modification Outline. -FEEDER ASSEMBLY	9.00	18-Feb-16	01-Mar-16
73115DD1050	Modification Design Requirements -FEEDER ASSEMBLY	9.00	18-Feb-16	01-Mar-16
73115DD1060	Internal Review of Master EC Package -FEEDER ASSEMBLY	4.00	02-Mar-16	07-Mar-16
73115DD1084	Incorporate Comments Master EC Package -FEEDER ASSEMBLY	2.00	08-Mar-16	09-Mar-16
73115DD1090	Submit Master EC Package Rev PB to OPG -FEEDER ASSEMBLY	1.00	10-Mar-16	10-Mar-16
73115DD1128	OPG Review of Master EC Package Rev PB -FEEDER ASSEMBLY	10.00	11-Mar-16	24-Mar-16
73115DD1142	Incorporate OPG Comments Master EC Package Rev PB -FEEDER ASSEMBL	2.00	25-Mar-16	28-Mar-16
73115DD1156	COMS / MDR Challenge -FEEDER ASSEMBLY	1.00	29-Mar-16	29-Mar-16
73115DD1194	Incorporate Comments from COMS & MDR -FEEDER ASSEMBLY	3.00	30-Mar-16	01-Apr-16
DNG-RFR-L5U3-11.73115.3.03.08 MEC 118771 MECH.OSM - FC/CT Assembly		13.00	08-Mar-16	24-Mar-16
73115DD1062	Kick-Off Meeting - TMod -Fuel Channel Assembly& Calandria Tube Assembly	1.00	08-Mar-16	08-Mar-16
73115DD1120	Prepare & Issue Design Plan -Fuel Channel Assembly& Calandria Tube Assem	12.00	09-Mar-16	24-Mar-16
DNG-RFR-L5U3-11.73115.3.03.09 MEC 119178 CIVIL Flask and Handling		22.00	08-Mar-16	06-Apr-16
73115DD1064	OPG - Action ECR -FLASK AND HANDLING	1.00	08-Mar-16	08-Mar-16
73115DD1066	Kick-Off Meeting - TMod -FLASK AND HANDLING	1.00	08-Mar-16	08-Mar-16
73115DD1078	Create Master EC -FLASK AND HANDLING	1.00	09-Mar-16	09-Mar-16
73115DD1122	Prepare & Issue Design Plan -FLASK AND HANDLING	12.00	09-Mar-16	24-Mar-16
73115DD1178	Preliminary Engineering Walkdown Report -FLASK AND HANDLING	6.00	25-Mar-16	01-Apr-16
73115DD1180	Opex Report -FLASK AND HANDLING	6.00	25-Mar-16	01-Apr-16
73115DD1204	Prepare Modification Outline. -FLASK AND HANDLING	9.00	25-Mar-16	06-Apr-16
73115DD1206	Modification Design Requirements -FLASK AND HANDLING	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U3-11.73115.3.03.10 MEC 120544 CIVIL Floor Reinforcement & Shield Wall Mods		22.00	08-Mar-16	06-Apr-16
73115DD1068	OPG - Action ECR -SHIELD WALL & AIR LOCK	1.00	08-Mar-16	08-Mar-16
73115DD1070	Kick-Off Meeting - TMod -SHIELD WALL & AIR LOCK	1.00	08-Mar-16	08-Mar-16
73115DD1080	Create Master EC -SHIELD WALL & AIR LOCK	1.00	09-Mar-16	09-Mar-16
73115DD1124	Prepare & Issue Design Plan -SHIELD WALL & AIR LOCK	12.00	09-Mar-16	24-Mar-16
73115DD1182	Preliminary Engineering Walkdown Report -SHIELD WALL & AIR LOCK	6.00	25-Mar-16	01-Apr-16
73115DD1184	Opex Report -SHIELD WALL & AIR LOCK	6.00	25-Mar-16	01-Apr-16
73115DD1208	Prepare Modification Outline. -SHIELD WALL & AIR LOCK	9.00	25-Mar-16	06-Apr-16
73115DD1210	Modification Design Requirements -SHIELD WALL & AIR LOCK	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U3-11.73115.3.03.11 MEC 120850 ELECTR. Containment Vault Cranes Upgrade		22.00	10-Mar-16	08-Apr-16
73115DD1086	OPG - Action ECR -VAULT CRANES UPGRADE	1.00	10-Mar-16	10-Mar-16
73115DD1088	Kick-Off Meeting - TMod -VAULT CRANES UPGRADE	1.00	10-Mar-16	10-Mar-16
73115DD1096	Create Master EC -VAULT CRANES UPGRADE	1.00	11-Mar-16	11-Mar-16
73115DD1140	Prepare & Issue Design Plan -VAULT CRANES UPGRADE	12.00	11-Mar-16	28-Mar-16
73115DD1198	Preliminary Engineering Walkdown Report -VAULT CRANES UPGRADE	6.00	29-Mar-16	05-Apr-16
73115DD1200	Opex Report -VAULT CRANES UPGRADE	6.00	29-Mar-16	05-Apr-16
73115DD1226	Prepare Modification Outline. -VAULT CRANES UPGRADE	9.00	29-Mar-16	08-Apr-16

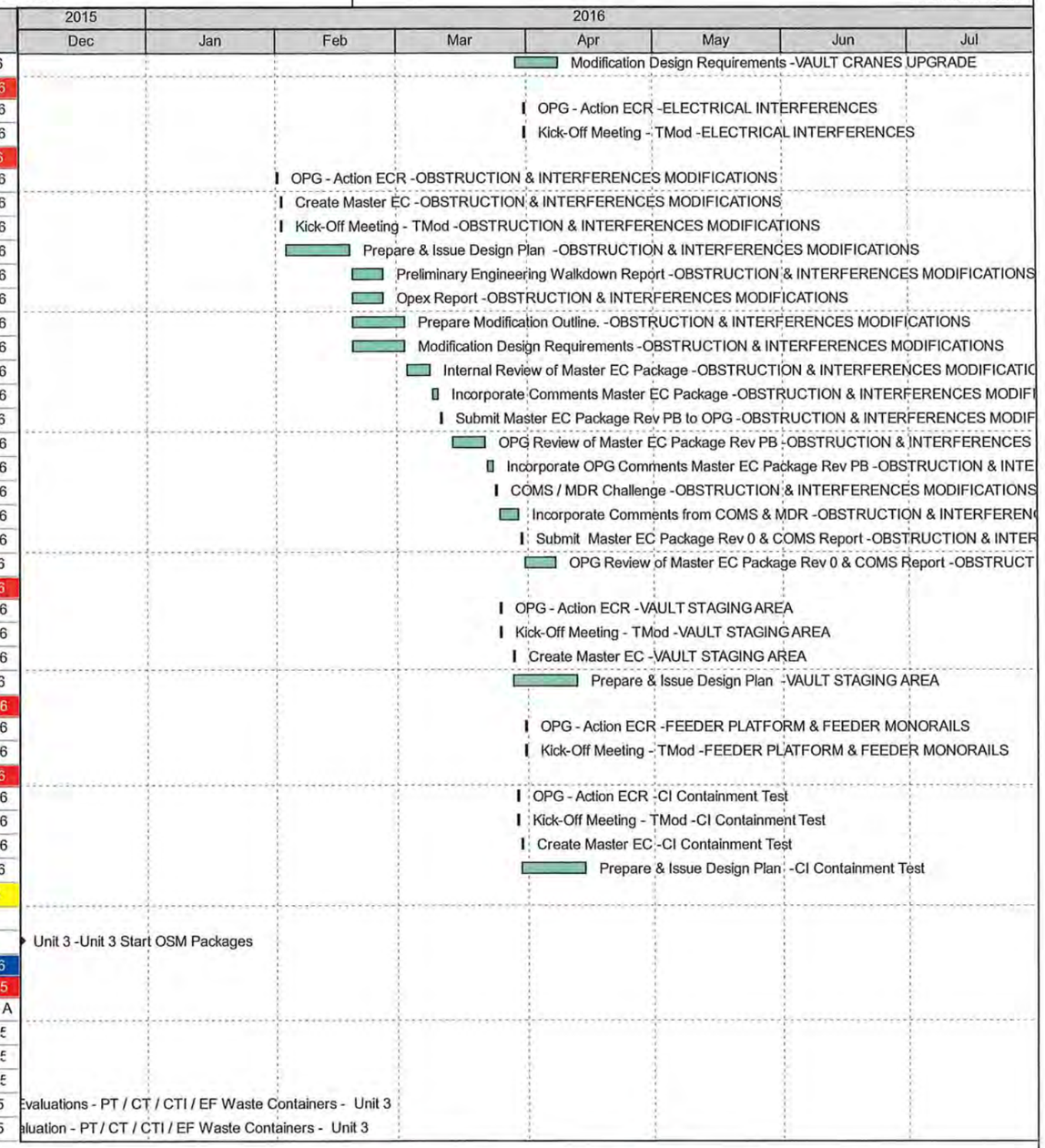


SNC·LAVALIN Nuclear
AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Critical Remaining Work
Actual Work
Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
73115DD1228	Modification Design Requirements -VAULT CRANES UPGRADE	9.00	29-Mar-16	08-Apr-16
DNG-RFR-L5U3-11.73115.3.03.12 MEC 121054 ELECTR. Electrical Interferences and Services		1.00	31-Mar-16	31-Mar-16
73115DD1170	OPG - Action ECR -ELECTRICAL INTERFERENCES	1.00	31-Mar-16	31-Mar-16
73115DD1172	Kick-Off Meeting - TMod -ELECTRICAL INTERFERENCES	1.00	31-Mar-16	31-Mar-16
DNG-RFR-L5U3-11.73115.3.03.13 MEC 121123 MECH Mech. Services		49.00	01-Feb-16	07-Apr-16
73115DD1010	OPG - Action ECR -OBSTRUCTION & INTERFERENCES MODIFICATIONS	1.00	01-Feb-16	01-Feb-16
73115DD1016	Create Master EC -OBSTRUCTION & INTERFERENCES MODIFICATIONS	1.00	02-Feb-16	02-Feb-16
73115DD1018	Kick-Off Meeting - TMod -OBSTRUCTION & INTERFERENCES MODIFICATI(	1.00	02-Feb-16	02-Feb-16
73115DD1028	Prepare & Issue Design Plan -OBSTRUCTION & INTERFERENCES MODIFI(	12.00	03-Feb-16	18-Feb-16
73115DD1040	Preliminary Engineering Walkdown Report -OBSTRUCTION & INTERFEREN(	6.00	19-Feb-16	26-Feb-16
73115DD1042	Opex Report -OBSTRUCTION & INTERFERENCES MODIFICATIONS	6.00	19-Feb-16	26-Feb-16
73115DD1052	Prepare Modification Outline. -OBSTRUCTION & INTERFERENCES MODIFIC	9.00	19-Feb-16	02-Mar-16
73115DD1054	Modification Design Requirements -OBSTRUCTION & INTERFERENCES MOI	9.00	19-Feb-16	02-Mar-16
73115DD1076	Internal Review of Master EC Package -OBSTRUCTION & INTERFERENCES	4.00	03-Mar-16	08-Mar-16
73115DD1092	Incorporate Comments Master EC Package -OBSTRUCTION & INTERFEREN	2.00	09-Mar-16	10-Mar-16
73115DD1098	Submit Master EC Package Rev PB to OPG -OBSTRUCTION & INTERFEREN	1.00	11-Mar-16	11-Mar-16
73115DD1110	OPG Review of Master EC Package Rev PB -OBSTRUCTION & INTERFEREN	6.00	14-Mar-16	21-Mar-16
73115DD1114	Incorporate OPG Comments Master EC Package Rev PB -OBSTRUCTION & I	2.00	22-Mar-16	23-Mar-16
73115DD1130	COMS / MDR Challenge -OBSTRUCTION & INTERFERENCES MODIFICATI(	1.00	24-Mar-16	24-Mar-16
73115DD1158	Incorporate Comments from COMS & MDR -OBSTRUCTION & INTERFEREN	3.00	25-Mar-16	29-Mar-16
73115DD1166	Submit Master EC Package Rev 0 & COMS Report -OBSTRUCTION & INTEF	1.00	30-Mar-16	30-Mar-16
73115DD1216	OPG Review of Master EC Package Rev 0 & COMS Report -OBSTRUCTION &	6.00	31-Mar-16	07-Apr-16
DNG-RFR-L5U3-11.73115.3.03.14 MEC 121200 MECH Staging and Storage Areas		13.00	25-Mar-16	12-Apr-16
73115DD1134	OPG - Action ECR -VAULT STAGING AREA	1.00	25-Mar-16	25-Mar-16
73115DD1136	Kick-Off Meeting - TMod -VAULT STAGING AREA	1.00	25-Mar-16	25-Mar-16
73115DD1144	Create Master EC -VAULT STAGING AREA	1.00	28-Mar-16	28-Mar-16
73115DD1244	Prepare & Issue Design Plan -VAULT STAGING AREA	12.00	28-Mar-16	12-Apr-16
DNG-RFR-L5U3-11.73115.3.03.19 MEC 121205 CIVIL Feeder Platform & Monorails		1.00	31-Mar-16	31-Mar-16
73115DD1174	OPG - Action ECR -FEEDER PLATFORM & FEEDER MONORAILS	1.00	31-Mar-16	31-Mar-16
73115DD1176	Kick-Off Meeting - TMod -FEEDER PLATFORM & FEEDER MONORAILS	1.00	31-Mar-16	31-Mar-16
DNG-RFR-L5U3-11.73115.3.03.16 MEC 121421 MECH Containment Isolations Test Tie-Ins		13.00	29-Mar-16	14-Apr-16
73115DD1152	OPG - Action ECR -CI Containment Test	1.00	29-Mar-16	29-Mar-16
73115DD1154	Kick-Off Meeting - TMod -CI Containment Test	1.00	29-Mar-16	29-Mar-16
73115DD1164	Create Master EC -CI Containment Test	1.00	30-Mar-16	30-Mar-16
73115DD1256	Prepare & Issue Design Plan -CI Containment Test	12.00	30-Mar-16	14-Apr-16
DNG-RFR-L5U3-11.73115.4 Unit 3 Procurement		702.00	21-Jun-1:	24-Jul-18
7311573135030a5	Unit 3 -Unit 3 Start Waste Containers	0.00	21-Jun-1:	
7311573135030a	Unit 3 -Unit 3 Start OSM Packages	0.00	01-Dec-1	
DNG-RFR-L5U3-11.73115.4.05 Unit 3 - Procurement - Long Lead		123.00	21-Jun-1:	22-Apr-16
DNG-RFR-L5U3-11.73115.4.05.05 Procurement of plant equipment for Fuel Channel Removal - I		62.00	21-Jun-1:	14-Dec-15
7311573115360a	Unit 3 -Prepare and Issue EQR - PT / CT / CTI / EF Waste Containers - Unit 3	20.00	21-Jun-1:	14-Jul-15 A
7311573115380a	Unit 3 -Prepare and Issue RFQ - PT / CT / CTI / EF Waste Containers - Unit 3	15.00	15-Jul-15	28-Aug-1:
7311573115385a	Unit 3 -Tender Period - PT / CT / CTI / EF Waste Containers - Unit 3	21.00	30-Aug-1	28-Sep-1:
7311573115390a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - PT / CT / CTI /	1.00	29-Sep-1	29-Sep-1:
7311573115395a	Unit 3 -Technical Tender Evaluations - PT / CT / CTI / EF Waste Containers - U	13.00	30-Sep-1	20-Oct-15
7311573115400a	Unit 3 -Quality Tender Evaluation - PT / CT / CTI / EF Waste Containers - Unit	13.00	30-Sep-1	20-Oct-15

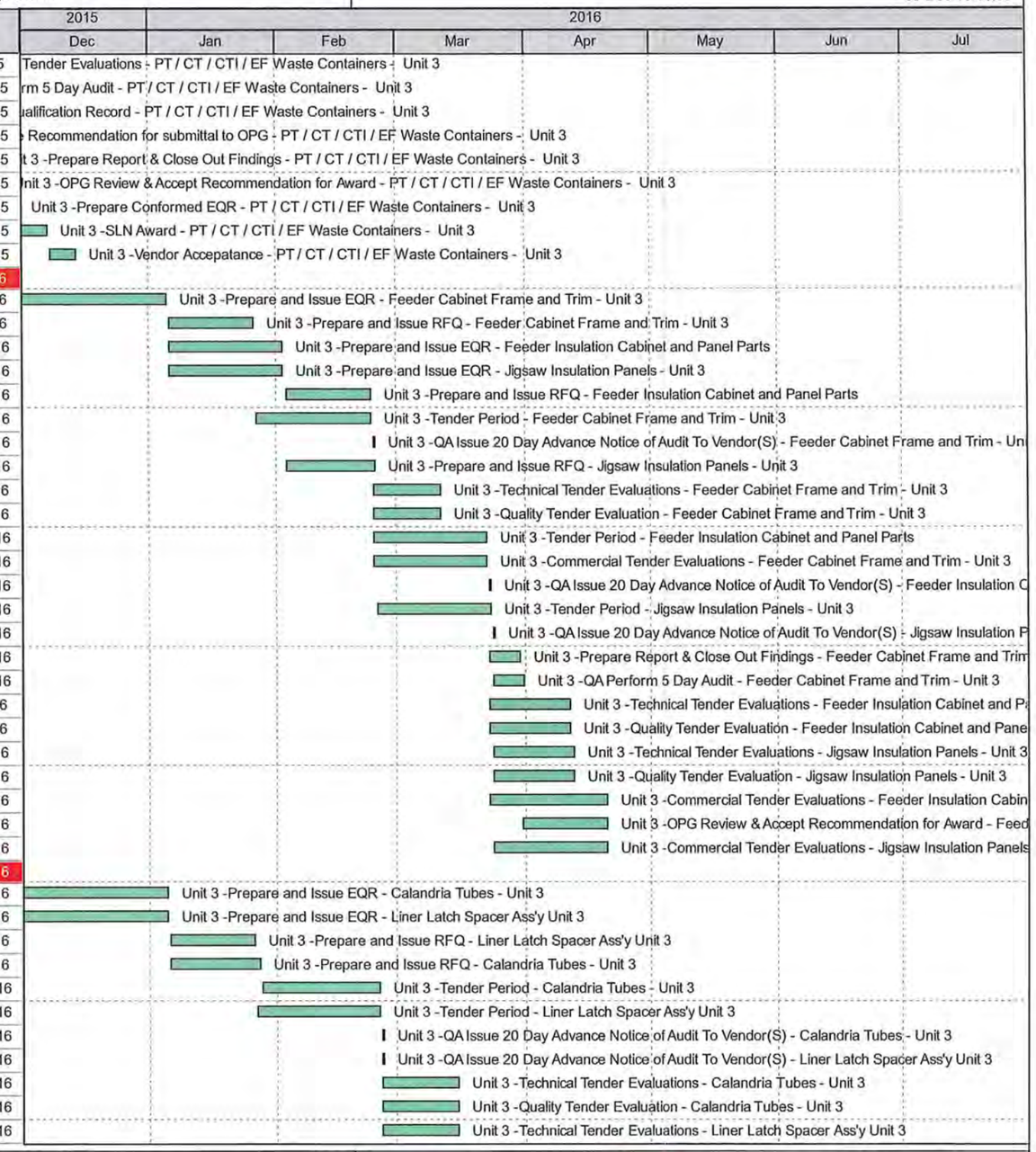


SNC·LAVALIN Nuclear AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort | Critical Remaining Work
Actual Work | ◆ Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
7311573115405a	Unit 3 -Commercial Tender Evaluations - PT / CT / CTI / EF Waste Containers	20.00	30-Sep-1	29-Oct-15
7311573115410a	Unit 3 -QA Perform 5 Day Audit - PT / CT / CTI / EF Waste Containers - Unit 3	5.00	28-Oct-15	03-Nov-15
7311573115415a	Unit 3 -Enter Qualification Record - PT / CT / CTI / EF Waste Containers - Unit	1.00	04-Nov-15	04-Nov-15
7311573115425a	Unit 3 -Prepare Recommendation for submittal to OPG - PT / CT / CTI / EF Wa	5.00	30-Oct-15	05-Nov-15
7311573115420a	Unit 3 -Prepare Report & Close Out Findings - PT / CT / CTI / EF Waste Conta	13.00	05-Nov-15	23-Nov-15
7311573115430a	Unit 3 -OPG Review & Accept Recommendation for Award - PT / CT / CTI / EF	15.00	06-Nov-15	26-Nov-15
7311573136210a	Unit 3 -Prepare Conformed EQR - PT / CT / CTI / EF Waste Containers - Unit	5.00	24-Nov-15	30-Nov-15
7311573115435a	Unit 3 -SLN Award - PT / CT / CTI / EF Waste Containers - Unit 3	5.00	01-Dec-15	07-Dec-15
7311573115440a	Unit 3 -Vendor Accepatance - PT / CT / CTI / EF Waste Containers - Unit 3	5.00	08-Dec-15	14-Dec-15
DNG-RFR-L5U3-11.73115.4.05.11	Procurement of plant equipment for Upper Feeder Install - OSM	94.00	01-Dec-15	20-Apr-16
7311573116470a	Unit 3 -Prepare and Issue EQR - Feeder Cabinet Frame and Trim - Unit 3	20.00	01-Dec-15	05-Jan-16
7311573116475a	Unit 3 -Prepare and Issue RFQ - Feeder Cabinet Frame and Trim - Unit 3	15.00	06-Jan-16	26-Jan-16
7311573116395a	Unit 3 -Prepare and Issue EQR - Feeder Insulation Cabinet and Panel Parts	20.00	06-Jan-16	02-Feb-16
7311573117660a	Unit 3 -Prepare and Issue EQR - Jigsaw Insulation Panels - Unit 3	20.00	06-Jan-16	02-Feb-16
7311573116400a	Unit 3 -Prepare and Issue RFQ - Feeder Insulation Cabinet and Panel Parts	14.00	03-Feb-16	23-Feb-16
7311573116480a	Unit 3 -Tender Period - Feeder Cabinet Frame and Trim - Unit 3	19.00	27-Jan-16	23-Feb-16
7311573116485a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Feeder Cabine	1.00	24-Feb-16	24-Feb-16
7311573117665a	Unit 3 -Prepare and Issue RFQ - Jigsaw Insulation Panels - Unit 3	15.00	03-Feb-16	24-Feb-16
7311573116490a	Unit 3 -Technical Tender Evaluations - Feeder Cabinet Frame and Trim - Unit 3	13.00	24-Feb-16	11-Mar-16
7311573116495a	Unit 3 -Quality Tender Evaluation - Feeder Cabinet Frame and Trim - Unit 3	13.00	24-Feb-16	11-Mar-16
7311573116405a	Unit 3 -Tender Period - Feeder Insulation Cabinet and Panel Parts	20.00	24-Feb-16	22-Mar-16
7311573116500a	Unit 3 -Commercial Tender Evaluations - Feeder Cabinet Frame and Trim - Un	20.00	24-Feb-16	22-Mar-16
7311573116410a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Feeder Insulat	1.00	23-Mar-16	23-Mar-16
7311573117670a	Unit 3 -Tender Period - Jigsaw Insulation Panels - Unit 3	20.00	25-Feb-16	23-Mar-16
7311573117675a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Jigsaw Insulati	1.00	24-Mar-16	24-Mar-16
7311573116520a	Unit 3 -Prepare Report & Close Out Findings - Feeder Cabinet Frame and Trin	5.00	23-Mar-16	30-Mar-16
7311573116505a	Unit 3 -QA Perform 5 Day Audit - Feeder Cabinet Frame and Trim - Unit 3	5.00	24-Mar-16	31-Mar-16
7311573116415a	Unit 3 -Technical Tender Evaluations - Feeder Insulation Cabinet and Panel Par	13.00	23-Mar-16	11-Apr-16
7311573116420a	Unit 3 -Quality Tender Evaluation - Feeder Insulation Cabinet and Panel Parts	13.00	23-Mar-16	11-Apr-16
7311573117680a	Unit 3 -Technical Tender Evaluations - Jigsaw Insulation Panels - Unit 3	13.00	24-Mar-16	12-Apr-16
7311573117685a	Unit 3 -Quality Tender Evaluation - Jigsaw Insulation Panels - Unit 3	13.00	24-Mar-16	12-Apr-16
7311573116425a	Unit 3 -Commercial Tender Evaluations - Feeder Insulation Cabinet and Panel I	20.00	23-Mar-16	20-Apr-16
7311573116525a	Unit 3 -OPG Review & Accept Recommendation for Award - Feeder Cabinet Fr	15.00	31-Mar-16	20-Apr-16
7311573117690a	Unit 3 -Commercial Tender Evaluations - Jigsaw Insulation Panels - Unit 3	19.00	24-Mar-16	20-Apr-16
DNG-RFR-L5U3-11.73115.4.05.15	Procurement of plant equipment for Fuel Channel Installation	82.00	01-Dec-15	04-Apr-16
7311573115260a	Unit 3 -Prepare and Issue EQR - Calandria Tubes - Unit 3	20.00	01-Dec-15	05-Jan-16
73115PR1000	Unit 3 -Prepare and Issue EQR - Liner Latch Spacer Ass'y Unit 3	20.00	01-Dec-15	05-Jan-16
73115PR1005	Unit 3 -Prepare and Issue RFQ - Liner Latch Spacer Ass'y Unit 3	15.00	06-Jan-16	26-Jan-16
7311573115445a	Unit 3 -Prepare and Issue RFQ - Calandria Tubes - Unit 3	16.00	06-Jan-16	27-Jan-16
7311573115450a	Unit 3 -Tender Period - Calandria Tubes - Unit 3	20.00	28-Jan-16	25-Feb-16
73115PR1010	Unit 3 -Tender Period - Liner Latch Spacer Ass'y Unit 3	21.00	27-Jan-16	25-Feb-16
7311573115455a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Calandria Tub	1.00	26-Feb-16	26-Feb-16
73115PR1015	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Liner Latch Sp	1.00	26-Feb-16	26-Feb-16
7311573115460a	Unit 3 -Technical Tender Evaluations - Calandria Tubes - Unit 3	13.00	26-Feb-16	15-Mar-16
7311573115465a	Unit 3 -Quality Tender Evaluation - Calandria Tubes - Unit 3	13.00	26-Feb-16	15-Mar-16
73115PR1020	Unit 3 -Technical Tender Evaluations - Liner Latch Spacer Ass'y Unit 3	13.00	26-Feb-16	15-Mar-16

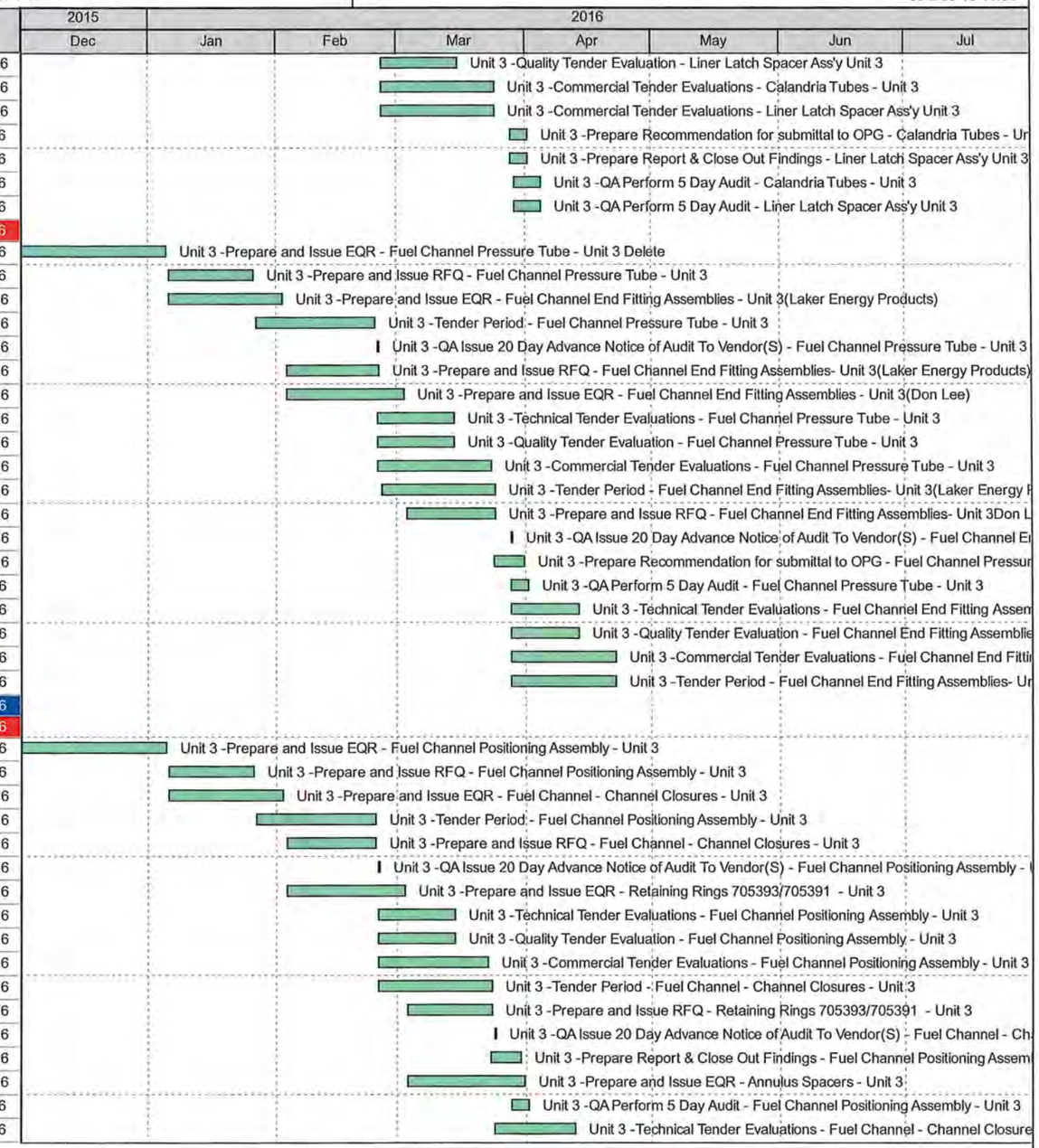


SNC·LAVALIN Nuclear
AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone

Activity ID	Activity Name	Original Duration	Start	Finish
73115PR1025	Unit 3 -Quality Tender Evaluation - Liner Latch Spacer Ass'y Unit 3	13.00	26-Feb-16	15-Mar-16
7311573115470a	Unit 3 -Commercial Tender Evaluations - Calandria Tubes - Unit 3	20.00	26-Feb-16	24-Mar-16
73115PR1030	Unit 3 -Commercial Tender Evaluations - Liner Latch Spacer Ass'y Unit 3	20.00	26-Feb-16	24-Mar-16
7311573115490a	Unit 3 -Prepare Recommendation for submittal to OPG - Calandria Tubes - Unit	5.00	28-Mar-16	01-Apr-16
73115PR1035	Unit 3 -Prepare Report & Close Out Findings - Liner Latch Spacer Ass'y Unit 3	5.00	28-Mar-16	01-Apr-16
7311573115475a	Unit 3 -QA Perform 5 Day Audit - Calandria Tubes - Unit 3	5.00	29-Mar-16	04-Apr-16
73115PR1040	Unit 3 -QA Perform 5 Day Audit - Liner Latch Spacer Ass'y Unit 3	5.00	29-Mar-16	04-Apr-16
DNG-RFR-L5U3-11.73115.4.05.16	Procurement of plant equipment for Fuel Channel Installation	96.00	01-Dec-15	22-Apr-16
7311573115265a	Unit 3 -Prepare and Issue EQR - Fuel Channel Pressure Tube - Unit 3 Delete	20.00	01-Dec-15	05-Jan-16
7311573115640a	Unit 3 -Prepare and Issue RFQ - Fuel Channel Pressure Tube - Unit 3	15.00	06-Jan-16	26-Jan-16
7311573115275a	Unit 3 -Prepare and Issue EQR - Fuel Channel End Fitting Assemblies - Unit 3(	20.00	06-Jan-16	02-Feb-16
7311573115645a	Unit 3 -Tender Period - Fuel Channel Pressure Tube - Unit 3	20.00	27-Jan-16	24-Feb-16
7311573115650a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Fuel Channel I	1.00	25-Feb-16	25-Feb-16
7311573117590a	Unit 3 -Prepare and Issue RFQ - Fuel Channel End Fitting Assemblies- Unit 3(L	16.00	03-Feb-16	25-Feb-16
7311573134855a	Unit 3 -Prepare and Issue EQR - Fuel Channel End Fitting Assemblies - Unit 3(	20.00	03-Feb-16	02-Mar-16
7311573115655a	Unit 3 -Technical Tender Evaluations - Fuel Channel Pressure Tube - Unit 3	13.00	25-Feb-16	14-Mar-16
7311573115660a	Unit 3 -Quality Tender Evaluation - Fuel Channel Pressure Tube - Unit 3	13.00	25-Feb-16	14-Mar-16
7311573115665a	Unit 3 -Commercial Tender Evaluations - Fuel Channel Pressure Tube - Unit 3	20.00	25-Feb-16	23-Mar-16
7311573117595a	Unit 3 -Tender Period - Fuel Channel End Fitting Assemblies- Unit 3(Laker Ene	20.00	26-Feb-16	24-Mar-16
7311573134860a	Unit 3 -Prepare and Issue RFQ - Fuel Channel End Fitting Assemblies- Unit 3D	16.00	03-Mar-16	24-Mar-16
7311573117600a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Fuel Channel I	1.00	28-Mar-16	28-Mar-16
7311573115685a	Unit 3 -Prepare Recommendation for submittal to OPG - Fuel Channel Pressur	5.00	24-Mar-16	31-Mar-16
7311573115670a	Unit 3 -QA Perform 5 Day Audit - Fuel Channel Pressure Tube - Unit 3	5.00	28-Mar-16	01-Apr-16
7311573117605a	Unit 3 -Technical Tender Evaluations - Fuel Channel End Fitting Assemblies- Ur	13.00	28-Mar-16	13-Apr-16
7311573117610a	Unit 3 -Quality Tender Evaluation - Fuel Channel End Fitting Assemblies- Unit 3	13.00	28-Mar-16	13-Apr-16
7311573117615a	Unit 3 -Commercial Tender Evaluations - Fuel Channel End Fitting Assemblies-	20.00	28-Mar-16	22-Apr-16
7311573134865a	Unit 3 -Tender Period - Fuel Channel End Fitting Assemblies- Unit 3Don Lee)	20.00	28-Mar-16	22-Apr-16
DNG-RFR-L5U3-11.73115.4.06	Unit 3 - Procurement - Non Long Lead	96.00	01-Dec-15	22-Apr-16
DNG-RFR-L5U3-11.73115.4.06.15	Procurement of plant equipment for Fuel Channel Installation	95.00	01-Dec-15	21-Apr-16
7311573115270a	Unit 3 -Prepare and Issue EQR - Fuel Channel Positioning Assembly - Unit 3	20.00	01-Dec-15	05-Jan-16
7311573116605a	Unit 3 -Prepare and Issue RFQ - Fuel Channel Positioning Assembly - Unit 3	15.00	06-Jan-16	26-Jan-16
7311573115280a	Unit 3 -Prepare and Issue EQR - Fuel Channel - Channel Closures - Unit 3	20.00	06-Jan-16	02-Feb-16
7311573116610a	Unit 3 -Tender Period - Fuel Channel Positioning Assembly - Unit 3	20.00	27-Jan-16	24-Feb-16
7311573116670a	Unit 3 -Prepare and Issue RFQ - Fuel Channel - Channel Closures - Unit 3	15.00	03-Feb-16	24-Feb-16
7311573116615a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Fuel Channel I	1.00	25-Feb-16	25-Feb-16
7311573115305a	Unit 3 -Prepare and Issue EQR - Retaining Rings 705393/705391 - Unit 3	20.00	03-Feb-16	02-Mar-16
7311573116620a	Unit 3 -Technical Tender Evaluations - Fuel Channel Positioning Assembly - Unit	13.00	25-Feb-16	14-Mar-16
7311573116625a	Unit 3 -Quality Tender Evaluation - Fuel Channel Positioning Assembly - Unit 3	13.00	25-Feb-16	14-Mar-16
7311573116630a	Unit 3 -Commercial Tender Evaluations - Fuel Channel Positioning Assembly - U	19.00	25-Feb-16	22-Mar-16
7311573116675a	Unit 3 -Tender Period - Fuel Channel - Channel Closures - Unit 3	20.00	25-Feb-16	23-Mar-16
7311573117320a	Unit 3 -Prepare and Issue RFQ - Retaining Rings 705393/705391 - Unit 3	15.00	03-Mar-16	23-Mar-16
7311573116680a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Fuel Channel -	1.00	24-Mar-16	24-Mar-16
7311573116650a	Unit 3 -Prepare Report & Close Out Findings - Fuel Channel Positioning Assem	5.00	23-Mar-16	30-Mar-16
7311573115310a	Unit 3 -Prepare and Issue EQR - Annulus Spacers - Unit 3	20.00	03-Mar-16	31-Mar-16
7311573116635a	Unit 3 -QA Perform 5 Day Audit - Fuel Channel Positioning Assembly - Unit 3	5.00	28-Mar-16	01-Apr-16
7311573116685a	Unit 3 -Technical Tender Evaluations - Fuel Channel - Channel Closures - Unit 3	13.00	24-Mar-16	12-Apr-16



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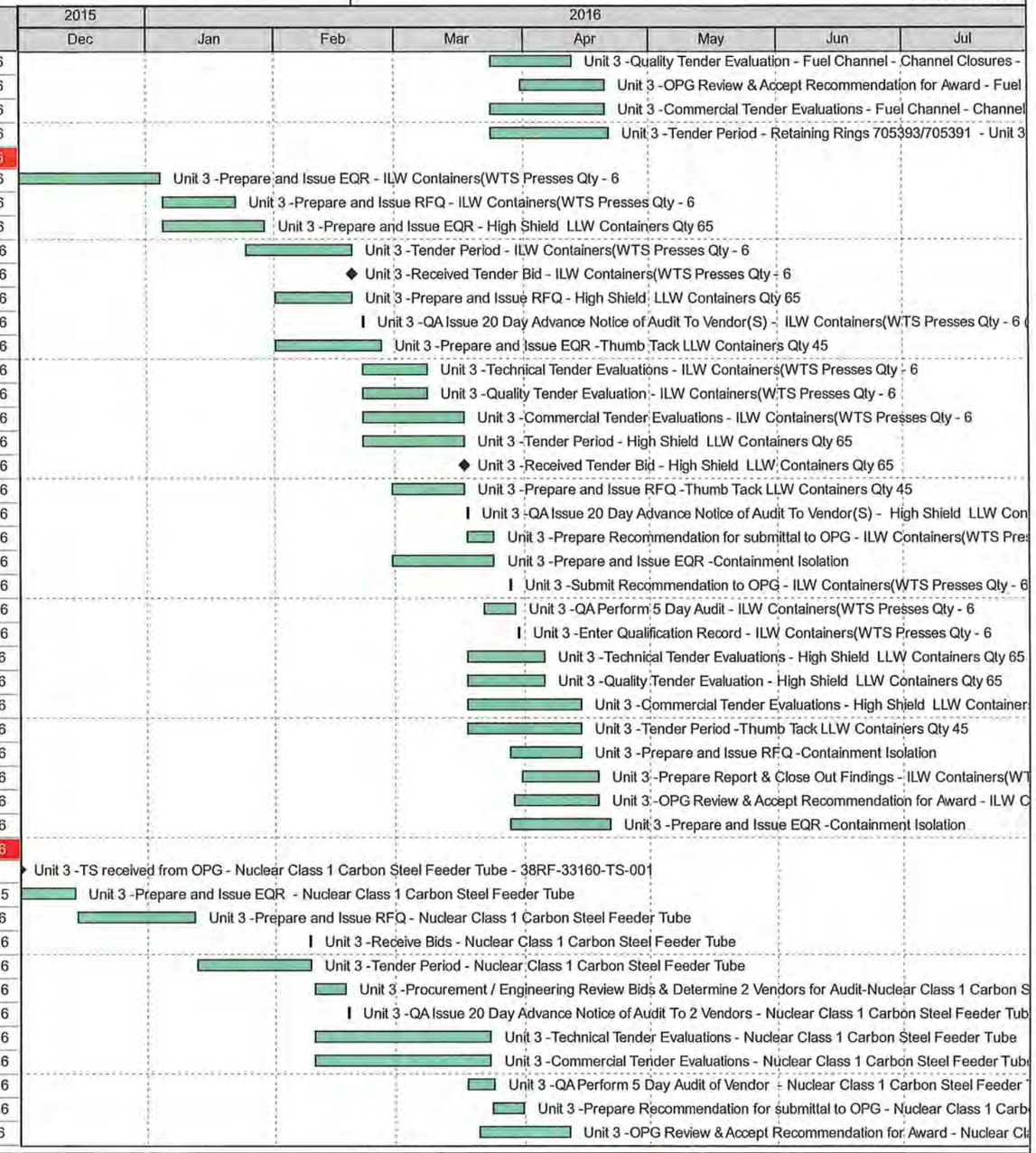
Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Critical Remaining Work
Actual Work
Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
7311573116690a	Unit 3 -Quality Tender Evaluation - Fuel Channel - Channel Closures - Unit 3	13.00	24-Mar-16	12-Apr-16
7311573116655a	Unit 3 -OPG Review & Accept Recommendation for Award - Fuel Channel Posit	15.00	31-Mar-16	20-Apr-16
7311573116695a	Unit 3 -Commercial Tender Evaluations - Fuel Channel - Channel Closures - Ur	19.00	24-Mar-16	20-Apr-16
7311573117325a	Unit 3 -Tender Period - Retaining Rings 705393/705391 - Unit 3	20.00	24-Mar-16	21-Apr-16
DNG-RFR-L5U3-11.73115.4.06.02	Procurement of plant equipment for pre-req series - Goods	95.00	01-Dec-15	21-Apr-16
73115PR1080	Unit 3 -Prepare and Issue EQR - ILW Containers(WTS Presses Qty - 6	19.00	01-Dec-15	04-Jan-16
73115PR1085	Unit 3 -Prepare and Issue RFQ - ILW Containers(WTS Presses Qty - 6	14.00	05-Jan-16	22-Jan-16
73115PR1200	Unit 3 -Prepare and Issue EQR - High Shield LLW Containers Qty 65	19.00	05-Jan-16	29-Jan-16
73115PR1090	Unit 3 -Tender Period - ILW Containers(WTS Presses Qty - 6	19.00	25-Jan-16	19-Feb-16
73115PR1095	Unit 3 -Received Tender Bid - ILW Containers(WTS Presses Qty - 6	0.00		19-Feb-16
73115PR1205	Unit 3 -Prepare and Issue RFQ - High Shield LLW Containers Qty 65	14.00	01-Feb-16	19-Feb-16
73115PR1100	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - ILW Containe	1.00	22-Feb-16	22-Feb-16
73115PR1300	Unit 3 -Prepare and Issue EQR -Thumb Tack LLW Containers Qty 45	19.00	01-Feb-16	26-Feb-16
73115PR1105	Unit 3 -Technical Tender Evaluations - ILW Containers(WTS Presses Qty - 6	12.00	22-Feb-16	08-Mar-16
73115PR1110	Unit 3 -Quality Tender Evaluation - ILW Containers(WTS Presses Qty - 6	12.00	22-Feb-16	08-Mar-16
73115PR1115	Unit 3 -Commercial Tender Evaluations - ILW Containers(WTS Presses Qty - 6	19.00	22-Feb-16	17-Mar-16
73115PR1210	Unit 3 -Tender Period - High Shield LLW Containers Qty 65	19.00	22-Feb-16	17-Mar-16
73115PR1215	Unit 3 -Received Tender Bid - High Shield LLW Containers Qty 65	0.00		17-Mar-16
73115PR1305	Unit 3 -Prepare and Issue RFQ -Thumb Tack LLW Containers Qty 45	14.00	29-Feb-16	17-Mar-16
73115PR1220	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - High Shield L	1.00	18-Mar-16	18-Mar-16
73115PR1120	Unit 3 -Prepare Recommendation for submittal to OPG - ILW Containers(WTS	5.00	18-Mar-16	24-Mar-16
73115PR1400	Unit 3 -Prepare and Issue EQR -Containment Isolation	19.00	29-Feb-16	24-Mar-16
73115PR1130	Unit 3 -Submit Recommendation to OPG - ILW Containers(WTS Presses Qty -	1.00	28-Mar-16	28-Mar-16
73115PR1125	Unit 3 -QA Perform 5 Day Audit - ILW Containers(WTS Presses Qty - 6	5.00	22-Mar-16	29-Mar-16
73115PR1140	Unit 3 -Enter Qualification Record - ILW Containers(WTS Presses Qty - 6	1.00	30-Mar-16	30-Mar-16
73115PR1225	Unit 3 -Technical Tender Evaluations - High Shield LLW Containers Qty 65	12.00	18-Mar-16	05-Apr-16
73115PR1230	Unit 3 -Quality Tender Evaluation - High Shield LLW Containers Qty 65	12.00	18-Mar-16	05-Apr-16
73115PR1235	Unit 3 -Commercial Tender Evaluations - High Shield LLW Containers Qty 65	19.00	18-Mar-16	14-Apr-16
73115PR1310	Unit 3 -Tender Period -Thumb Tack LLW Containers Qty 45	19.00	18-Mar-16	14-Apr-16
73115PR1405	Unit 3 -Prepare and Issue RFQ -Containment Isolation	14.00	28-Mar-16	14-Apr-16
73115PR1145	Unit 3 -Prepare Report & Close Out Findings - ILW Containers(WTS Presses C	13.00	31-Mar-16	18-Apr-16
73115PR1135	Unit 3 -OPG Review & Accept Recommendation for Award - ILW Containers(W	15.00	29-Mar-16	18-Apr-16
73115PR1500	Unit 3 -Prepare and Issue EQR -Containment Isolation	19.00	28-Mar-16	21-Apr-16
DNG-RFR-L5U3-11.73115.4.06.10	Procurement of plant equipment for Feeder preparation - Goo	96.00	01-Dec-15	22-Apr-16
7311573130395a	Unit 3 -TS received from OPG - Nuclear Class 1 Carbon Steel Feeder Tube - 3	0.00	01-Dec-15	
7311573130405a	Unit 3 -Prepare and Issue EQR - Nuclear Class 1 Carbon Steel Feeder Tube	10.00	01-Dec-15	14-Dec-15
7311573130400a	Unit 3 -Prepare and Issue RFQ - Nuclear Class 1 Carbon Steel Feeder Tube	15.00	15-Dec-15	12-Jan-16
7311573130390a	Unit 3 -Receive Bids - Nuclear Class 1 Carbon Steel Feeder Tube	1.00	09-Feb-16	09-Feb-16
7311573130435a	Unit 3 -Tender Period - Nuclear Class 1 Carbon Steel Feeder Tube	20.00	13-Jan-16	09-Feb-16
7311573130370a	Unit 3 -Procurement / Engineering Review Bids & Determine 2 Vendors for Aud	5.00	10-Feb-16	17-Feb-16
7311573130375a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To 2 Vendors - Nuclear Class	1.00	18-Feb-16	18-Feb-16
7311573130410a	Unit 3 -Technical Tender Evaluations - Nuclear Class 1 Carbon Steel Feeder Tu	30.00	10-Feb-16	23-Mar-16
7311573130440a	Unit 3 -Commercial Tender Evaluations - Nuclear Class 1 Carbon Steel Feeder	30.00	10-Feb-16	23-Mar-16
7311573130380a	Unit 3 -QA Perform 5 Day Audit of Vendor - Nuclear Class 1 Carbon Steel Fee	5.00	18-Mar-16	24-Mar-16
7311573130415a	Unit 3 -Prepare Recommendation for submittal to OPG - Nuclear Class 1 Carbo	5.00	24-Mar-16	31-Mar-16
7311573130425a	Unit 3 -OPG Review & Accept Recommendation for Award - Nuclear Class 1 Ca	15.00	21-Mar-16	11-Apr-16



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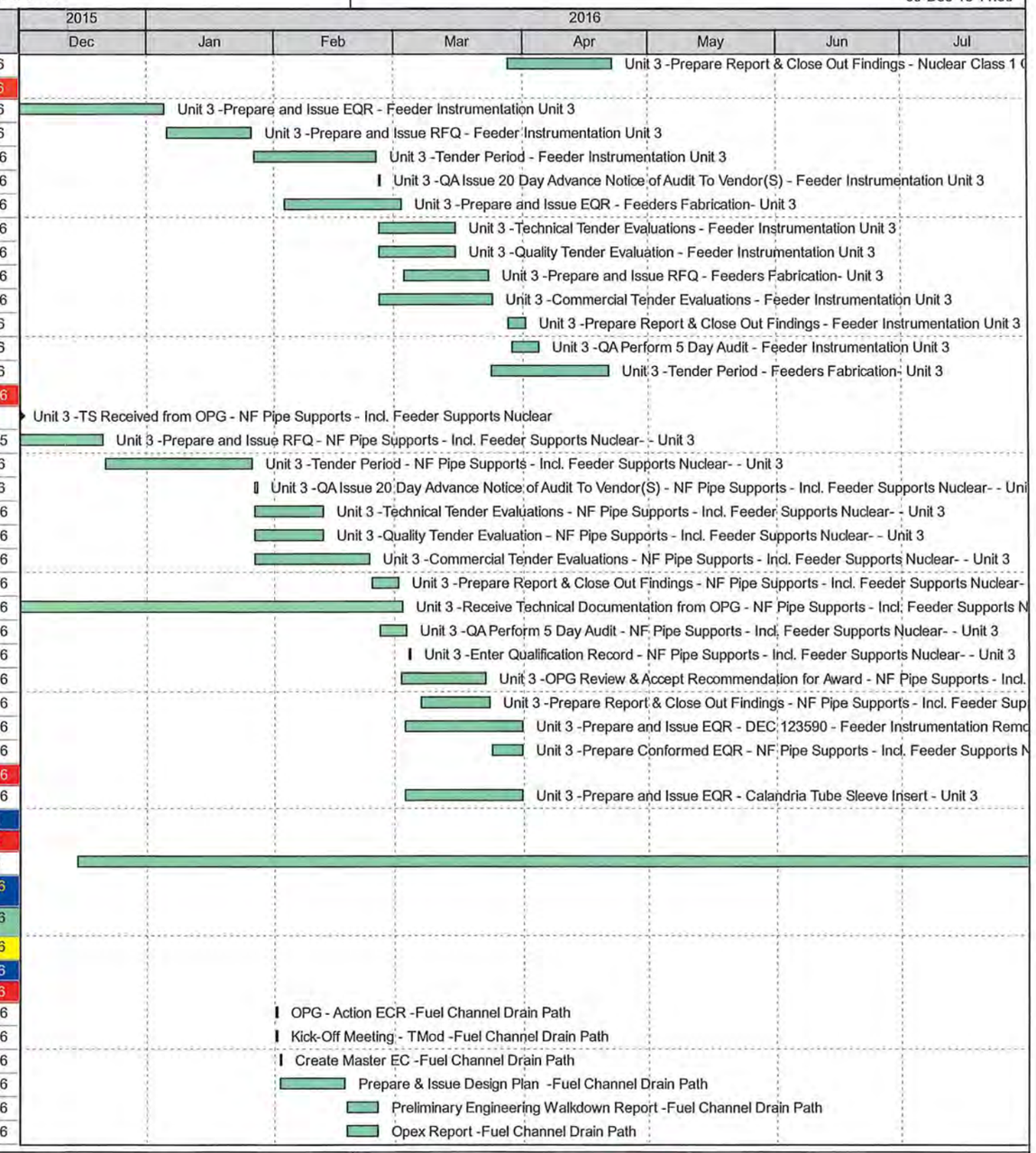
Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Actual Work
Remaining Work
Critical Remaining Work
Milestone

Activity ID	Activity Name	Original Duration	Start	Finish
7311573130385a	Unit 3 -Prepare Report & Close Out Findings - Nuclear Class 1 Carbon Steel F	20.00	28-Mar-16	22-Apr-16
DNG-RFR-L5U3-11.73115.4.06.11	Procurement of plant equipment for Upper Feeder Install - OSM	95.00	01-Dec-15	21-Apr-16
7311573115370a	Unit 3 -Prepare and Issue EQR - Feeder Instrumentation Unit 3	20.00	01-Dec-15	05-Jan-16
7311573117125a	Unit 3 -Prepare and Issue RFQ - Feeder Instrumentation Unit 3	15.00	06-Jan-16	26-Jan-16
7311573117130a	Unit 3 -Tender Period - Feeder Instrumentation Unit 3	21.00	27-Jan-16	25-Feb-16
7311573117135a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - Feeder Instrur	1.00	26-Feb-16	26-Feb-16
7311573115245a	Unit 3 -Prepare and Issue EQR - Feeders Fabrication- Unit 3	20.00	03-Feb-16	02-Mar-16
7311573117140a	Unit 3 -Technical Tender Evaluations - Feeder Instrumentation Unit 3	13.00	26-Feb-16	15-Mar-16
7311573117145a	Unit 3 -Quality Tender Evaluation - Feeder Instrumentation Unit 3	13.00	26-Feb-16	15-Mar-16
7311573115575a	Unit 3 -Prepare and Issue RFQ - Feeders Fabrication- Unit 3	15.00	03-Mar-16	23-Mar-16
7311573117150a	Unit 3 -Commercial Tender Evaluations - Feeder Instrumentation Unit 3	20.00	26-Feb-16	24-Mar-16
7311573117170a	Unit 3 -Prepare Report & Close Out Findings - Feeder Instrumentation Unit 3	5.00	28-Mar-16	01-Apr-16
7311573117155a	Unit 3 -QA Perform 5 Day Audit - Feeder Instrumentation Unit 3	5.00	29-Mar-16	04-Apr-16
7311573115580a	Unit 3 -Tender Period - Feeders Fabrication- Unit 3	20.00	24-Mar-16	21-Apr-16
DNG-RFR-L5U3-11.73115.4.06.12	Procurement of plant equipment for Upper Feeder Install - Go	80.00	01-Dec-15	31-Mar-16
7311573130240a	Unit 3 -TS Received from OPG - NF Pipe Supports - Incl. Feeder Supports Nuc	0.00	01-Dec-15	
7311573116735a	Unit 3 -Prepare and Issue RFQ - NF Pipe Supports - Incl. Feeder Supports Nu	15.00	01-Dec-15	21-Dec-15
7311573116740a	Unit 3 -Tender Period - NF Pipe Supports - Incl. Feeder Supports Nuclear- - Ur	20.00	22-Dec-15	26-Jan-16
7311573116745a	Unit 3 -QA Issue 20 Day Advance Notice of Audit To Vendor(S) - NF Pipe Suppo	1.00	27-Jan-16	27-Jan-16
7311573116750a	Unit 3 -Technical Tender Evaluations - NF Pipe Supports - Incl. Feeder Support	13.00	27-Jan-16	12-Feb-16
7311573116755a	Unit 3 -Quality Tender Evaluation - NF Pipe Supports - Incl. Feeder Supports N	13.00	27-Jan-16	12-Feb-16
7311573116760a	Unit 3 -Commercial Tender Evaluations - NF Pipe Supports - Incl. Feeder Supp	19.00	27-Jan-16	23-Feb-16
7311573116780a	Unit 3 -Prepare Report & Close Out Findings - NF Pipe Supports - Incl. Feeder	5.00	24-Feb-16	01-Mar-16
7311573130285a	Unit 3 -Receive Technical Documentation from OPG - NF Pipe Supports - Incl. I	60.00	01-Dec-15	02-Mar-16
7311573116765a	Unit 3 -QA Perform 5 Day Audit - NF Pipe Supports - Incl. Feeder Supports Nu	5.00	26-Feb-16	03-Mar-16
7311573116770a	Unit 3 -Enter Qualification Record - NF Pipe Supports - Incl. Feeder Supports N	1.00	04-Mar-16	04-Mar-16
7311573116785a	Unit 3 -OPG Review & Accept Recommendation for Award - NF Pipe Supports -	15.00	02-Mar-16	22-Mar-16
7311573116775a	Unit 3 -Prepare Report & Close Out Findings - NF Pipe Supports - Incl. Feeder	13.00	07-Mar-16	23-Mar-16
7311573130300a	Unit 3 -Prepare and Issue EQR - DEC 123590 - Feeder Instrumentation Remo	20.00	03-Mar-16	31-Mar-16
7311573136075a	Unit 3 -Prepare Conformed EQR - NF Pipe Supports - Incl. Feeder Supports N	5.00	24-Mar-16	31-Mar-16
DNG-RFR-L5U3-11.73115.4.06.16	Procurement of plant equipment for Fuel Channel Installation	20.00	03-Mar-16	31-Mar-16
7311573115340a	Unit 3 -Prepare and Issue EQR - Calandria Tube Sleeve Insert - Unit 3	20.00	03-Mar-16	31-Mar-16
DNG-RFR-L5U3-11.73115.4.07	Unit 3 - Procurement - Manufacturing	650.00	15-Dec-15	24-Jul-18
DNG-RFR-L5U3-11.73115.4.07.05	Manufacturing of plant equipment for Fuel Channel Removal	650.00	15-Dec-15	24-Jul-18
7311573115220a	Unit 3 -Manufacture and Delivery - PT / CT / CTI / EF Waste Containers - Uni	650.00	15-Dec-15	24-Jul-18
DNG-RFR-L5U1-11	509407-RFR Level 5 Execution Schedule Unit 1 Rev 0'	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U1-11.73114	Unit 1 (73114)	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U1-11.73114.3	Unit 1 Engineering	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U1-11.73114.3.03	Unit 1 Engineering MEC Packages	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U1-11.73114.3.03.02	MEC 117317 MECH. Fuel Channel Drain Path	49.10	01-Feb-16	08-Apr-16
73114DD1002	OPG - Action ECR -Fuel Channel Drain Path	1.00	01-Feb-16	01-Feb-16
73114DD1004	Kick-Off Meeting - TMod -Fuel Channel Drain Path	1.00	01-Feb-16	01-Feb-16
73114DD1012	Create Master EC -Fuel Channel Drain Path	1.00	02-Feb-16	02-Feb-16
73114DD1020	Prepare & Issue Design Plan -Fuel Channel Drain Path	12.00	02-Feb-16	17-Feb-16
73114DD1032	Preliminary Engineering Walkdown Report -Fuel Channel Drain Path	6.00	18-Feb-16	25-Feb-16
73114DD1034	Opex Report -Fuel Channel Drain Path	6.00	18-Feb-16	25-Feb-16



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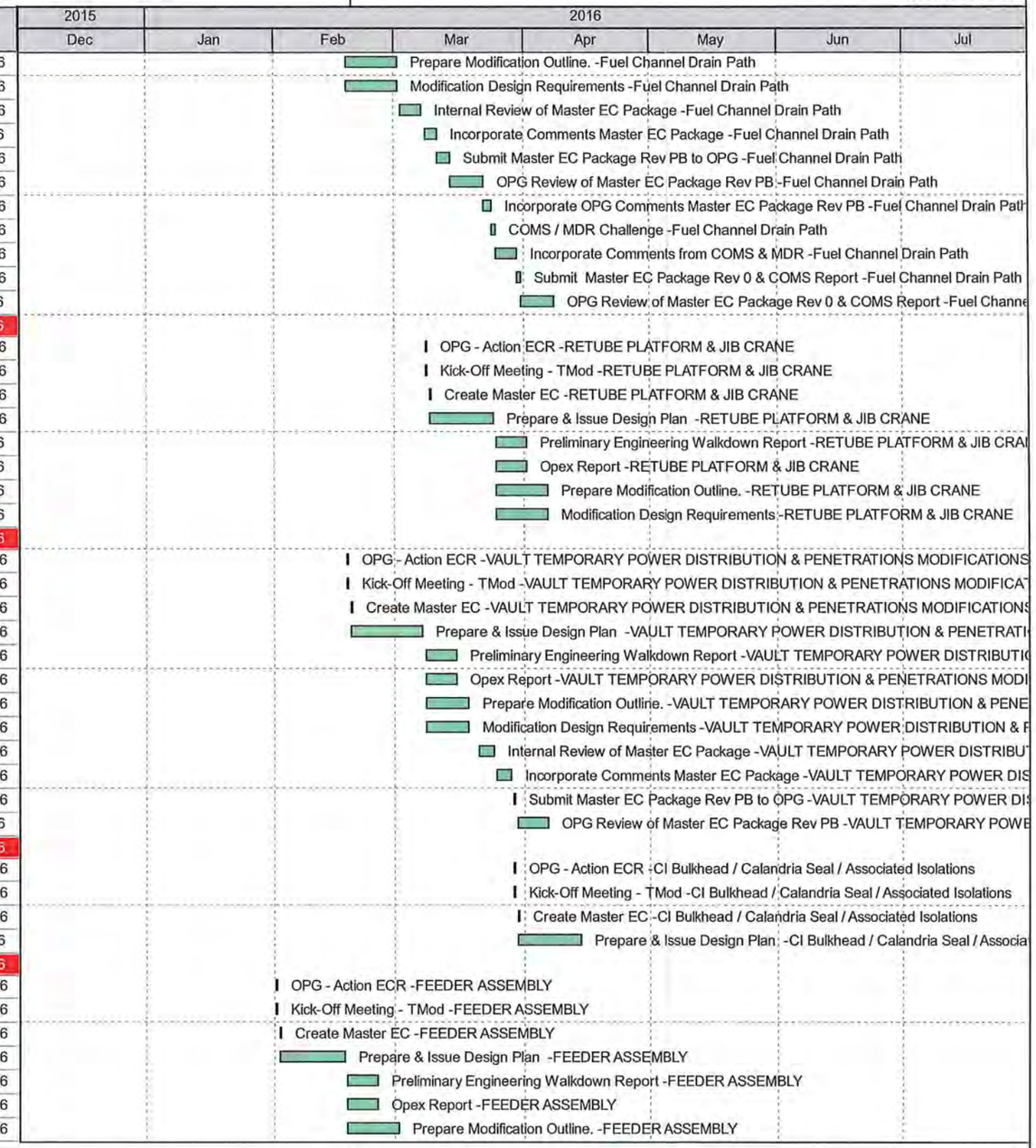
Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Critical Remaining Work
Actual Work
Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
73114DD1044	Prepare Modification Outline. -Fuel Channel Drain Path	9.00	18-Feb-16	01-Mar-16
73114DD1046	Modification Design Requirements -Fuel Channel Drain Path	9.00	18-Feb-16	01-Mar-16
73114DD1056	Internal Review of Master EC Package -Fuel Channel Drain Path	4.00	02-Mar-16	07-Mar-16
73114DD1094	Incorporate Comments Master EC Package -Fuel Channel Drain Path	3.10	08-Mar-16	11-Mar-16
73114DD1100	Submit Master EC Package Rev PB to OPG -Fuel Channel Drain Path	1.00	11-Mar-16	14-Mar-16
73114DD1112	OPG Review of Master EC Package Rev PB -Fuel Channel Drain Path	6.00	14-Mar-16	22-Mar-16
73114DD1116	Incorporate OPG Comments Master EC Package Rev PB -Fuel Channel Drain	2.00	22-Mar-16	24-Mar-16
73114DD1132	COMS / MDR Challenge -Fuel Channel Drain Path	1.00	24-Mar-16	25-Mar-16
73114DD1160	Incorporate Comments from COMS & MDR -Fuel Channel Drain Path	3.00	25-Mar-16	30-Mar-16
73114DD1168	Submit Master EC Package Rev 0 & COMS Report -Fuel Channel Drain Path	1.00	30-Mar-16	31-Mar-16
73114DD1220	OPG Review of Master EC Package Rev 0 & COMS Report -Fuel Channel Dra	6.00	31-Mar-16	08-Apr-16
DNG-RFR-L5U1-11.73114.3.03.18	MEC 118506 CIVIL Retube Tooling Platform Installation	22.00	08-Mar-16	06-Apr-16
73114DD1072	OPG - Action ECR -RETUBE PLATFORM & JIB CRANE	1.00	08-Mar-16	08-Mar-16
73114DD1074	Kick-Off Meeting - TMod -RETUBE PLATFORM & JIB CRANE	1.00	08-Mar-16	08-Mar-16
73114DD1082	Create Master EC -RETUBE PLATFORM & JIB CRANE	1.00	09-Mar-16	09-Mar-16
73114DD1126	Prepare & Issue Design Plan -RETUBE PLATFORM & JIB CRANE	12.00	09-Mar-16	24-Mar-16
73114DD1188	Preliminary Engineering Walkdown Report -RETUBE PLATFORM & JIB CRAN	6.00	25-Mar-16	01-Apr-16
73114DD1190	Opex Report -RETUBE PLATFORM & JIB CRANE	6.00	25-Mar-16	01-Apr-16
73114DD1212	Prepare Modification Outline. -RETUBE PLATFORM & JIB CRANE	9.00	25-Mar-16	06-Apr-16
73114DD1214	Modification Design Requirements -RETUBE PLATFORM & JIB CRANE	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U1-11.73114.3.03.03	MEC 118671 ELECTRICAL Vault Temp. Power Distr. & Penetr. N	35.00	18-Feb-16	06-Apr-16
73114DD1024	OPG - Action ECR -VAULT TEMPORARY POWER DISTRIBUTION & PENETF	1.00	18-Feb-16	18-Feb-16
73114DD1026	Kick-Off Meeting - TMod -VAULT TEMPORARY POWER DISTRIBUTION & PE	1.00	18-Feb-16	18-Feb-16
73114DD1030	Create Master EC -VAULT TEMPORARY POWER DISTRIBUTION & PENETF	1.00	19-Feb-16	19-Feb-16
73114DD1058	Prepare & Issue Design Plan -VAULT TEMPORARY POWER DISTRIBUTION	12.00	19-Feb-16	07-Mar-16
73114DD1102	Preliminary Engineering Walkdown Report -VAULT TEMPORARY POWER DIS	6.00	08-Mar-16	15-Mar-16
73114DD1104	Opex Report -VAULT TEMPORARY POWER DISTRIBUTION & PENETRATIC	6.00	08-Mar-16	15-Mar-16
73114DD1106	Prepare Modification Outline. -VAULT TEMPORARY POWER DISTRIBUTION	9.00	08-Mar-16	18-Mar-16
73114DD1108	Modification Design Requirements -VAULT TEMPORARY POWER DISTRIBUT	9.00	08-Mar-16	18-Mar-16
73114DD1118	Internal Review of Master EC Package -VAULT TEMPORARY POWER DISTR	4.00	21-Mar-16	24-Mar-16
73114DD1138	Incorporate Comments Master EC Package -VAULT TEMPORARY POWER DI	2.00	25-Mar-16	28-Mar-16
73114DD1146	Submit Master EC Package Rev PB to OPG -VAULT TEMPORARY POWER DI	1.00	29-Mar-16	29-Mar-16
73114DD1202	OPG Review of Master EC Package Rev PB -VAULT TEMPORARY POWER D	6.00	30-Mar-16	06-Apr-16
DNG-RFR-L5U1-11.73114.3.03.07	MEC 118769 MECH Containment Isolations	13.00	29-Mar-16	14-Apr-16
73114DD1148	OPG - Action ECR -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	29-Mar-16	29-Mar-16
73114DD1150	Kick-Off Meeting - TMod -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	29-Mar-16	29-Mar-16
73114DD1162	Create Master EC -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	30-Mar-16	30-Mar-16
73114DD1248	Prepare & Issue Design Plan -CI Bulkhead / Calandria Seal / Associated Isolati	12.00	30-Mar-16	14-Apr-16
DNG-RFR-L5U1-11.73114.3.03.20	MEC 118770 MECH.OSM Feeder Assembly	45.00	01-Feb-16	01-Apr-16
73114DD1006	OPG - Action ECR -FEEDER ASSEMBLY	1.00	01-Feb-16	01-Feb-16
73114DD1008	Kick-Off Meeting - TMod -FEEDER ASSEMBLY	1.00	01-Feb-16	01-Feb-16
73114DD1014	Create Master EC -FEEDER ASSEMBLY	1.00	02-Feb-16	02-Feb-16
73114DD1022	Prepare & Issue Design Plan -FEEDER ASSEMBLY	12.00	02-Feb-16	17-Feb-16
73114DD1036	Preliminary Engineering Walkdown Report -FEEDER ASSEMBLY	6.00	18-Feb-16	25-Feb-16
73114DD1038	Opex Report -FEEDER ASSEMBLY	6.00	18-Feb-16	25-Feb-16
73114DD1048	Prepare Modification Outline. -FEEDER ASSEMBLY	9.00	18-Feb-16	01-Mar-16

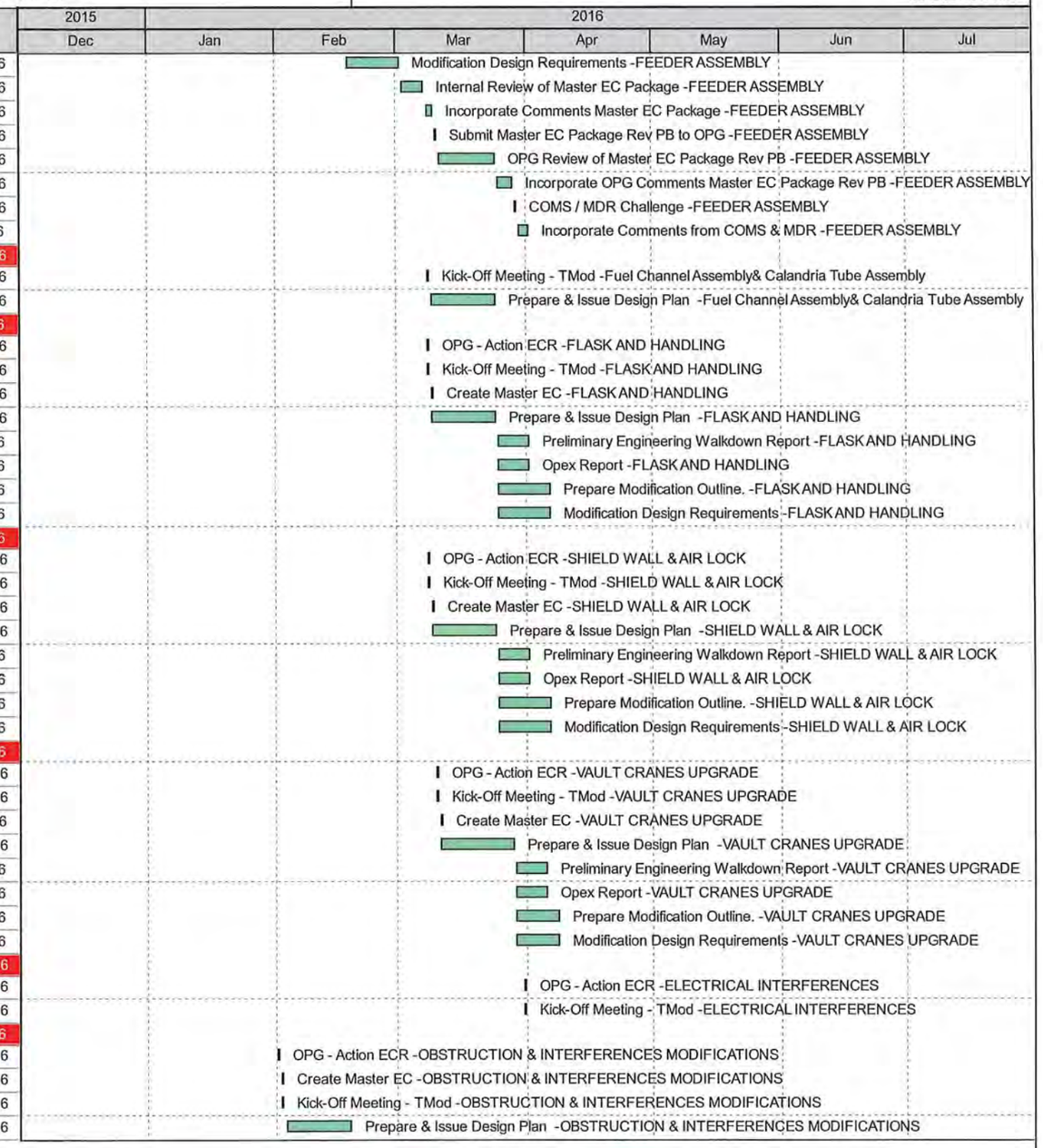


SNC·LAVALIN Nuclear
AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Critical Remaining Work
Actual Work
Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
73114DD1050	Modification Design Requirements -FEEDER ASSEMBLY	9.00	18-Feb-16	01-Mar-16
73114DD1060	Internal Review of Master EC Package -FEEDER ASSEMBLY	4.00	02-Mar-16	07-Mar-16
73114DD1084	Incorporate Comments Master EC Package -FEEDER ASSEMBLY	2.00	08-Mar-16	09-Mar-16
73114DD1090	Submit Master EC Package Rev PB to OPG -FEEDER ASSEMBLY	1.00	10-Mar-16	10-Mar-16
73114DD1128	OPG Review of Master EC Package Rev PB -FEEDER ASSEMBLY	10.00	11-Mar-16	24-Mar-16
73114DD1142	Incorporate OPG Comments Master EC Package Rev PB -FEEDER ASSEMBL	2.00	25-Mar-16	28-Mar-16
73114DD1156	COMS / MDR Challenge -FEEDER ASSEMBLY	1.00	29-Mar-16	29-Mar-16
73114DD1194	Incorporate Comments from COMS & MDR -FEEDER ASSEMBLY	3.00	30-Mar-16	01-Apr-16
DNG-RFR-L5U1-11.73114.3.03.08 MEC 118771 MECH.OSM - FC/CT Assembly		13.00	08-Mar-16	24-Mar-16
73114DD1062	Kick-Off Meeting - TMod -Fuel Channel Assembly& Calandria Tube Assembly	1.00	08-Mar-16	08-Mar-16
73114DD1120	Prepare & Issue Design Plan -Fuel Channel Assembly& Calandria Tube Assem	12.00	09-Mar-16	24-Mar-16
DNG-RFR-L5U1-11.73114.3.03.09 MEC 119178 CIVIL Flask and Handling		22.00	08-Mar-16	06-Apr-16
73114DD1064	OPG - Action ECR -FLASK AND HANDLING	1.00	08-Mar-16	08-Mar-16
73114DD1066	Kick-Off Meeting - TMod -FLASK AND HANDLING	1.00	08-Mar-16	08-Mar-16
73114DD1078	Create Master EC -FLASK AND HANDLING	1.00	09-Mar-16	09-Mar-16
73114DD1122	Prepare & Issue Design Plan -FLASK AND HANDLING	12.00	09-Mar-16	24-Mar-16
73114DD1178	Preliminary Engineering Walkdown Report -FLASK AND HANDLING	6.00	25-Mar-16	01-Apr-16
73114DD1180	Opex Report -FLASK AND HANDLING	6.00	25-Mar-16	01-Apr-16
73114DD1204	Prepare Modification Outline. -FLASK AND HANDLING	9.00	25-Mar-16	06-Apr-16
73114DD1206	Modification Design Requirements -FLASK AND HANDLING	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U1-11.73114.3.03.10 MEC 120544 CIVIL Floor Reinforcement & Shield Wall Mods		22.00	08-Mar-16	06-Apr-16
73114DD1068	OPG - Action ECR -SHIELD WALL & AIR LOCK	1.00	08-Mar-16	08-Mar-16
73114DD1070	Kick-Off Meeting - TMod -SHIELD WALL & AIR LOCK	1.00	08-Mar-16	08-Mar-16
73114DD1080	Create Master EC -SHIELD WALL & AIR LOCK	1.00	09-Mar-16	09-Mar-16
73114DD1124	Prepare & Issue Design Plan -SHIELD WALL & AIR LOCK	12.00	09-Mar-16	24-Mar-16
73114DD1182	Preliminary Engineering Walkdown Report -SHIELD WALL & AIR LOCK	6.00	25-Mar-16	01-Apr-16
73114DD1184	Opex Report -SHIELD WALL & AIR LOCK	6.00	25-Mar-16	01-Apr-16
73114DD1208	Prepare Modification Outline. -SHIELD WALL & AIR LOCK	9.00	25-Mar-16	06-Apr-16
73114DD1210	Modification Design Requirements -SHIELD WALL & AIR LOCK	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U1-11.73114.3.03.11 MEC 120850 ELECTR. Containment Vault Cranes Upgrade		22.00	10-Mar-16	08-Apr-16
73114DD1086	OPG - Action ECR -VAULT CRANES UPGRADE	1.00	10-Mar-16	10-Mar-16
73114DD1088	Kick-Off Meeting - TMod -VAULT CRANES UPGRADE	1.00	10-Mar-16	10-Mar-16
73114DD1096	Create Master EC -VAULT CRANES UPGRADE	1.00	11-Mar-16	11-Mar-16
73114DD1140	Prepare & Issue Design Plan -VAULT CRANES UPGRADE	12.00	11-Mar-16	28-Mar-16
73114DD1198	Preliminary Engineering Walkdown Report -VAULT CRANES UPGRADE	6.00	29-Mar-16	05-Apr-16
73114DD1200	Opex Report -VAULT CRANES UPGRADE	6.00	29-Mar-16	05-Apr-16
73114DD1226	Prepare Modification Outline. -VAULT CRANES UPGRADE	9.00	29-Mar-16	08-Apr-16
73114DD1228	Modification Design Requirements -VAULT CRANES UPGRADE	9.00	29-Mar-16	08-Apr-16
DNG-RFR-L5U1-11.73114.3.03.12 MEC 121054 ELECTR. Electrical Interferences and Services		1.00	31-Mar-16	31-Mar-16
73114DD1170	OPG - Action ECR -ELECTRICAL INTERFERENCES	1.00	31-Mar-16	31-Mar-16
73114DD1172	Kick-Off Meeting - TMod -ELECTRICAL INTERFERENCES	1.00	31-Mar-16	31-Mar-16
DNG-RFR-L5U1-11.73114.3.03.13 MEC 121123 MECH Mech. Services		49.00	01-Feb-16	07-Apr-16
73114DD1010	OPG - Action ECR -OBSTRUCTION & INTERFERENCES MODIFICATIONS	1.00	01-Feb-16	01-Feb-16
73114DD1016	Create Master EC -OBSTRUCTION & INTERFERENCES MODIFICATIONS	1.00	02-Feb-16	02-Feb-16
73114DD1018	Kick-Off Meeting - TMod -OBSTRUCTION & INTERFERENCES MODIFICATI(	1.00	02-Feb-16	02-Feb-16
73114DD1028	Prepare & Issue Design Plan -OBSTRUCTION & INTERFERENCES MODIFI(	12.00	03-Feb-16	18-Feb-16

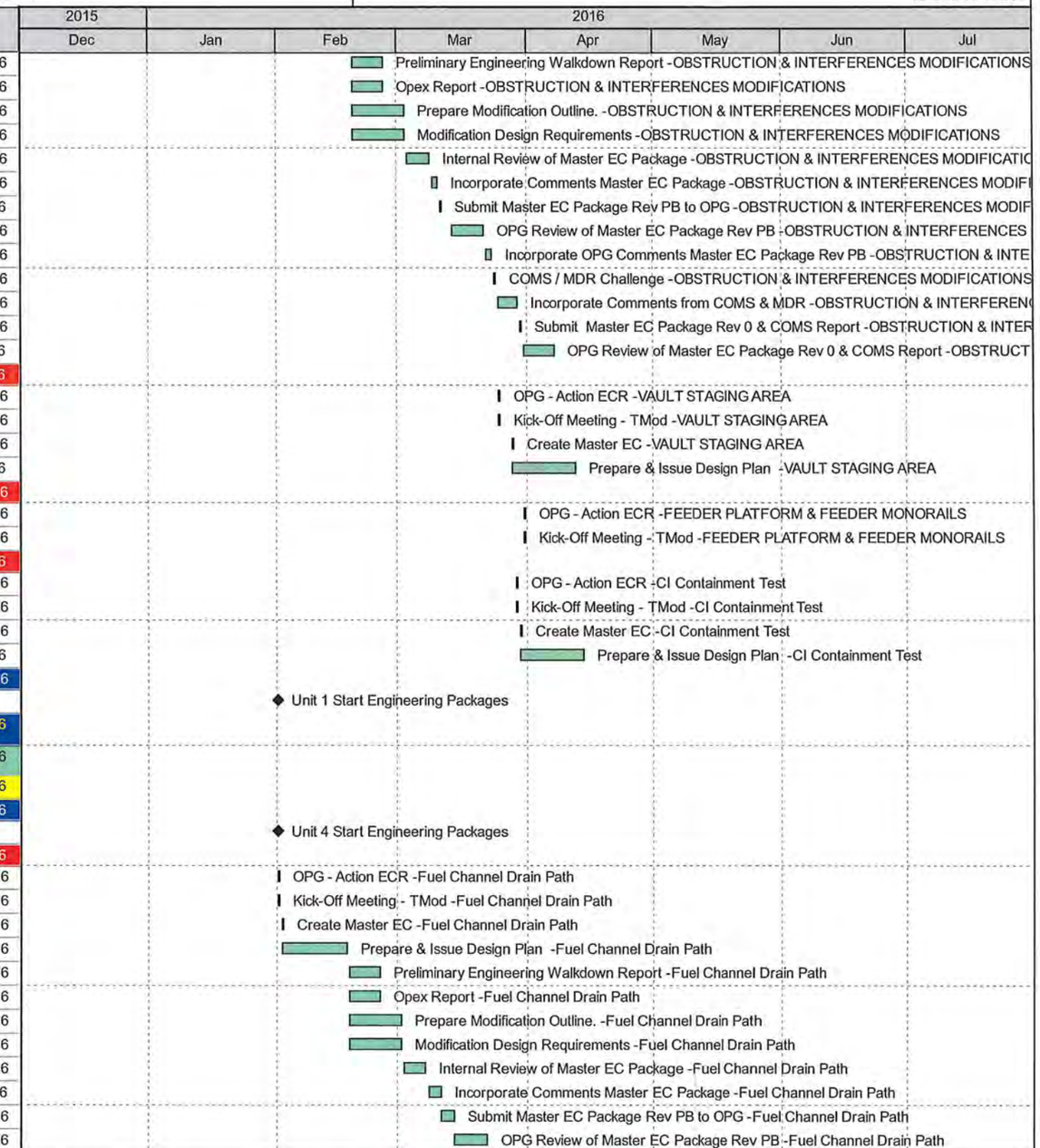


SNC·LAVALIN Nuclear
AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Critical Remaining Work
Actual Work
Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
73114DD1040	Preliminary Engineering Walkdown Report -OBSTRUCTION & INTERFERENC	6.00	19-Feb-16	26-Feb-16
73114DD1042	Opex Report -OBSTRUCTION & INTERFERENCES MODIFICATIONS	6.00	19-Feb-16	26-Feb-16
73114DD1052	Prepare Modification Outline. -OBSTRUCTION & INTERFERENCES MODIFIC	9.00	19-Feb-16	02-Mar-16
73114DD1054	Modification Design Requirements -OBSTRUCTION & INTERFERENCES MOI	9.00	19-Feb-16	02-Mar-16
73114DD1076	Internal Review of Master EC Package -OBSTRUCTION & INTERFERENCES	4.00	03-Mar-16	08-Mar-16
73114DD1092	Incorporate Comments Master EC Package -OBSTRUCTION & INTERFEREN	2.00	09-Mar-16	10-Mar-16
73114DD1098	Submit Master EC Package Rev PB to OPG -OBSTRUCTION & INTERFEREN	1.00	11-Mar-16	11-Mar-16
73114DD1110	OPG Review of Master EC Package Rev PB -OBSTRUCTION & INTERFEREN	6.00	14-Mar-16	21-Mar-16
73114DD1114	Incorporate OPG Comments Master EC Package Rev PB -OBSTRUCTION & I	2.00	22-Mar-16	23-Mar-16
73114DD1130	COMS / MDR Challenge -OBSTRUCTION & INTERFERENCES MODIFICATI	1.00	24-Mar-16	24-Mar-16
73114DD1158	Incorporate Comments from COMS & MDR -OBSTRUCTION & INTERFEREN	3.00	25-Mar-16	29-Mar-16
73114DD1166	Submit Master EC Package Rev 0 & COMS Report -OBSTRUCTION & INTEF	1.00	30-Mar-16	30-Mar-16
73114DD1216	OPG Review of Master EC Package Rev 0 & COMS Report -OBSTRUCTION &	6.00	31-Mar-16	07-Apr-16
DNG-RFR-L5U1-11.73114.3.03.14	MEC 121200 MECH Staging and Storage Areas	13.00	25-Mar-16	12-Apr-16
73114DD1134	OPG - Action ECR -VAULT STAGING AREA	1.00	25-Mar-16	25-Mar-16
73114DD1136	Kick-Off Meeting - TMod -VAULT STAGING AREA	1.00	25-Mar-16	25-Mar-16
73114DD1144	Create Master EC -VAULT STAGING AREA	1.00	28-Mar-16	28-Mar-16
73114DD1244	Prepare & Issue Design Plan -VAULT STAGING AREA	12.00	28-Mar-16	12-Apr-16
DNG-RFR-L5U1-11.73114.3.03.19	MEC 121205 CIVIL Feeder Platform & Monorails	1.00	31-Mar-16	31-Mar-16
73114DD1174	OPG - Action ECR -FEEDER PLATFORM & FEEDER MONORAILS	1.00	31-Mar-16	31-Mar-16
73114DD1176	Kick-Off Meeting - TMod -FEEDER PLATFORM & FEEDER MONORAILS	1.00	31-Mar-16	31-Mar-16
DNG-RFR-L5U1-11.73114.3.03.16	MEC 121421 MECH Containment Isolations Test Tie-Ins	13.00	29-Mar-16	14-Apr-16
73114DD1152	OPG - Action ECR -CI Containment Test	1.00	29-Mar-16	29-Mar-16
73114DD1154	Kick-Off Meeting - TMod -CI Containment Test	1.00	29-Mar-16	29-Mar-16
73114DD1164	Create Master EC -CI Containment Test	1.00	30-Mar-16	30-Mar-16
73114DD1256	Prepare & Issue Design Plan -CI Containment Test	12.00	30-Mar-16	14-Apr-16
DNG-RFR-L5U1-11.73114.3.04	Unit 1 Engineering DEC Packages	0.00	01-Feb-16	01-Feb-16
73114DD1000	Unit 1 Start Engineering Packages	0.00	01-Feb-1	
DNG-RFR-L5U4-11	509407-RFR Level 5 Execution Schedule Unit 4 Rev 0'	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U4-11.73116	Unit 4 (73116)	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U4-11.73116.3	Unit 4 Engineering	54.00	01-Feb-16	14-Apr-16
DNG-RFR-L5U4-11.73116.3.03	Unit 4 Engineering Preliminary Design MEC Packages	54.00	01-Feb-16	14-Apr-16
73116DD1000	Unit 4 Start Engineering Packages	0.00	01-Feb-1	
DNG-RFR-L5U4-11.73116.3.03.02	MEC 117317 MECH. Fuel Channel Drain Path	49.10	01-Feb-16	08-Apr-16
73116DD1002	OPG - Action ECR -Fuel Channel Drain Path	1.00	01-Feb-16	01-Feb-16
73116DD1004	Kick-Off Meeting - TMod -Fuel Channel Drain Path	1.00	01-Feb-16	01-Feb-16
73116DD1012	Create Master EC -Fuel Channel Drain Path	1.00	02-Feb-16	02-Feb-16
73116DD1020	Prepare & Issue Design Plan -Fuel Channel Drain Path	12.00	02-Feb-16	17-Feb-16
73116DD1032	Preliminary Engineering Walkdown Report -Fuel Channel Drain Path	6.00	18-Feb-16	25-Feb-16
73116DD1034	Opex Report -Fuel Channel Drain Path	6.00	18-Feb-16	25-Feb-16
73116DD1044	Prepare Modification Outline. -Fuel Channel Drain Path	9.00	18-Feb-16	01-Mar-16
73116DD1046	Modification Design Requirements -Fuel Channel Drain Path	9.00	18-Feb-16	01-Mar-16
73116DD1056	Internal Review of Master EC Package -Fuel Channel Drain Path	4.00	02-Mar-16	07-Mar-16
73116DD1094	Incorporate Comments Master EC Package -Fuel Channel Drain Path	3.10	08-Mar-16	11-Mar-16
73116DD1100	Submit Master EC Package Rev PB to OPG -Fuel Channel Drain Path	1.00	11-Mar-16	14-Mar-16
73116DD1112	OPG Review of Master EC Package Rev PB -Fuel Channel Drain Path	6.00	14-Mar-16	22-Mar-16

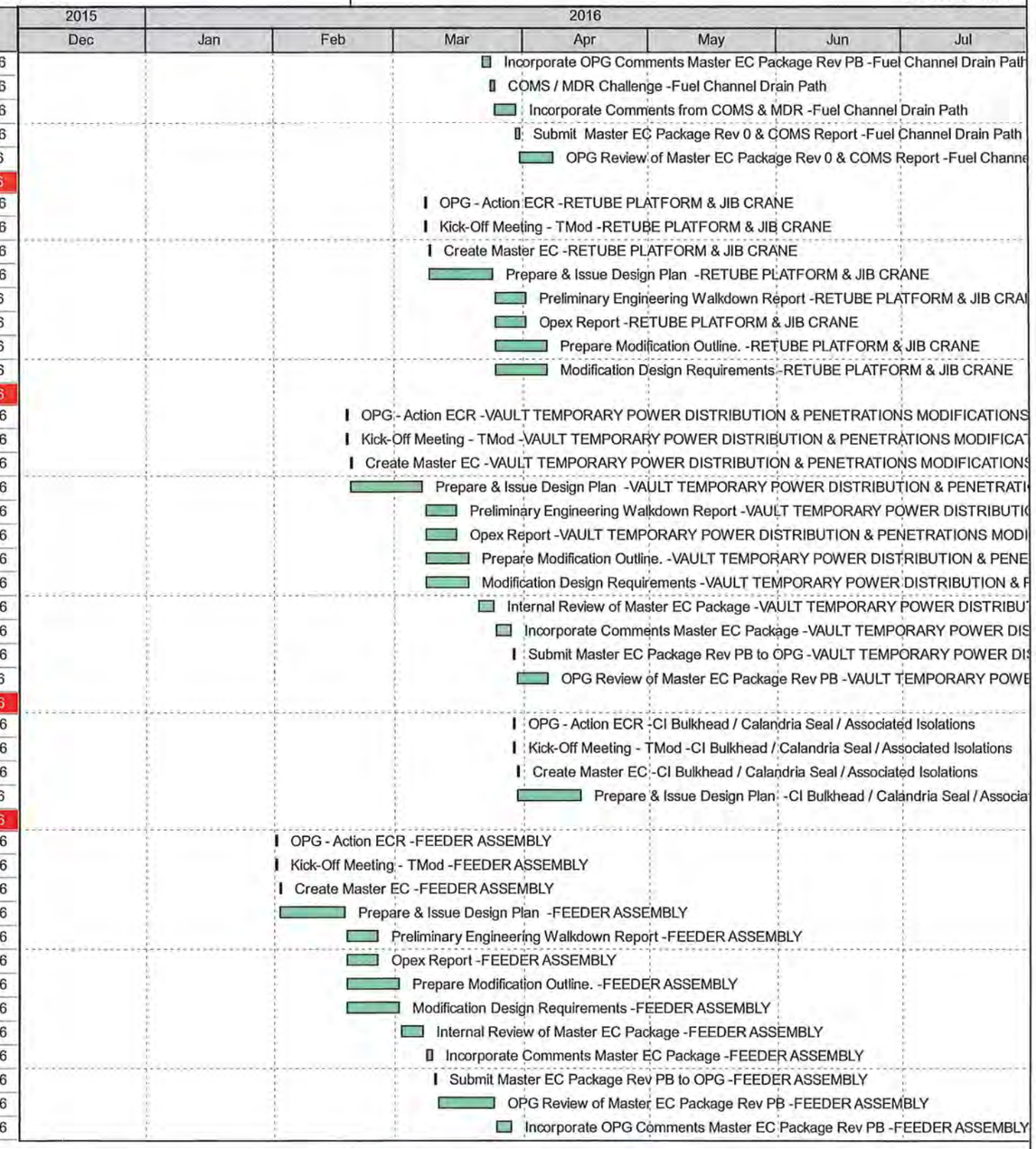


SNC·LAVALIN Nuclear AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort | Critical Remaining Work
Actual Work | Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
73116DD1116	Incorporate OPG Comments Master EC Package Rev PB -Fuel Channel Drain	2.00	22-Mar-16	24-Mar-16
73116DD1132	COMS / MDR Challenge -Fuel Channel Drain Path	1.00	24-Mar-16	25-Mar-16
73116DD1160	Incorporate Comments from COMS & MDR -Fuel Channel Drain Path	3.00	25-Mar-16	30-Mar-16
73116DD1168	Submit Master EC Package Rev 0 & COMS Report -Fuel Channel Drain Path	1.00	30-Mar-16	31-Mar-16
73116DD1220	OPG Review of Master EC Package Rev 0 & COMS Report -Fuel Channel Dra	6.00	31-Mar-16	08-Apr-16
DNG-RFR-L5U4-11.73116.3.03.18	MEC 118506 CIVIL Retube Tooling Platform Installation	22.00	08-Mar-16	06-Apr-16
73116DD1072	OPG - Action ECR -RETUBE PLATFORM & JIB CRANE	1.00	08-Mar-16	08-Mar-16
73116DD1074	Kick-Off Meeting - TMod -RETUBE PLATFORM & JIB CRANE	1.00	08-Mar-16	08-Mar-16
73116DD1082	Create Master EC -RETUBE PLATFORM & JIB CRANE	1.00	09-Mar-16	09-Mar-16
73116DD1126	Prepare & Issue Design Plan -RETUBE PLATFORM & JIB CRANE	12.00	09-Mar-16	24-Mar-16
73116DD1188	Preliminary Engineering Walkdown Report -RETUBE PLATFORM & JIB CRAN	6.00	25-Mar-16	01-Apr-16
73116DD1190	Opex Report -RETUBE PLATFORM & JIB CRANE	6.00	25-Mar-16	01-Apr-16
73116DD1212	Prepare Modification Outline. -RETUBE PLATFORM & JIB CRANE	9.00	25-Mar-16	06-Apr-16
73116DD1214	Modification Design Requirements -RETUBE PLATFORM & JIB CRANE	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U4-11.73116.3.03.03	MEC 118671 ELECTRICAL Vault Temp. Power Distr. & Penetr. M	35.00	18-Feb-16	06-Apr-16
73116DD1024	OPG - Action ECR -VAULT TEMPORARY POWER DISTRIBUTION & PENETF	1.00	18-Feb-16	18-Feb-16
73116DD1026	Kick-Off Meeting - TMod -VAULT TEMPORARY POWER DISTRIBUTION & PE	1.00	18-Feb-16	18-Feb-16
73116DD1030	Create Master EC -VAULT TEMPORARY POWER DISTRIBUTION & PENETF	1.00	19-Feb-16	19-Feb-16
73116DD1058	Prepare & Issue Design Plan -VAULT TEMPORARY POWER DISTRIBUTION	12.00	19-Feb-16	07-Mar-16
73116DD1102	Preliminary Engineering Walkdown Report -VAULT TEMPORARY POWER DIS	6.00	08-Mar-16	15-Mar-16
73116DD1104	Opex Report -VAULT TEMPORARY POWER DISTRIBUTION & PENETRATIC	6.00	08-Mar-16	15-Mar-16
73116DD1106	Prepare Modification Outline. -VAULT TEMPORARY POWER DISTRIBUTION	9.00	08-Mar-16	18-Mar-16
73116DD1108	Modification Design Requirements -VAULT TEMPORARY POWER DISTRIBUT	9.00	08-Mar-16	18-Mar-16
73116DD1118	Internal Review of Master EC Package -VAULT TEMPORARY POWER DISTR	4.00	21-Mar-16	24-Mar-16
73116DD1138	Incorporate Comments Master EC Package -VAULT TEMPORARY POWER DI	2.00	25-Mar-16	28-Mar-16
73116DD1146	Submit Master EC Package Rev PB to OPG -VAULT TEMPORARY POWER DI	1.00	29-Mar-16	29-Mar-16
73116DD1202	OPG Review of Master EC Package Rev PB -VAULT TEMPORARY POWER D	6.00	30-Mar-16	06-Apr-16
DNG-RFR-L5U4-11.73116.3.03.07	MEC 118769 MECH Containment Isolations	13.00	29-Mar-16	14-Apr-16
73116DD1148	OPG - Action ECR -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	29-Mar-16	29-Mar-16
73116DD1150	Kick-Off Meeting - TMod -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	29-Mar-16	29-Mar-16
73116DD1162	Create Master EC -CI Bulkhead / Calandria Seal / Associated Isolations	1.00	30-Mar-16	30-Mar-16
73116DD1248	Prepare & Issue Design Plan -CI Bulkhead / Calandria Seal / Associated Isolati	12.00	30-Mar-16	14-Apr-16
DNG-RFR-L5U4-11.73116.3.03.20	MEC 118770 MECH.OSM Feeder Assembly	45.00	01-Feb-16	01-Apr-16
73116DD1006	OPG - Action ECR -FEEDER ASSEMBLY	1.00	01-Feb-16	01-Feb-16
73116DD1008	Kick-Off Meeting - TMod -FEEDER ASSEMBLY	1.00	01-Feb-16	01-Feb-16
73116DD1014	Create Master EC -FEEDER ASSEMBLY	1.00	02-Feb-16	02-Feb-16
73116DD1022	Prepare & Issue Design Plan -FEEDER ASSEMBLY	12.00	02-Feb-16	17-Feb-16
73116DD1036	Preliminary Engineering Walkdown Report -FEEDER ASSEMBLY	6.00	18-Feb-16	25-Feb-16
73116DD1038	Opex Report -FEEDER ASSEMBLY	6.00	18-Feb-16	25-Feb-16
73116DD1048	Prepare Modification Outline. -FEEDER ASSEMBLY	9.00	18-Feb-16	01-Mar-16
73116DD1050	Modification Design Requirements -FEEDER ASSEMBLY	9.00	18-Feb-16	01-Mar-16
73116DD1060	Internal Review of Master EC Package -FEEDER ASSEMBLY	4.00	02-Mar-16	07-Mar-16
73116DD1084	Incorporate Comments Master EC Package -FEEDER ASSEMBLY	2.00	08-Mar-16	09-Mar-16
73116DD1090	Submit Master EC Package Rev PB to OPG -FEEDER ASSEMBLY	1.00	10-Mar-16	10-Mar-16
73116DD1128	OPG Review of Master EC Package Rev PB -FEEDER ASSEMBLY	10.00	11-Mar-16	24-Mar-16
73116DD1142	Incorporate OPG Comments Master EC Package Rev PB -FEEDER ASSEMBL	2.00	25-Mar-16	28-Mar-16

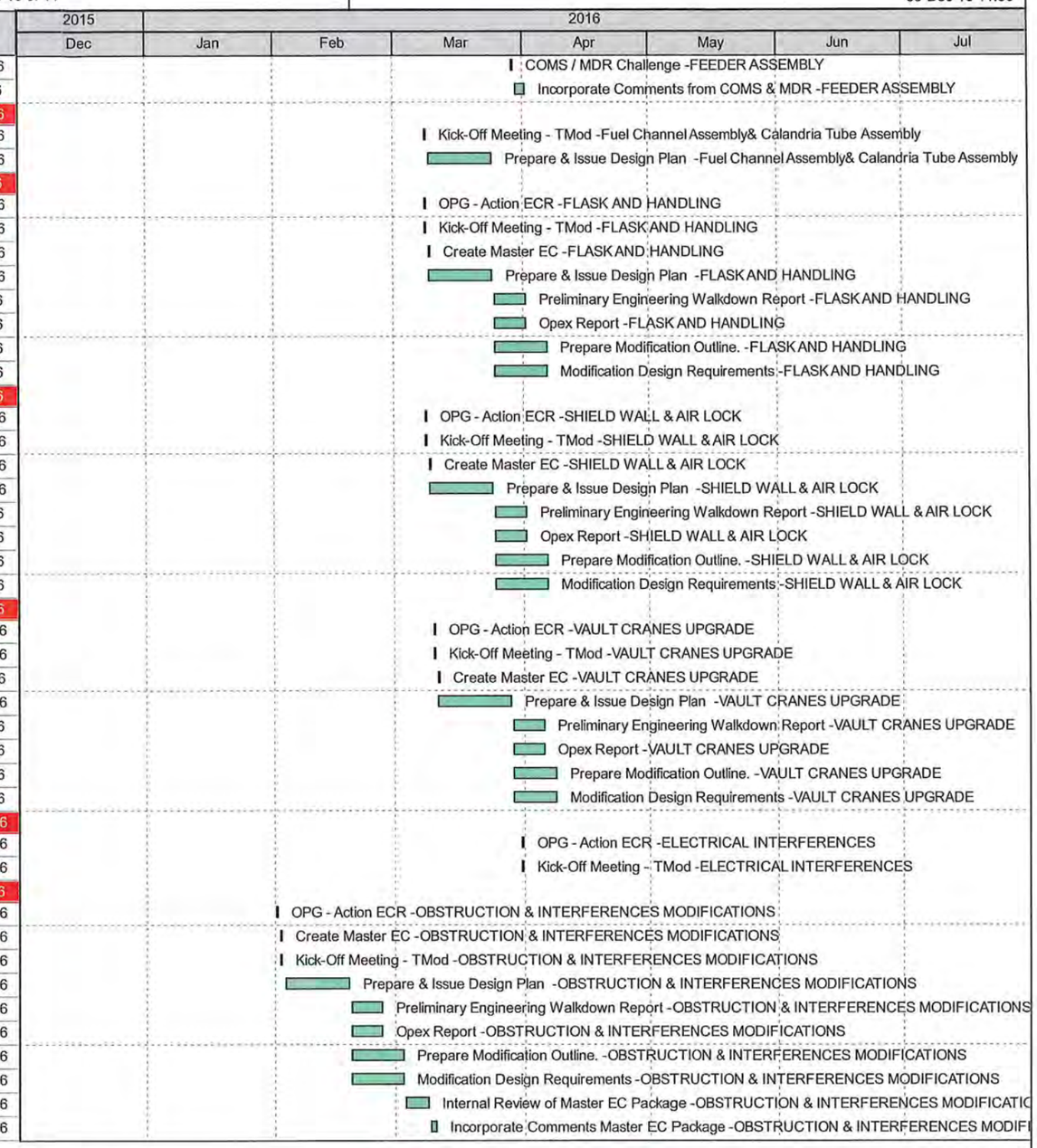


SNC·LAVALIN Nuclear
AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Critical Remaining Work
Actual Work
Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
73116DD1156	COMS / MDR Challenge -FEEDER ASSEMBLY	1.00	29-Mar-16	29-Mar-16
73116DD1194	Incorporate Comments from COMS & MDR -FEEDER ASSEMBLY	3.00	30-Mar-16	01-Apr-16
DNG-RFR-L5U4-11.73116.3.03.08 MEC 118771 MECH.OSM - FC/CT Assembly		13.00	08-Mar-16	24-Mar-16
73116DD1062	Kick-Off Meeting - TMod -Fuel Channel Assembly& Calandria Tube Assembly	1.00	08-Mar-16	08-Mar-16
73116DD1120	Prepare & Issue Design Plan -Fuel Channel Assembly& Calandria Tube Assem	12.00	09-Mar-16	24-Mar-16
DNG-RFR-L5U4-11.73116.3.03.09 MEC 119178 CIVIL Flask and Handling		22.00	08-Mar-16	06-Apr-16
73116DD1064	OPG - Action ECR -FLASK AND HANDLING	1.00	08-Mar-16	08-Mar-16
73116DD1066	Kick-Off Meeting - TMod -FLASK AND HANDLING	1.00	08-Mar-16	08-Mar-16
73116DD1078	Create Master EC -FLASK AND HANDLING	1.00	09-Mar-16	09-Mar-16
73116DD1122	Prepare & Issue Design Plan -FLASK AND HANDLING	12.00	09-Mar-16	24-Mar-16
73116DD1178	Preliminary Engineering Walkdown Report -FLASK AND HANDLING	6.00	25-Mar-16	01-Apr-16
73116DD1180	Opex Report -FLASK AND HANDLING	6.00	25-Mar-16	01-Apr-16
73116DD1204	Prepare Modification Outline. -FLASK AND HANDLING	9.00	25-Mar-16	06-Apr-16
73116DD1206	Modification Design Requirements -FLASK AND HANDLING	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U4-11.73116.3.03.10 MEC 120544 CIVIL Floor Reinforcement & Shield Wall Mods		22.00	08-Mar-16	06-Apr-16
73116DD1068	OPG - Action ECR -SHIELD WALL & AIR LOCK	1.00	08-Mar-16	08-Mar-16
73116DD1070	Kick-Off Meeting - TMod -SHIELD WALL & AIR LOCK	1.00	08-Mar-16	08-Mar-16
73116DD1080	Create Master EC -SHIELD WALL & AIR LOCK	1.00	09-Mar-16	09-Mar-16
73116DD1124	Prepare & Issue Design Plan -SHIELD WALL & AIR LOCK	12.00	09-Mar-16	24-Mar-16
73116DD1182	Preliminary Engineering Walkdown Report -SHIELD WALL & AIR LOCK	6.00	25-Mar-16	01-Apr-16
73116DD1184	Opex Report -SHIELD WALL & AIR LOCK	6.00	25-Mar-16	01-Apr-16
73116DD1208	Prepare Modification Outline. -SHIELD WALL & AIR LOCK	9.00	25-Mar-16	06-Apr-16
73116DD1210	Modification Design Requirements -SHIELD WALL & AIR LOCK	9.00	25-Mar-16	06-Apr-16
DNG-RFR-L5U4-11.73116.3.03.11 MEC 120850 ELECTR. Containment Vault Cranes Upgrade		22.00	10-Mar-16	08-Apr-16
73116DD1086	OPG - Action ECR -VAULT CRANES UPGRADE	1.00	10-Mar-16	10-Mar-16
73116DD1088	Kick-Off Meeting - TMod -VAULT CRANES UPGRADE	1.00	10-Mar-16	10-Mar-16
73116DD1096	Create Master EC -VAULT CRANES UPGRADE	1.00	11-Mar-16	11-Mar-16
73116DD1140	Prepare & Issue Design Plan -VAULT CRANES UPGRADE	12.00	11-Mar-16	28-Mar-16
73116DD1198	Preliminary Engineering Walkdown Report -VAULT CRANES UPGRADE	6.00	29-Mar-16	05-Apr-16
73116DD1200	Opex Report -VAULT CRANES UPGRADE	6.00	29-Mar-16	05-Apr-16
73116DD1226	Prepare Modification Outline. -VAULT CRANES UPGRADE	9.00	29-Mar-16	08-Apr-16
73116DD1228	Modification Design Requirements -VAULT CRANES UPGRADE	9.00	29-Mar-16	08-Apr-16
DNG-RFR-L5U4-11.73116.3.03.12 MEC 121054 ELECTR. Electrical Interferences and Services		1.00	31-Mar-16	31-Mar-16
73116DD1170	OPG - Action ECR -ELECTRICAL INTERFERENCES	1.00	31-Mar-16	31-Mar-16
73116DD1172	Kick-Off Meeting - TMod -ELECTRICAL INTERFERENCES	1.00	31-Mar-16	31-Mar-16
DNG-RFR-L5U4-11.73116.3.03.13 MEC 121123 MECH Mech. Services		49.00	01-Feb-16	07-Apr-16
73116DD1010	OPG - Action ECR -OBSTRUCTION & INTERFERENCES MODIFICATIONS	1.00	01-Feb-16	01-Feb-16
73116DD1016	Create Master EC -OBSTRUCTION & INTERFERENCES MODIFICATIONS	1.00	02-Feb-16	02-Feb-16
73116DD1018	Kick-Off Meeting - TMod -OBSTRUCTION & INTERFERENCES MODIFICATI(	1.00	02-Feb-16	02-Feb-16
73116DD1028	Prepare & Issue Design Plan -OBSTRUCTION & INTERFERENCES MODIFI(	12.00	03-Feb-16	18-Feb-16
73116DD1040	Preliminary Engineering Walkdown Report -OBSTRUCTION & INTERFEREN(	6.00	19-Feb-16	26-Feb-16
73116DD1042	Opex Report -OBSTRUCTION & INTERFERENCES MODIFICATIONS	6.00	19-Feb-16	26-Feb-16
73116DD1052	Prepare Modification Outline. -OBSTRUCTION & INTERFERENCES MODIFIC	9.00	19-Feb-16	02-Mar-16
73116DD1054	Modification Design Requirements -OBSTRUCTION & INTERFERENCES MOI	9.00	19-Feb-16	02-Mar-16
73116DD1076	Internal Review of Master EC Package -OBSTRUCTION & INTERFERENCES	4.00	03-Mar-16	08-Mar-16
73116DD1092	Incorporate Comments Master EC Package -OBSTRUCTION & INTERFEREN	2.00	09-Mar-16	10-Mar-16



SNC·LAVALIN Nuclear
AECON Joint Venture

Darlington NGS Retube and Feeder Replacement
Exhibit 1 Early Works

Remaining Level of Effort
Critical Remaining Work
Actual Work
Milestone
Remaining Work

Activity ID	Activity Name	Original Duration	Start	Finish
73116DD1098	Submit Master EC Package Rev PB to OPG -OBSTRUCTION & INTERFEREN	1.00	11-Mar-16	11-Mar-16
73116DD1110	OPG Review of Master EC Package Rev PB -OBSTRUCTION & INTERFEREN	6.00	14-Mar-16	21-Mar-16
73116DD1114	Incorporate OPG Comments Master EC Package Rev PB -OBSTRUCTION & I	2.00	22-Mar-16	23-Mar-16
73116DD1130	COMS / MDR Challenge -OBSTRUCTION & INTERFERENCES MODIFICATI	1.00	24-Mar-16	24-Mar-16
73116DD1158	Incorporate Comments from COMS & MDR -OBSTRUCTION & INTERFEREN	3.00	25-Mar-16	29-Mar-16
73116DD1166	Submit Master EC Package Rev 0 & COMS Report -OBSTRUCTION & INTEF	1.00	30-Mar-16	30-Mar-16
73116DD1216	OPG Review of Master EC Package Rev 0 & COMS Report -OBSTRUCTION &	6.00	31-Mar-16	07-Apr-16
DNG-RFR-L5U4-11.73116.3.03.14	MEC 121200 MECH Staging and Storage Areas	13.00	25-Mar-16	12-Apr-16
73116DD1134	OPG - Action ECR -VAULT STAGING AREA	1.00	25-Mar-16	25-Mar-16
73116DD1136	Kick-Off Meeting - TMod -VAULT STAGING AREA	1.00	25-Mar-16	25-Mar-16
73116DD1144	Create Master EC -VAULT STAGING AREA	1.00	28-Mar-16	28-Mar-16
73116DD1244	Prepare & Issue Design Plan -VAULT STAGING AREA	12.00	28-Mar-16	12-Apr-16
DNG-RFR-L5U4-11.73116.3.03.19	MEC 121205 CIVIL Feeder Platform & Monorails	1.00	31-Mar-16	31-Mar-16
73116DD1174	OPG - Action ECR -FEEDER PLATFORM & FEEDER MONORAILS	1.00	31-Mar-16	31-Mar-16
73116DD1176	Kick-Off Meeting - TMod -FEEDER PLATFORM & FEEDER MONORAILS	1.00	31-Mar-16	31-Mar-16
DNG-RFR-L5U4-11.73116.3.03.16	MEC 121421 MECH Containment Isolations Test Tie-Ins	13.00	29-Mar-16	14-Apr-16
73116DD1152	OPG - Action ECR -CI Containment Test	1.00	29-Mar-16	29-Mar-16
73116DD1154	Kick-Off Meeting - TMod -CI Containment Test	1.00	29-Mar-16	29-Mar-16
73116DD1164	Create Master EC -CI Containment Test	1.00	30-Mar-16	30-Mar-16
73116DD1256	Prepare & Issue Design Plan -CI Containment Test	12.00	30-Mar-16	14-Apr-16

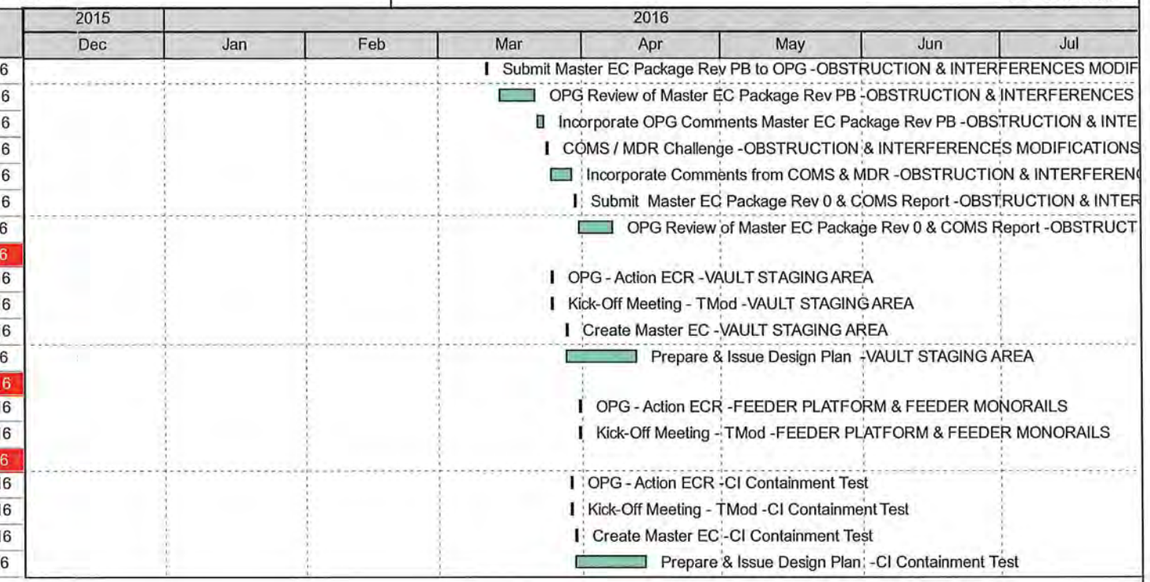


EXHIBIT 2

Milestone Payment Schedule for Early Works

	Milestone	Completion Date	Requirements to Satisfy Milestone Completion	% Fixed Fee Paid
1st Unit				
	Execution Phase Notice to Proceed	01-Jan-16	OPG Notice provided to contractor to commence Execution Phase.	[redacted]
	Execution Phase Schedule Integration	30-Jan-16	Execution Phase Schedule Management Plan and Project Controls Plan Reviewed/Reviewed as noted by OPG	[redacted]
	Detailed Execution Phase Target Schedule	28-Feb-16	Detailed Execution Phase Target Schedule Reviewed/Reviewed as noted by OPG	[redacted]
	Execution Phase Project Management Plans	30-Mar-16	Execution Phase Project Execution Plan, Quality Plan, Procurement Plan, Engineering Plan Reviewed/Reviewed as noted by OPG	[redacted]

ONTARIO POWER GENERATION

November 09, 2015 **CONFIDENTIAL & COMMERCIALLY SENSITIVE**

DNGS-Refurb - 213497

SNC-Lavalin Nuclear Inc.
2275 Upper Middle Road east
Oakville, Ontario L6H 0C3

Attention: Robert Stewart
Senior Vice President, Operations

Aecon Construction Group Inc.
150 Sheldon Drive
Cambridge, Ontario N1R 7K9

Attention: Ian Turnbull
President, Aecon Industrial,
a division of Aecon Construction Group Inc.

Dear Sirs:

Re: **Engineering, Procurement and Construction Agreement for the Darlington Refurbishment Retube and Feeder Replacement Project (the "RFR Project") between OPG and the contractual joint venture of SNC-Lavalin Nuclear Inc. and Aecon Construction Group Inc. (together, the "Joint Venture") dated as of March 1, 2012 (the "Agreement")**

Execution Phase Amendment

Rev. 1 of Class 2 Estimate Submission dated September 18, 2015, Document Identification Number 509407-0000-00000-33RA-0174 (the "Submission")

Thank you for providing us with the Submission and working with the OPG team to finalize the Execution Phase Amendment for the RFR Project.

As you are aware, OPG requires various approvals prior to signing the Execution Phase Amendment and proceeding with the Execution Phase of the RFR Project. OPG intends to seek those approvals on the basis of the Joint Venture's executed copy of the Execution Phase Amendment. By signing and returning a copy of this letter to OPG, you confirm that the Joint Venture's executed copy of the Execution Phase Amendment (a copy of which is attached to this letter), including all exhibits, schedules and appendices attached to it, will remain valid, binding and open for acceptance by OPG until the end of 2016.

Notwithstanding the foregoing paragraph, the Execution Phase Amendment, as executed by the Joint Venture, will not come into full force and effect until:

(a) the Execution Phase Amendment has been executed by OPG, following receipt by OPG of all required approvals, and delivered by OPG to the Joint Venture;

(b) OPG and the Joint Venture, acting reasonably, have finalized and executed a separate amendment to the Agreement reflecting the parties' agreement on the scope clarification chapter of the Submission and the mobilization plans comprised of project change directives 021, 025, 026, 027, 028 and 029;

(c) OPG has paid the Joint Venture (which payment will be made as soon as reasonably possible in accordance with the payment provisions of the Agreement) a fixed fee calculated in accordance with Exhibit 6.1 with respect to work for procuring and constructing the retube waste processing building performed under project change directive 020 up to October 31, 2015, which will be deducted from the fixed fee to be agreed upon for such work; and

(d) OPG and the Joint Venture, acting reasonably, have finalized and agreed to the following exhibits to the Execution Phase Amendment:

a. Exhibit 2.1(d)(12) (List of Modifications);
b. Exhibit 2.15(d) (List of Subcontractors and Key Subcontrectors);
c. Exhibit 3.1(b) (Execution Phase Milestone Schedule);
d. Exhibit 3.1(c)(B) (Target Schedule for Execution Phase Work);
e. Exhibit 3.1(d)(B) (Submittal Schedule for Execution Phase Work); and
f. Exhibit 12.1(a)(1) (Graphical Representation of Unit Mechanical Completion).

If the Execution Phase Amendment has not been executed and delivered by OPG prior to December 15, 2015, OPG will direct the Joint Venture to commence the Execution Phase Work preapproved by OPG and satisfactory to the Joint Venture, both acting reasonably, required to be performed by the Joint Venture after December 15, 2015 to perform the Work in support of the Execution Phase Target Schedule, and pay when due, in accordance with the payment provisions set out in the Agreement, any undisputed amounts owing to the Joint Venture for such Execution Phase Work performed after December 15, 2015. If OPG does not direct the Joint Venture to commence such Execution Phase Work on or prior to December 15, 2015, then if and when OPG executes the Execution Phase Amendment, OPG will be deemed to have changed the start date less than six months in advance of the start date for the Execution Phase Work and the provisions of section 3.10 of the Agreement will apply.

Neither OPG nor the Joint Venture will disseminate any press releases or make any other public statements regarding the Execution Phase of the RFR Project until the Execution Phase Amendment is fully executed and delivered by OPG and the above conditions have been met.

It is also expected that, if and as applicable, the escalation mechanism contained in the Agreement will apply to the pricing components of the Execution Phase Amendment.

This letter is the only document that reflects the parties' expectations regarding the process for executing the Execution Phase Amendment.

Yours truly,

ONTARIO POWER GENERATION INC.

Dietmar Reiner
SVP, Nuclear Projects

Agreed on this 9th day of November 2015, by:

SNC-LAVALIN NUCLEAR INC.

By:
Name: Robert Stewart
Title: Senior Vice President, Operations

AECON CONSTRUCTION GROUP INC.

By:
Name: Ian Turnbull
Title: President, Aecon Industrial, a division of Aecon Construction Group Inc.

Encl:

- Execution Phase Amendment executed by the Joint Venture;
- Exhibit 3.5(g) (Risk Register);
- Exhibit 3.11 (Baseline Outage Durations and Productivity Gains Illustrative Examples);
- Exhibit 5.2(k) (Radiation Protection Protocol);
- Exhibit 6.1 (Pricing);
- Exhibit 8.2(a) (Illustration and Examples: Execution Phase Target Cost – Incentives/Disincentives);
- Exhibit 16.1 (Suspension of Work Protocol).

cc: Scott Martin, OPG, SVP, Business and Administrative Services
Chris Ginther, OPG, SVP, Law and General Counsel, Chief Ethics Officer

ONTARIO POWER GENERATION

1855 Energy Drive, Courtice Ontario, L1E 0E7; Tel: (905) 623-6670

MEMORANDUM

OPG Confidential
Commercially Sensitive

January 7, 2016

PO No.: 213497

Mr. Jeff Lyash
President and Chief Executive Officer
Ontario Power Generation
700 University Avenue
Toronto, ON M5G 1Z5

Dear Mr. Lyash,

Re: Execution Phase Amendment (Amendment 4) to the Darlington Retube and Feeder Replacement Engineering, Procurement and Construction Agreement (RFR EPC Agreement) with the Joint Venture of SNC - Lavalin Nuclear Inc., and Aecon Construction Group Inc. (JV), dated as of March 1, 2012, previously amended as of October 1, 2012, February 28, 2014 and November 2, 2015.

The purpose of this Memorandum is to request approval for the Execution Phase Amendment (Amendment 4) to the RFR EPC Agreement with the JV.

Context:

The RFR EPC Agreement was executed effective March 1, 2012. Attached in Appendix A is the Major Contract Memorandum that was approved at that time, which summarizes the material terms and conditions of the RFR EPC Agreement, including the terms and conditions applicable to the Definition, Execution and Commissioning Phases of the Work.

The RFR EPC Agreement contemplates that as part of the Definition Phase Work, the JV would prepare an Execution Phase Plan, which includes the cost estimate, schedules (milestone, target and submittal) and risk register. The Execution Phase Plan was collaboratively reviewed by OPG and the JV (see Summary of Due Diligence Reviews below). It provides both parties with the detailed understanding of the scope of work, the risks and other information necessary to agree upon the cost, schedule and other terms and conditions upon which OPG will retain the JV to perform the Execution Phase Work. As required by the RFR EPC Agreement, these terms and conditions are to be incorporated via an Execution Phase Amendment, which is reflected in Amendment 4 (see Summary of Execution Phase Amendment below).

Summary of Due Diligence Reviews:

Between 2012 and 2014, the JV prepared progressively more detailed Execution Phase Estimates and Schedules, which culminated in the JV submitting the Class 2 Estimate, Level 5 Schedule and Risk Register Submission to OPG on June 2, 2015 (the R0 Submission). This Submission was intended to form the foundation of the Execution Phase Plan, however, it reflected an estimated cost between $3.3B and $3.7B and a total target duration of approximately 13 years, which was not acceptable to OPG.

To progress the R0 Submission to a point where OPG and the JV agreed upon the Execution Phase Plan, the RFR Project Team completed the following:

- Internal reviews of the R0 Submission.

- A collaborative detailed review and development process of the R0 Submission with the JV that led to the JV formally submitting Revision 01 of the Submission on September 18, 2015.
- The OPG RFR Project Team formally accepted the Revision 01 Submission on October 23, 2015.
- In parallel with this detailed review process, the OPG Refurbishment Executives were engaged in high level reviews with the JV Management Team.
- The detailed and high level reviews were interactive in nature, to ensure that all members of the OPG and JV Teams would be aligned with the results.

The detailed and high level reviews collectively resulted in agreement on the terms and conditions on which OPG would retain the JV to perform the Execution Phase Work, reflecting a total estimated cost of $2.75B and total schedule duration of approximately 9 years.

Summary of Execution Phase Amendment:

The Execution Phase Amendment (Amendment 4) (see Appendix B) reflects the terms and conditions upon which OPG will retain the JV to perform the Execution Phase Work, including the Execution Phase Plan, as follows (refer to Appendix C for more information):

1. **Incorporation of the Execution Phase Plan.** The following amendments have been agreed upon to reflect the changes contemplated in the RFR EPC Agreement that are required to proceed to the Execution Phase:

   - Exhibit 2.1(d)(12) List of Modifications was updated to reflect the Execution Phase Work modifications
   - Exhibit 2.15(d) List of Subcontractors and Key Subcontractors was updated to reflect the Execution Phase Work plans
   - Exhibit 3.1(b) Execution Phase Milestone Schedule was updated with all Execution Phase Schedule Milestones
   - Exhibit 3.1(c)(B) Target Schedule for Execution Phase Work was updated, including to reflect agreed Baseline Target Unit Outage Durations, which form the basis on which schedule incentives and disincentives will apply:

     [redacted]

   - Exhibit 3.1(d)(B) Submittal Schedule for Execution Phase work was updated to include all submittals required from the JV during the Execution Phase Work
   - Exhibit 3.5(g) Risk Register was updated to include Execution Phase Risks into the Risk Register.

- Exhibit 6.1 Pricing was updated to include the estimated total Execution Phase Cost ($2.75B), which is broken down as follows:

$1591M	Execution Phase Target Cost
$480M	Execution Phase Fixed Fee (Profit, Overhead and risk)
$68M	Support Services and Equipment (SS&E) Target Cost
$12M	SS&E Fixed Fee (Profit, Overhead and risk)
$599M	Estimate for all reimbursable costs including applicable mark ups (includes Owner Specified Materials (OSM), Goods, Commissioning Support, etc.)
$2.75B	TOTAL EXECUTION PHASE COST (unescalated)

2. [redacted]

3. **Clarification of Unit Outage Start and End Dates.** The Schedule Incentives and Disincentives are intended to apply to the period of time when the JV controls the work activities in the vault (the "JV Vault Work Window"). During the course of the Definition Phase, the Execution Phase scope of work was developed in detail, which resulted in the need to clarify the wording in the RFR EPC Agreement regarding the start and end date of the JV Vault Work Window for each Unit. These clarifications are reflected in the amendment to the definition of "Actual Outage Duration" in section 3.11.

4. **Radiation Protection (RP) Protocol.** The scope of work requires that OPG provide RP support to the JV on critical path during the JV Vault Work Window. The Initial Submission contemplated that OPG's RP support would delay critical path by approximately 61 days per Unit (244 days in total). It was agreed that since OPG controls the provision of RP support, that OPG should bear this risk. An RP Protocol was agreed upon which provides guidance on how to track and report circumstances where OPG's RP support unduly delays critical path and such delays were not the fault of the JV. The RP Protocol is attached as Exhibit 5.2(k) to the RFR EPC Agreement.

5. **Neutral Band Surrounding Execution Phase Target Cost.** There is a neutral band around the Target Cost for the Execution Phase Work, which reflects the range within which cost incentives/disincentives will not be payable. The neutral band around the Execution Phase Target Cost of approximately $1.6B was increased from +/- $25M to +/- $75M. This change resulted in the JV aggressively removing risk that had been embedded in the R0 Submission, amounting to approximately 200 days and $600M reduction in cost. Section 8.2(b)(2) and (c)(2) of the RFR EPC Agreement were amended to reflect this change.

6. **Incentive to Minimize Cost of Goods and Owner Specified Materials (OSM).** Goods and OSM are paid on a cost reimbursable basis, plus an agreed upon mark up on the actual cost. The JV is contractually required to obtain value for money and minimize these costs, however, there was no direct incentive mechanism attached to Goods and OSM. OPG and the JV have now agreed to create an incentive mechanism for the JV to achieve cost savings on Goods and OSM compared to the estimates in the Submission. If the actual aggregate cost of the OSM and Goods at the end of the project is less than the current aggregate estimate of OSM and Goods (excluding escalation), then this difference will be added to the neutral band around the Target Cost. These changes are reflected in section 8.2(c)(2) and Exhibit 6.1.

7. **Suspension of Work Protocol.** The RFR EPC Agreement contemplates that OPG may suspend all or part of the Work from time to time, in which event the JV receives its actual cost and the suspension period is not included in the calculation of the target schedule. The RFR EPC Agreement did not specifically provide the JV with the right to request appropriate cost and schedule relief in circumstances where OPG adds a new activity to the RFR critical path, and the new activity is not being performed by the JV. A Suspension of Work Protocol was agreed to clarify that in such circumstances, the JV will be entitled to ask OPG to confirm it is suspending the JV's work and allow for relief, in accordance with the previously agreed upon process for a suspension of work.

The release of all funds will continue to be managed in accordance with the Darlington Refurbishment Program release strategy which requires approval at various phases throughout the Project lifecycle.

Should you have any questions, please contact the undersigned.

Recommended By:

Jan 8/16

Meg Timberg Date
VP, Project Assurance &
Contract Management
Ontario Power Generation

Jan 8/16

Dietmar Reiner Date
SVP, Nuclear Projects
Ontario Power Generation

Jan 11, 2016

Glenn Jager Date
Chief Nuclear Officer
Ontario Power Generation

Approved By:

Jan 11/16

Stephen Cliver Date
Chief Supply Officer
Ontario Power Generation
(OAR 7.2 DLE Purchasing Approval)

Carlo Crozzoli Date
SVP and Acting Chief Financial Officer
Ontario Power Generation
(OAR 7.2 DLE Secondary Purchasing Approval)
(OAR 1.5 DLE Requisitioning Approval)

Jan 11/16

Scott Martin Date
SVP Business & Admin Services
Ontario Power Generation
(OAR 7.2 DLE Purchasing Approval)

Jan 11/2016

Jeff Lyash Date
President & CEO
Ontario Power Generation
(OAR 7.2 DLE Purchasing Approval)
(OAR 1.5 DLE Requisitioning Approval)

Encl:

- Appendix A – Darlington Retube and Feeder Replacement Contract Approval and Major Contract Memorandum
- Appendix B – Execution Phase Amendment (Amendment 4)
- Appendix C – Summary of Changes to RFR Agreement

Cc:
Mike Allen VP, Refurbishment
Roy Brown, Sr. Project Director, RFR
Nicole Fabbro, Sr. Manager, Supply Services
Leo Saagi, Director Finance
Cameron MacLeod, Manager, Strategic Contract Management
Evguenia Prokopieva, Sr. Counsel and Director, Law Division/Refurbishment

Approved By:

Stephun Cliver Date
Chief Supply Officer
Ontario Power Generation
(OAR 7.2 DLE Purchasing Approval)

Carlo Crozzoli Jan 11/16 Date
SVP and Acting Chief Financial Officer
Ontario Power Generation
(OAR 7.2 DLE Secondary Purchasing Approval)
(OAR 1.5 DLE Requisitioning Approval)

Scott Martin Date
SVP Business & Admin Services
Ontario Power Generation
(OAR 7.2 DLE Purchasing Approval)

Jeff Lyash Date
President & CEO
Ontario Power Generation
(OAR 7.2 DLE Purchasing Approval)
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Encl:

- Appendix A – Darlington Retube and Feeder Replacement Contract Approval and Major Contract Memorandum
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Leo Saagi, Director Finance
Cameron MacLeod, Manager, Strategic Contract Management
Evguenia Prokopieva, Sr. Counsel and Director, Law Division/Refurbishment

COST RISKS

Risk ID	Risk Title	Risk Description	Unit 2				Unit 3				Unit 1				Unit 4		
			Consequence		Probability		Consequence		Probability		Consequence		Probability		Consequence		Proba
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1.6	Forced work off site due to lack of site office space	If there is a lack of site office space it may cause work to be forced off site resulting in additional costs for building rentals.	$1M	$1M	0%	20%	$1M	$1M	0	10	$ -	$ -	$ -	$ -	$ -	$ -	$ -
1.8	Outage start date changes after target established	If the outage start date changes significantly it may cause the JV to incur costs that are not addressed by the provisions in the EPC agreement (Article 3.10 and 16.1) . Prolonged delay in start date may result in demobilization and remobilization that would adversely impact the JV's ability to retain staff and thus, adhere to the established targets.	$0M	$0M	0%	0%	$0M	$3M	20%	30%	$0M	$3M	10%	20%	$0M	$3M	10%
8.112	Bankruptcy of key vendors and requalification	Bankruptcy of key vendors and requalification	$0M	$0M	0%	0%	$0.6M	$0.6M	10%	30%	$ -	$ -	$ -	$ -	$ -	$ -	$ -
17.14	Unavailability of adequate apprentices	Potential unavailability of adequate apprentices will cause the inability to achieve the 1:5 apprentice to experienced trade ratio resulting in future labour shortages and additional costs to hire fully qualified craft	$0M	$3M	0%	10%	$0M	$3M	0%	8%	$0M	$3M	0%	8%	$ -	$ -	$ -
29.14	Changes to logistic/transportation for contaminated tools	Lack of space/vendors to store contaminated tools in certain peak times may cause significant changes to logistics/transportation methodology and storage rates resulting in additional costs.	$0.6M	$1.2M	10%	30%	$1.2M	2.4M	30%	50%	$1.2M	2.4M	30%	50%	$0.6M	$1.2M	10%

ability
Max
$ -
20%
$ -
$ -
30%

Section 7 - Range Analysis & Risk Quantification

1. Workshop Attendees

Risk ID	Risk Title	Risk Description	Basis	Mitigating Actions
6.4.	Crane Breakdown	If the reactor building crane breaks down, it may cause disruption to material and equipment movements resulting in productivity losses.	Based on OPEX multiple crane failures occurred (PLGS)	None.
6.7	RWPB Crane Failure	If the RWPB crane breaks down, it may cause disruption to material and equipment movements resulting in productivity losses.	Flask Handling will take more time. Lower crane failing in the way of the upper crane.	None.
6.8.	Lack of Power for tools and supporting equipment (i.e. lighting, munters)	If there is a power loss in the station it will cause lack of power to tools and supporting equipment resulting in a work stoppage and additional activities to return to service	Best estimate. Assuming UPS starts off immediately and there is no disruption in shutdown sequence. Likelihood of interruption is low. Recovery is generally obtained within the same shift.	None.
7.1.	Unexpected Vault Equipment Airlock Malfunction	Poor reliability of the vault equipment airlock may cause an unexpected malfunction resulting in restriction for transferring equipment, materials and tooling in and out of the vault	Mechanical airlocks. Affects CP only during pre-req and post-req. Darlington OPEX: 5 hours recovery time on CP.	Ensure dedicated airlock support staff available. Spare parts on-hand in case. Use the alternate airlock for personnel entry/exit. Confirm with Conventional Safety if the access to vault will be restricted if the main airlock will be damaged - open/closed.
10.3.	Unexpected failure of RTP elevator mechanism	Unexpected failures of the RTP elevator mechanism may cause loaded flasks with radiated material to remain on the RTP resulting in additional dose and productivity losses	Design improvements based on OPEX from LePreau and Wolsong	Contingency plan to be put in place to utilize Vault crane while RTP cannot be elevated.

16.7.	Interference with RFR activities due to unexpected OPG Plant Operations activities (for flask transfer activities)	Unexpected OPG Plant Operations for adjacent units may cause interference with JV RFR flask transfer activities resulting in work stoppages and a backlog of flasks.	1. Frequent ERT announcements that occur (fire alarms (not drills), rescue etc), may result of stoppage of work in some areas of the plant to permit ERT unimpeded access or local evacuation area to be established. 2. Radiography occurring in some plant areas result in temporary barriers and obstructions (potential to interfere with material, tooling, flask and personnel movements) 3. Site security issues resulting in temporary closure of incoming traffic of people and/or equipment 4. OPEX concerns raised on equipment that is used generally across the plant and within RFR. For example- manufacturer's product notices causing temporary freeze on the use of some equipment until a recall inspection is done, use of Cranes generally across the plant resulting in a lock up of Cranes until inspected, PPE generic issues across the plant, etc.etc. OPG will issue blanket instructions For action to be taken 5. OPG or other contractors management of labour issues that spill over into the RFR project causing work delays, labour actions, or expectations of "same treatment" within the JV work force= increased cost 6. fire drills working through accounting processes, assembly all clear etc. where work must stop 7. Outdoor restrictions (lighting weather tornado etc.) may interfere with material, RWC shipments etc. 8. Re-alignment of electrical supplies on station side, maintenance outages on service water, exhaust stack, monitors etc. all of which support the RFR - Quiet mode declared on operating units resulting in evacuation of RFR vault - Steam release in an operating unit resulting in evacuation of RFR vault - maintenance/shut down of telemetry dose monitoring system run by OPG RP - Plus many others that would take a roundtable discussion of GFs to bring out.	OPG to have interface protocol in place with Operations to minimise the impacts.
16.12.	Interference with RFR activities due to unexpected OPG Plant Operations activities (for in Vault Activities)	Unexpected OPG Plant Operations (i.e. Fuel Handling, Islanding, etc.) activiites may cause interference with JV RFR activities resulting in critical path delays	**1. Radiography (ESW) 0.5 day** **2. HFD Replacement - 0.5 day** **3. Fuel Handling - FM stuck under the Unit in once a month travel** **4. B Cooler (1 unit) - 1 day** **5. STOP - 0.5 day** **6. SG - 0.5 day** **7. PHT valves -** **8. VVRS - 1 day**	**JV to establish protocols with OPG and other vendors, as per agreement**
16.13.	Safety events caused by OPG or other contractors (occurences <3 days)	If OPG or other contractors do adhere to safety procedures it may cause a number of safety events less than 3 days resulting in an aggregate delay to critical path	Based upon OPEX i.e, Bruce RFR crane safety standown due to Bruce B incidents. Tied to OPG Safety Statistics as per millions of man hours worked.	OPG to reinforce safety culture amongst all contractors and OPG itself.
24.10.	Ozone excursion into the vault	Ozone excursion into the vault will cause a stand-down in the work. Would be caused by Calandria losing negative pressure due to ventilation system disturbances.	Wolsong OPEX in place.	Ensure that the vessel is kept at negative pressure. Set up equipment in advance and put program in place for proper monitoring.

27.3.	Heat Stress	Higher than expected temperature in vault areas may cause heat stress resulting a higher number of craft turnover.	Confined spaces and areas of higher elevation will result in areas of higher heat stress. This is an aggregated event and not a single one.	Ice vests maybe worn Time would be limited to < 1 hour continuously/employee. Temporary Chillers/ACUs to be installed before work begins. More plastic suits might be demanded.
16.8.	Multiple empowered single points of contact within OPG space	Multiple empowered single points of contact within OPG space (i.e. Ops, project, construction, etc.) may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	***SEE DIRECTLY BELOW: Broken into 4 risks***	
19.26.	Multiple empowered OPG Operations	Multiple empowered OPG Operations may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	Work Protection: 12 swaps - 1/2 a shift per swap = 3 days Ops Interference prior to escalation: one shift impact = 1/2 day	OPG to manage the interfaces
19.27.	Multiple empowered OPG Engineering	Multiple empowered OPG Engineering may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	Very minimal impact on critical path as most activities are expected to be on parallel path. Not a lot of engineering activities completed during execution phase. Expectation is to have an engineering group specifically for RFR that can sign off on changes.	OPG to manage the interfaces
19.28.	Multiple empowered OPG Work Management	Multiple empowered OPG Work Management may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	Expected quantification same as engineering	OPG to manage the interfaces

19.29.	Multiple empowered OPG Construction Oversight	Multiple empowered OPG Construction may cause difficulty to react to events and make decisions in a timely manner resulting in critical path delays	Less impact than Operations.	OPG to manage the interfaces
4.76.	Personnel injury/near miss	Personnel injury/near miss	Target 3 near misses causing one standdown. 4 incidents per 200,000 manhours as standard. The DFL / SS has so many hours. Lepreau OPEX - improper clamping as well as break in communication. Wolsong OPEX - Feeders dropped + Temp. shielding wall fall on personnel. Bruce OPEX - Electriclal panel dropped + RTP collision (4 week standown) Standown causing duration increases. Assuming procedures and prudent practices are followed.	
5.5.	Plant Equipment/Material Damage	Human performance incidents resulting damage to station equipment damage OR personnel injuries, resulting in standdown. This risk is the post-mitigated value after following prudent practices,.	The residual risk, after following prudent practices. Risk ID 11.1, 26.7 and 5.5 amalgamated. This risk includes activities such as flask transfer in station, waste reduction activities, large equipment transition movement in/out of the vault, hot welding activities.	Require confirmation from management that this is rework or not.
5.51.	Damage to existing common tooling i.e., HWT, pallet, IWT, RTP and related equipment, AGVs etc.	Human error during transitions may cause damage to existing common tooling resulting in craft being idle while the tool is repaired or replaced.	OPEX. Every refurb project including Darlington mock-up. Impact will reduce when there is a team ready to take action to transition into a new tool. HU related damages. Depends upon the severity of the damage.	Confirmation to be obtained on movement of panels. Rehearse transitions at the mock up (standby plan, if approved).

10.13.	Unavailability of Tools or Unexpected Tool Failure	Unpexpected tool set reliability and/or incorrect tool set up/usage may cause the tool to unexpectedly fail resulting in additional work for tool troubleshooting/maintenance. This includes HU type error as well as tool unavailability	The residual risk, after following prudent practices. Risk ID 29.12, 6.6, 4.55, 26.12, 4.49, 10.33, and 10.13 amalgamated. Contingencies set at: - Waste processing, 10% of Best Case overall, 7 days - Bellows Cut, 2.5 days, - AGV , 1 day - General, 3% of Tool availability excluding the Bellows Cut For last 2 Units - Waste processing, 2% 2days - Bellows Cut, 1 days, - General, 2%	It is advised to go through each series to understand the likelihood of tool failure. Relook at the evolution of tooling and lessons learned from previous tooling
16.9.	Interference with RFR activities due to unexpected OPG RFR related activities	Unexpected/Unplanned/Currently Unkonwn OPG or other OPG Contractor Activities may cause interference with JV RFR activities resulting in critical path delays.	Reactor vault when it is under JV jurisdiction.	Changes might be required to contract for scope injection process. Create language that creates a remidable delay for added non-JV scope in excess of the Level 5 execution phase schedule. 16.9.1. Work with OPG to determine appropriate time to complete PM activities. 16.9.2 Prepare Access Protocol agreement as per Article 2.16 (i) to coordinate work between contractors and OPG 16.9.3 OPG to provide an obligation in its 3rd party agreements to comply with Article 2.16 (i) to ensure cooperation between contractors and the JV

16.15.	OPG and/or other contractors will not be able to complete their critical path activities on schedule	If OPG and/or other contractors are not able to complete their critical path activities on schedule, this will impact JV target cost	Consequences being 0-30 days (The difference of total of most likely and total of worst case of OPG tasks before Airlock is Open). This risk has no impact on Target Schedule of JV, only Target Cost. 7 interfaces are identified that JV tasks will be impacted directly by OPG / other contractors.	None
4.118.	Calandria Seal Leak Test	May have extra duration on critical path, due to results of Calandria Seal Leak Test		

Mitigation Status	Rework (Yes or No)	New Conseq. (days)		New Prob. (%)		New Resultant P50	Comments	JV/OPG Risk Register	Response
Proposed	No	2	4	50	70	1.8		JV	
Proposed	No	0	2	10	30	0.2	No change to the New Coneq. Numbers.	JV	
Proposed	No	0	2	80	100	0.9		JV	Accepted as 4-1. OPEX in PLGS - one incident.
Proposed	No	0	2	80	100	0.9		JV	Mechanical lock with experienced operator attendants opening / closing to lower probability of risk events.
To Do	No	8	12	0	10	0.5		JV	Rule of 4-1 applies

Proposed	No	2	4	30	50	1.2		JV	
Proposed	NO	5	5	100	100	5	Unit to unit reduction. May need to be revisited for each unit.	JV	Radiography in the eavestrough pipe;
To Do	NO	0	4	40	60	1	Based on current outage OPEX	JV	
Proposed	No	2	4	30	50	1.2	Agreed Quantification	JV	Greater quantification suggested for subsequent units as the Thumb Tacks will be reused (possible seal failures)

To Do	No	4	8	20	40	1.8	Vault area ACUs are to be rebuilt and may not be available. No changes to the new conseq.	JV	Planned dates in summer vs winter.
						0			
To Do		6	8	40	60	3.5		JV	Operations Quantification: - 25 days @ 50% for cost - 10 days @ 50% for schedule Rationale: - OPG operations will be focused on keeping operating units running - during pre and post vault turnover, interfacing activities with OPG operations will be predominant - OPG operations are not accountable for JV RFR activities - changes authorized made by the group not aligning with the OPG Contract
To Do		0	2	20	40	0.3		JV	
To Do		0	2	20	40	0.3		JV	OPG Work Management Quantification: - 20 days, @ 50% Rationale: - Current OPG governance places OPG work management (Unit outage director) in position of authority to direct overall work program - OPG work management not accountable for RFR project activities

To Do		3	5	40	70	2.2		JV	Construction Oversight Quantification: - 10 days @ 50% Rationale: - Oversight roles not performed directly by OPG RFR project team have consistently provided instruction not alignment with OPG RFR project team (OPEX). - changes authorized made by the group not aligning with the RFR Contract
	No	8	12	0	20	1		JV	
To Do	?	10	30	10	30	4	None	JV	A large volume of material/tooling/heavy equipment handling is greater in magnitude than during operation/outages. Also the material/tooling/heavy equipment is much larger. At PLGS and Wolsong, rails were used and still damaged surrounding equipment on several occations. The quantitative assessment encompases a lower consequence than past OPEX and takes into account lessons learned. The craft handling the movements are not "specialized"/dedicated trades. Risk team believes that there would be insignificant risk reduction from unit to unit.
To Do	No	2	4	10	30	0.6	Tool Performance Guarentee reports provides great insight on improvements for such activity.	JV	Dropped shield plug in wolsong and damaged FCP ball screws, platform events (Retube platform damaged feeder platform in PLGS), shock heating tool that bent platform, collisions with RWC at Bruce, Positioning bar for rack on HWT), With the amount of lost time based on OPEX, quantification is based on improvement.

To do	No	21	21	100	100	21		JV	~375 day duration for tool availability. Based on current assessment, the P50 duration would only account for 8% of tool unavailability. The unavailability of tooling at any of the past refubs was significantly higher. Wolsong was also 2nd generation tooling.
16.9.1. Proposed 16.9.2 To Do 16.9.3 To Do	NO	10	20	10	30	3	Agreed jointly.	JV	Could be mitigated by defining the Non-JV Unknown Scope as Excusable Delays. Quantification of risk is subjective.

Proposed	No	0	30	20	40	4.5		JV	How is this a cost risk? It is a schedule (time dependent) risk that will inherently affect the Target Cost since most activities are outside the target outage duration
		0	0	0	0	0			
		NEW RESULTANT P50				54.9			

CWP	CWP Description	Risk ID	Risk Title	Risk Description	Cons eq. (days)		Prob. (%)		Team	Response	U3 (% of U2)	U1 (% of U2)	U4 (% of U2)
2017	RTP Install	12.51.	Tritium levels in vault	Higher tritium levels can force one of the airlock doors to be closed, impacting the ability to freely move material through the airlock.	1	5	0	10	TMODs	Potential leeching from concrete. Risk of an unforeseen tritium spill/event could drive up tritium levels which may result in the need to close airlock doors to ensure RAB tritium levels do not rise above 1MPCA. Mitigation would be to minimize activities that could generate spike in tritium.	100%	100%	100%

2017	RTP Install	4.54.	Hitting rebar/embedded steel during core drilling (Pressure boundary)	If a piece of rebar is hit in the ballscrew pits, then the area will have to be analyzed to ensure that the containment boundary is not compromised by the rebar being cut. Current approach is to scan, and avoid hitting rebar, limiting the possibility of cutting rebar. If a piece of rebar is cut, a PMOD will have to be processed, and OPG safety analysis approval to proceed in parallel with the PMOD completion will have to be received.	1	5	80	90		Increased tolerance for anchor bolt placement may not adequately mitigate this risk. Further development of contingency plans required. Approval for a contingency PMOD should be sought to ensure the critical path impact is kept to a minimum. Estimate of engineering cost to develop contingency plans needs to be provided by Greg Morandin and Steve Rate by EOD Aug 25. These costs will be carried in Class 2 Rev01. Risk has been reduced on the assumption of these contingency plans being in place for execution. Initial mitigation is oversized holes. Secondary mitigation is 5" tolerance on hole relocation. Final mitigation is contingency PMOD scenario.			
									TMODs	**Cost of mitigation required**	100%	100%	100%

2017	RTP Install	4.39.	Hitting Rebar (Non pressure boundary)	If newly specified anchor requires further drilling it may hit rebar resulting in relocation of the anchors or qualifying another anchor.	1	5	80	90		Increased tolerance for anchor bolt placement may not adequately mitigate this risk. Further development of contingency plans required. Approval for a contingency PMOD should be sought to ensure the critical path impact is kept to a minimum. Estimate of engineering cost to develop contingency plans needs to be provided by Greg Morandin and Steve Rate by EOD Aug 25. These costs will be carried in Class 2 Rev01. Risk has been reduced on the assumption of these contingency plans being in place for execution. Initial mitigation is oversized holes. Secondary mitigation is 5" tolerance on hole relocation. Final mitigation is contingency PMOD scenario.			
									TMODs	**Cost of mitigation required**	100%	100%	100%

2060	Replace Access Stairs	4.39.	Hitting Rebar (Non pressure boundary)	If newly specified anchor requires further drilling it may hit rebar resulting in relocation of the anchors or qualifying another anchor.	1	5	80	90		Replacement anchors are larger and deeper than the existing. Increased tolerance for anchor bolt placement may not adequately mitigate this risk. Further development of contingency plans required. Approval for a contingency PMOD should be sought to ensure the critical path impact is kept to a minimum. Estimate of engineering cost to develop contingency plans needs to be provided by Greg Morandin and Steve Rate by EOD Aug 25. These costs will be carried in Class 2 Rev01. Risk has been reduced on the assumption of these contingency plans being in place for execution. Initial mitigation is oversized holes. Secondary mitigation is 5" tolerance on hole relocation. Final mitigation is contingency PMOD scenario. **Cost of mitigation required**			
									TMODs		100%	100%	100%

2060	Replace Access Stairs	4.54.	Hitting rebar/embedded steel during core drilling (Pressure boundary)	If a piece of rebar is hit in the ballscrew pits, then the area will have to be analyzed to ensure that the containment boundary is not compromised by the rebar being cut. Current approach is to scan, and avoid hitting rebar, limiting the possibility of cutting rebar. If a piece of rebar is cut, a PMOD will have to be processed, and OPG safety analysis approval to proceed in parallel with the PMOD completion will have to be received.	1	5	80	90		Replacement anchors are larger and deeper than the existing. Increased tolerance for anchor bolt placement may not adequately mitigate this risk. Further development of contingency plans required. Approval for a contingency PMOD should be sought to ensure the critical path impact is kept to a minimum. Estimate of engineering cost to develop contingency plans needs to be provided by Greg Morandin and Steve Rate by EOD Aug 25. These costs will be carried in Class 2 Rev01. Risk has been reduced on the assumption of these contingency plans being in place for execution. Initial mitigation is oversized holes. Secondary mitigation is 5" tolerance on hole relocation. Final mitigation is contingency PMOD scenario. **Cost of mitigation required**			
									TMODs		100%	100%	100%

2100	Remove Reactor Area Bridge	4.52.	Remove roundways to remove elevator	If dowell set up is not as expected it will cause the roundways to be removed resulting in additional time for alignment during reinstallation.	2	4	30	50	TMODs	Based on OPEX during TPG	100%	100%	100%
2124	Bulkhead Install	24.11.	Pressure equalization between Vault and Duct	Inability to equalize pressure between Vault and Fuel Duct - The ability to weld the root pass on the bulkheads may be affected due to the pressure differential causing loss of cover gas	1	2	80	100	TMODs	Opportunity exists to apply sealant to catch containment trays between seal plate interface locations to mitigate negative pressure draw from fuelling duct, thus reducing the risk of weld failure.	100%	100%	100%

2124	Bulkhead Install	10.38.	APT breakdown	APT breakdown may cause critical path delays	1	5	20	30					
									TMODs	Currently no design. It remains an unknown at this time. Risk to be carried. Probability has been reduced to 20%-30%	90%	80%	70%

2125	Bulkhead Removal	10.38.	APT breakdown	APT breakdown may cause critical path delays	1	3	20	30	TMODs	Currently no design. It remains an unknown at this time. Risk to be carried.	90%	80%	70%
2166	PT Cut	4.72.	Contingency cut (Rework)	Rework	0	1	0	10	Removal/ Inspection	Agreed, rework **Follow-up required on confirmation of successful cut**	100%	100%	100%

2169	PT Removal	12.1.	Loss of highly radioactive debris/particles	Highly radioactive debris escaping the designed flow path into the work areas may cause worker exposure to higher dose resulting in contingency plan for recovery and work stoppage.	0	2	10	30	Removal/ Inspection	Risk to remain The PT will be pulled into the flask, the garter springs may remain in the ouboard end of the Guide Sleeve (groove in GS flange). The integrity of the garter spring is in an unknown condition	100%	100%	100%

2169	PT Removal	18.11.	PT Cut contingency piece falls over	If a PT contingency cut piece falls over it may impede the PT gripper to engage to PT resulting in retrieval/removal of the bracelet	0	2	0	10	Removal/ Inspection	Risk to remain Currently, the design is such that if the ligament exists it will be potentially attached to the EF. A ligament resulting from a false negative primary cut has the potential to fall over regardless of the cut parameters/cut location.	100%	100%	100%
2169	PT Removal TRANSITION OUT	12.39.	Serapid chain exceeding safe working dose rate	If build up of contamination on serapid chain is higher than expected it may cause the serapid chain to exceed safe working dose rate resulting in replacement of a full palette	1	2	50	70	Removal/ Inspection	Chain is likely to become contaminated, requiring a pallet change out at the end of the series. Tool change out is faster than replacing the serapid chain.	100%	100%	100%

2169	PT Removal	4.95.	Dummy Bundle/FROB lost during PT removal process	Need to find the dummy bundle/FROB that was lost during the removal process	1	2	10	15	Removal/ Inspection	Cosequence lowered, probablity lowered Mitigation is to have tracking form to identify what PT is in what FLASK. **Previous**: consequence (3-5), probability (40-60) **New**: consequence (1-2), probability (10-15)	100%	100%	100%
2170	Bellows Replacement	5.46.	Damage to Bellows (rework)	If there is damage to bellows, repair/replacement will be required resulting in schedule delays	0	7	40	60	Removal/ Inspection		100%	100%	100%
2172	FC Install	4.87.	Weld Failure (Visual inspection) (rework)	Bellows weld failure and resulting cut out could potentially affect critical path	0	2	0	10	Install	Rework risk	100%	100%	100%

2172	FC Install	4.61.	Fuel channel replacement (Rework)	Based on Wolsong/Bruce OPEX, 1 SFCR may have to be performed during FC Install series due to quality issues (i.e., feeder port angle out of spec)	1	4	40	50	Install	Rework risk	100%	100%	100%

2173	New Fuel Load	4.43.	Broken Shim/Fuel Bundle Removal	Heavy fuel bundles may cause the shim to break off in the channel resulting retreival of the shim	0	1	5	10	Install	Risk to remain Low probability and low consequence reflects improved process	100%	100%	100%
2173	New Fuel Load	9.41.	Lapping/Mouldin g of the EF Closure Cap sealing surface (Rework)	If indications are found on the end fitting closure cap sealing surface during inspection it may cause lapping of the sealing surface	2	3	10	20	Install	Rework risk	100%	100%	100%

2173	New Fuel Load	4.100.	CNSC/ OPG Fuel Secure Requirements	A method needs to be developed and agreed upon to ensure Fuel Security requirements are being met.	4	5	5	10	Install	This should remain a risk, if the special initiative to allow 'NFL resequencing' is rejected, this critical path time will be incurred	0%	0%	0%

2176	CTI Removal	4.84.	CTI falls out of tubesheet into lattice tube	CTI falls out of tubesheet into lattice tube	1	2	10	20	Removal/ Inspection	This scenario occurred a total of 6 times during the Wolsong campaign.	100%	100%	100%
2176	CTI Removal	4.85.	CTI warping (Rework)	reshock required, plus removal	6	8	0	10	Removal/ Inspection	agree, rework	0%	0%	0%

2177	CT Removal	15.11.	Additional force required to remove CT	If designed force does not successfully remove the CT is may cause reactor engineering to approve additional force above the tech spec resulting in schedule delays	2	3	40	60	Removal/ Inspection	agree, retire **Before this can be retired, there needs to be engineering pre-approval for RTP loading up to 40000 lbs**	0%	0%	0%

2178	Calandria Vessel Inspection	4.81.	Technical staff do not have jurisdiction to operate CVI tooling	**Technical staff do not have jurisdiction to operate CVI tooling, resulting in camera cable entanglement**	0	1	0	10	Removal/ Inspection	Basis - previous Retube projects had experts running the tools (designers of the tools). Darlington will have trained trades (not designers) to run the tools. Mitigation - jurisdiction markup shall include non-trade tool operators to eliminate risk for subsequent units	0%	0%	0%
2179	LT and Bellows Inspection	29.6.	Bellows cut not square due to tool failure (Rework)	If bellows cutting tool fails it may cause bellows not being square resulting in re-squaring bellows	1	2	0	10	Removal/ Inspection	**Cost of mitigation required - SCADA sequence change to use laser on BCT to obtain adhoc squareness measurements in order to reduce consequence of this risk**	100%	100%	100%
2179	LT and Bellows Inspection	4.8.	Helicoil replacement	May have to replace the helicoils when removing the TTs as the TT studs will need to be removed	0	2	10	20	Removal/ Inspection	**Cost of mitigation required - mitigating activities to reduce likelihood of helicoils coming out. Assessed as not being rework on the basis that handling of helicoil is part of standard work process steps**	100%	100%	100%

2180	CTSB Inspection	12.45.	Loss of Contamination Control resulting in work stoppage	High volume of contamination may cause loss of contamination control resulting in a work stoppage and initiating decontamination to recover	1	3	40	60	Removal/ Inspection	No change to risk	50%	50%	50%
2180	CTSB Inspection	5.17.	Improper brushing and excessive as found deposits (CTSB)	Improper brushing and excessive as found deposits may cause damage resulting in additional brushing, swabbing or debris cleaning.	8	12	10	30	Removal/ Inspection	**This risk will remain for the first unit but will be eliminated by U2 OPEX for subsequent units**	0%	0%	0%
2180	CTSB Inspection	4.44.	CTSB Milling (Rework)	CTSB milling required due to JV human performance/tooling issue damaging tubesheet (Not concealed condition)	2	4	0	10	Removal/ Inspection	**No change to risk - risk scoring is post-mitigation and is outside any concealed conditions**	100%	50%	50%

2181	FME Inspection	4.48.	Hitting a reactor component during FME Debris Retrieval	If a reactor component is hit by the FME Debris Retrieval tool, a stand-down could take place and assessments of the component would be on critical path	1	3	0	10	Removal/ Inspection	Risk to remain this happened at Lepreau with trained operators and a simulation. the tool is manually operated. The duration was reduced to reflect the time to inspect the component that was hit, and to assess tooling and simulation to ensure this does not happen again. The probability was reduced as OPEX was based on Lepreau tool that is different from the Darlington RFR tool **Cost of mitigation required to ensure simulation and proper operator training is in place for this series. In addition, there should be a prepared pathforward on dispositioning any impacts with internal calandria components (i.e., adjuster rods, VFDs etc.) in the event that they occur during this series**	0%	0%	0%
2183	CT Install	18.12.	Calandria tube replacement (Rework)	Tubes installed out of tolerance, requiring Rolled Joint to be shock-heated and tooling installed to remove tubes, and tube then reinstalled. This risk also captures contingency actions associated with RJ leak test failure	15	20	0	20	Install	agree, rework Justification for duration: 1. Transition out of CT install tools and IWT 2. Transition in, install and commission of CTI Release tooling 3. Perform shock heat 4. Transition in CT Removal Contingency tools 5. Remove CT 6. Transition out of CT Removal Contingency Tools 7. Transition in CT Install tools 8. Re-install CTs	100%	100%	100%
2183	CT Install	14.8.	FME loss during series	FME loss during production after FME inspection and retrieval series	1	2	10	20	Install	Risk to remain, agree	100%	100%	100%

2187	Bulkhead Containment Test	24.7.	An isolation point between units is missed (JV and OPG)	An isolation point in containment or an internal process system is missed this will require the test to stop, the isolation be corrected and the test to be restarted.	8	12	0	10		If a leak is encountered, leak searching must be performed to identify the source, TCB must be depressurized, repairs must be done, and test profile must be repeated			
									TMODs	**Mistakes will be identified and rectified for subsequent units**	0%	0%	0%

2227	Dummy Bundle Retrieval	4.97.	Hot fleas released	possibility that hot fleas are released on the RTP when the dummy bundles are removed	1	2	20	30	Removal/ Inspection	Risk modification Risk probability reduced from (20-40%) to (20-30%)	100%	100%	100%
0010	Waste EF Processing	26.20.	Recovery from an Outboard EF being dropped during the transfer from the Trough to the LLWC as a result of a Robot failure	Assumes recovery procedure is in place in case this risk happens	0	1	0	10	Waste Processing	This is a measure of tooling performance and procedures. Additional post FAT Testing including dry cycling testing. Robot can be operated in manual mode if required.			

0010	Waste EF Processing	26.21.	Trolley not being able to rotate the RWC/DSO	Assumes recovery procedure is in place in case this risk happens	0	1	0	10	Waste Processing	This is a measure of tooling performance and procedures. Manual recovery mode is available. Switch to the second line and change out defective motor Rehearsals to perform motor change out and this is a planned contingency operation during PTP.			
2146	Lower Feeder Install	4.106.	Rework (Weld Repair, End Fitting Side Port and Feeder Coupling Hub Repair)	Poor feeder weld quality may cause high rejection rates, PAUT interpretation, higher dose uptakes, and additional time for repairs. In addition End Fitting side port and Feeder coupling hub may require repair.	8	12	30	50	Feeders		100%	100%	100%
2145	Upper Feeder Install	4.107.	Delays associated with Rework	Poor feeder weld quality may cause high rejection rates, PAUT interpretation, higher dose uptakes, and additional radiography for repairs resulting in productivity losses. This duration includes nozzle height repair	16	20	40	60	Feeders		100%	100%	100%
2124	Bulkhead Install	4.108.	Rework	Poor access ability or human performance of bulkhead weld locations may result in failed weld and require repair.	1	2	80	90	TMODs	**Can apply CAT welding system to reduce incidents of failed welds**			
2124	Bulkhead Install	4.109.	Pressure equalization between Vault and Duct	Inability to equalize pressure between Vault and Fuel Duct - OPS has identified the potential issue of the VVRS having reduced capacity due to breathing air load and elevated tritium levels during bulkhead install resulting in reduced manpower levels to 10 people in vault for final welding.	2	6	40	70	TMODs	**Can apply CAT welding system to reduce number of mandatory welders**			

~~0010~~	~~Waste PT Processing~~	~~26.12.~~	~~Simultaneous dual-line failure~~	~~Simultaneous dual-line failure occurs resulting in press swap-outs. Recovery achieved with one line restored~~	~~0~~	~~14~~	~~0~~	~~10~~	~~Waste Processing~~	~~Tool failure and unavailability is a measure of tooling performance and procedures.~~ ~~More Training for Press Changeout which should reduce the time taken~~ ~~Extra Testing post FAT and the ability to run in Burst Mode which will allow the system to catch up~~ ~~There is a possibility that the second Processing Line can go down while the primary line is being repaired~~			
2175	CTI Release	4.110.	ES Measurements require additional assessment due to unexpected readings	TS requires measurements to be provided to the Design Organization for every row of CTI released and CT removed for acceptance and approval to proceed. 10 sites can be released/removed prior to receiving approval to proceed from the Design Organization. Risk is the directive from the Design Organization to stop work if the values are outside the acceptance criteria range	1	3	0	10	Removal/ Inspection	**Revise TS requirement to eliminate this risk (Cost of mitigation)**	0%	0%	0%
2176	CTI Removal	4.110.	ES Measurements require additional assessment due to unexpected readings	TS requires measurements to be provided to the Design Organization for every row of CTI released and CT removed for acceptance and approval to proceed. 10 sites can be released/removed prior to receiving approval to proceed from the Design Organization. Risk is the directive from the Design Organization to stop work if the values are outside the acceptance criteria range	1	3	0	10	Removal/ Inspection	**Revise TS requirement to eliminate this risk (Cost of mitigation)**	0%	0%	0%
2183	CT Install	4.8.	Helicoil replacement	May have to replace the helicoils when removing the TTs as the TT studs will need to be removed	0	2	10	20	Removal/ Inspection	**Cost of mitigation required - mitigating activities to reduce likelihood of helicoils coming out. Assessed as not being rework on the basis that handling of helicoil is part of standard work process steps**	100%	100%	100%
2172	FC Install	4.8.	Helicoil replacement	May have to replace the helicoils when removing the TT studs and temporary PA hardware	0	2	10	20	Removal/ Inspection	**Cost of mitigation required - mitigating activities to reduce likelihood of helicoils coming out. Assessed as not being rework on the basis that handling of helicoil is part of standard work process steps**	100%	100%	100%
2177	CT Removal	4.110.	ES Measurements require additional assessment due to unexpected readings	TS requires measurements to be provided to the Design Organization for every row of CTI released and CT removed for acceptance and approval to proceed. 10 sites can be released/removed prior to receiving approval to proceed from the Design Organization. Risk is the directive from the Design Organization to stop work if the values are outside the acceptance criteria range	1	3	0	10	Removal/ Inspection	**Revise TS requirement to eliminate this risk (Cost of mitigation)**	0%	0%	0%

2181	FME Inspection	4.111.	Debris Retrieval (Rework)	If debris is introduced to the calandria vessel during CT Install, it will have to be retrieved using FME tooling	1	3	40	60	Removal/ Inspection		100%	100%	100%

ONTARIO POWER GENERATION

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Document Number: **N-MAN-00120-10001**	Usage Classification:
Sheet Number: **RISK-04**	Revision: **R002**

Title:
NUCLEAR REFURBISHMENT RISK MANAGEMENT & CONTINGENCY DEVELOPMENT GUIDE

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Nuclear Refurbishment Risk Management & Contingency Development Guide

N-MAN-00120-10001-RISK-04-R002
2014-24-03

Order Number: N/A
Other Reference Number:

Internal Use Only

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Revision Summary

Revision Number	Date	Comments
R000	2012-07-25	First Issue
R001	2013-12-01	Major Revision to the document to provide additional guidance to the NR Risk Management Process to supplement the Program Risk Management Plan. Also aligned probability and impact risk assessment scale to the Corporate risk assessment scale.
R002	2014-03-24	Integrate N-MAN-00120-10001-Risk 05 (contingency development) to create a consolidated single document. Removed the cost control/change control/reporting sections for contingency. Non-intent updates to provide clarification or context as requested by manual users.

1.0 DIRECTION

This document provides guidance for risk management activities at Nuclear Refurbishment (NR) and is to be used as a supplemental guide to the Refurbishment Program Planning & Control Management Plan NK38-NR-PLAN-09701-10001 Sheet 2.

2.0 RISK MANAGEMENT PROCESS

The objectives of risk management are to increase the probability and impact of positive events, and decrease the probability and impact of negative events.

Risk management processes at NR include the following:

a) **Risk Management Planning** – the process of defining how to conduct risk management activities for a project/program

b) **Risk Identification** – the process of determining which risks may affect the project and documenting their characteristics

c) **Risk Assessment** (Qualitative and Quantitative) – the process of analyzing the risks on their probability and impact

d) **Risk Response Planning** – the process of developing options and actions to reduce threats to project objectives

e) **Risk Monitoring and Control** – the process of implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks, and evaluating risk process effectiveness throughout the NR life cycle.

2.1 Risk Management Planning

A well thought out risk management plan enhances the probability of success for the subsequent risk management processes. As such, the risk management planning process begins as soon as a project is conceived.

2.1.1 Risk Management Plan

A Risk Management Plan describes how risk management will be structured and performed for a Program or Project.

Each project execution bundle prepares a Project Risk Management Plan (RMP), referencing the Refurbishment Program Planning & Control Management Plan NK38-

NR-PLAN-09701-10001 Sheet 2 and documents any specific project variances to the program risk management process.

Included in Project/Bundle Risk Management Plans are the following:

(1) Risk Management Methodology

Defines the approach, tools, and data sources that may be used to perform risk management on the project.

(2) Roles and Responsibilities

Defines the lead, support, and risk management team members for each type of activity in the risk management plan and clarify their responsibilities.

(3) Budgeting

Assign resources, estimate funds needed for risk management for inclusions in the base cost of the project.

(4) Timing

Defines when and how often the risk management process will be performed through the NR life cycle and establish risk management activities to be included in the project schedule.

(5) Risk Categories

Provides a structure that ensures a comprehensive process of systematically identifying risks to a consistent level of detail. A Risk Breakdown Structure (RBS) may be used as a tool to organize project risks hierarchically, where risks are arranged by category and subcategory, identifying the various areas and causes of potential risks. An example is shown in Figure 1.

(6) Applicable Probability and Impact Matrix

See Appendix C for the Risk Assessment Criteria/Scale for Program and Project Risks.

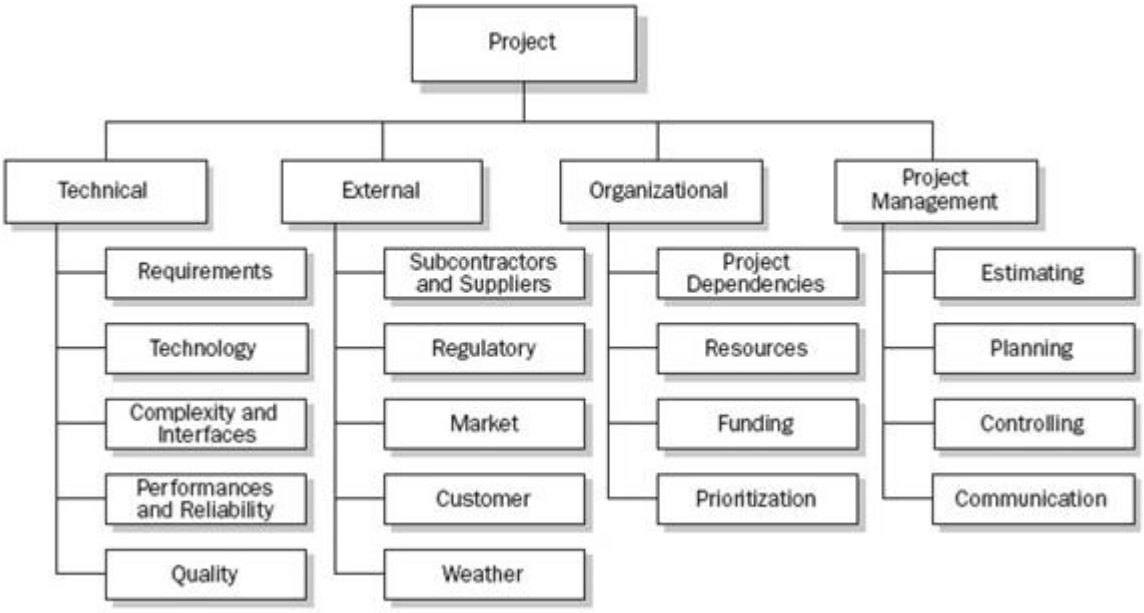


Figure 1 Sample Risk Breakdown Structure

2.2 Risk Identification

Risk identification is an iterative process since new risks may evolve or become known as the project/program progresses.

A number of techniques or forums may be used for the identification of risks. In all cases, the project team & function is involved so they can develop and maintain a sense of ownership and responsibility for the risks and associated risk response actions.

Tools and techniques to identify risks include, but are not limited to:

(b) Facilitated workshops; forums where participants brainstorm ideas about risks, and then identify, categorize, and further define them. Workshops can be facilitated by the NR Risk Section, the P&C lead, or a third party as approved by the NR risk section manager.

(c) Structured Interviews with experienced project team members, stakeholders and SMEs.

(d) Project Definition Rating Index (PDRI) Workshops

- A Construction Industry Institute (CII) tool

- A facilitated forum where participants assess the readiness of the project to proceed by answering a list of standardized and categorized questions. Workshops can be facilitated by the NR Risk Section, the P&C lead, or a third party as approved by the NR risk section manager.

(e) OPEX Review (Refer to N-MAN-00120-10001 Risk 06)

(f) Key Assumptions Review (Refer to N-MAN-00120-10001 Risk 07)

(g) Basis of Estimate (BOE) Review; review of assumptions and constraints in the BOE can be used as a source for risk identification.

(h) Project Schedule Review; review of near critical, critical path and schedule float in schedule assumptions can be used as a source for risk identification.

2.2.1 Common Pitfalls in Risk Identification

There are four common pitfalls in risk identification that leads to inefficiencies in managing risks:

(1) The presumption of failure of the base plan;

(2) Identifying Issues as Risks;

(3) Business-as-Usual Risks; and

(4) Vague or misleading Risk Titles and Risk Descriptions

2.2.1.1 The Presumption of Failure

Too often project and functional managers submit base plans (scope, cost, schedule, resources) for approval that they do not believe are reasonable and acheivable. The risk register submitted alongside the base plan then becomes a bulky list of items that are not true risks, but rather items designed to compensate for the known deficiencies or challenges of the base plan. Further, a large risk register may be viewed as a means to indicate to the approval boards that the project ‘’is not easy’’ or has been unsuccessful in the past. This presumption of failure creates too many risks to effectively manage and a lack of clear priortization for the team.

2.2.1.2 Identifying Issues as Risks

Issues are events that have 100% probability of occurring, or have occurred already and require resolution. As such, these are not risk events, but rather, issues that the project or functions should address or monitor. Hence, risks that have been realized are considered as issues. Identifying issues as risks may distract the project or function managers and prevent them from focusing on the adverse impacts that are truly preventable.

2.2.1.3 Business-as-Usual Risks

Events that will be addressed in the normal course of conducting work are termed Business-as-Usual risks. These are items that have a process, plan or organization in place to address them, but the concern is that the execution may be “less than adequate”.

Examples of poor use of Business-as-Usual risks include:

- “Project Managers may not meet milestones”.
- “Oversight plan may not provide complete details to provide guidance for oversight.”

In general, in order to be a risk there has to be impact to the objectives of the base plan. Business as usual items may truly present a risk to the base plan but this impact must be clearly identified in the risk description in order to be effectively managed.

2.2.1.4 Vague or Misleading Risk Titles and Risk Descriptions

Risk titles that are too vague or misleading may result in risk response plans that do not truly address the risks that the project/program are facing. The following are guidelines to follow when drafting risk titles and risk descriptions:

a) Risk Titles

(1) Risk titles describe the **event** and the **context** of the event.

- E.g. “There is a risk of insufficient welders available <*event*> to support Execution <*context*>”

(2) Risk titles should not include potential impact, especially if there are multiple impacts (as these should be characterized under Risk Description instead)

b) Risk Descriptions

(1) Risk descriptions should be comprised of the risk **event**, the **cause**, and the **impact** of the event.

- E.g. “There is a risk of insufficient welders available <*event*> to support Execution due to competition with other large industrial projects in the province <*cause*>, resulting in a delay that will impact the critical path by 30 days<*impact*>”.

2.2.2 Risk Register

A risk register is a living repository of risks. There are two risk registers for the NR. The Program Risk Assessment Database and Register (RADAR) and Project RADAR. See Appendix A for steps to create, update, and close risks.See Appendix B for descriptions of the fields contained in the database

2.2.2.1 Risk Register Administration

(a) Program RADAR is managed by the P&C Risk Section. It contains risks that apply to the entire NR program and risks that are related to the functions.

(b) Project RADAR is managed by each individual project bundle and is overseen and supported by the P&C Risk Section.

(c) Read and Write Access to the RADAR logs are controlled by an administrator, contact the P&C Risk Section if read/write access is required.

(d) Risks cannot be deleted from RADAR. Risks entered in error should be closed with a note to indicate that the risk was entered inadvertently.

2.3 Risk Assessment

Risk Assessment is the process of analyzing the risks on their probability and impact. Risks can be assessed qualitatively, quantitatively, or both.

2.3.2.1 Qualitative Scoring of Risks

Qualitative scores are based on probability of occurence, schedule impact and financial impact of a risk. These scores are assigned based on a standard Risk Assessment Criteria/Scales for the purpose of consistency and ease of priortization.

There is a set of criteria for Program Risks, and another set of criteria for Project Risks. See Appendix C for the Risk Assessment Criteria/Scale.

Note: The RFR project bundle uses the program risk assessment criteria/scale due to the magnitude of their risk impact.

After the probability, financial impact and schedule impact scores are determined, the risk score is calculated **by multiplying the probability score with the financial or schedule score which ever is higher.** When scoring, ensure the cost impact of a schedule delay (“burn rate”) is addressed by the financial score.

2.3.2.2 Heat Map

Figure 2 shows a heat map representing the severity of a risk based on probability and impact.

Impact Score						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
RED = Significant Risks YELLOW = Major Risks GREEN = Minor Risks		**1**	**2**	**3**	**4**	**5**
		Probability Score				

Figure 2: Heat Map

2.3.3 Quantitative Risk Analysis

A quantitative risk analysis is the process of assigning a dollar value to the effect of identified risks on overall project objectives. Quantitative risk analysis is performed on risks that have a significant qualitative risk and require contingency fund allocation. Not all risks qualitatively scored and managed per this risk management process will qualify for contingency (refer to Section 3.0). Wherever possible, the estimating group should be engaged in supporting the quantificaton (cost impact) of a risk to the base plan.

2.4 Risk Response Planning

Risk response requires effort to develop a plan to minimize the risk and implement response actions. All risks in the risk register should have one of the following risk responses:

- Avoid – Obtain information to better define the risk source, eliminating the risk entirely.
- Transfer – Shifting some or all negative impacts of a threat to a third party (eg. to a contractor via contract terms and conditions). If this response is chosen, the NR risk owner is ***still accountable*** to manage this risk on an ongoing basis.
- Mitigate – Take actions to reduce the probability and/or impact of an adverse risk event to be within acceptable limits.

- Accept – Take no action and accept the possibility that the risk could occur.
- Monitor – Periodically assess the risk through the normal course of project execution until, a) clear mitigating actions are identified, or b) a more appropriate risk response is identified.

2.4.1 Evaluating the Effectiveness of Risk Responses

All risks in the risk register should have three sets of risk scores:

(a) Pre-Response Risk Score – the score assuming that the risk will be accepted. This is a one-time assessment at the ‘’point of discovery” of the risk.

(b) Post-Response Risk Score – the score of the residual risk assuming the risk response is completed successfully. This score is subjective and based on the confidence level of the risk owner in the effectiveness of their risk response. This post response score is a gauge of how manageable the risk owner believes the risk is.

(c) Current Risk Score – the score reflecting the current status of the risk. This is the primary measure of risk exposure for the purpose of planning and risk metrics/response analysis.

2.4.2 Considerations in Risk Response Planning

Prior to selecting a risk response for an identified risk, the following items should be considered:

a) An informal cost-benefit analysis may be performed to evaluate the effectiveness of the risk response. If the cost to mitigate the risk is greater than accepting the probability and the impact of the risk “as-is”, then the risk response should be “Accept” and not “Mitigate”.

b) The seemingly appropriate risk response strategy for one project or function cannot come at the detriment of another (or the NR program as a whole) unless supported by a cost benefit analysis. Contact NR Risk Section for guidance if required.

2.5 Risk Monitoring and Control

2.5.1 Risk Reviews

The risk owner has the accountibillity for the content of their risks in RADAR, even if they have delegated their authority to update or manage the risk to others. Each risk owner shall perform, at minimum, monthly risk reviews to:

(a) Ensure risk responses are optimal based on the latest information;

(b) Ensure mitigation actions are on track and status the actions in the Actions Log;

(c) Determine if the assumptions related to the risks are still valid and update in the Key Assumptions Log, if applicable;

(d) Determine if the risk characteristics have changed;

(e) Determine if new risks should be identified;

(f) Determine if risk has realized or expired and can be closed in RADAR (with justification).

The Risk Owner should be notified of all changes on a risk.

2.5.2 Risk Reporting

Risk reporting is performed in line with monthly or quarterly reporting cycles. The content of risk reports prepared shall reflect the content in RADAR. The P&C Risk section will perform oversight of the functions and bundles to ensure consistency between RADAR and the risk content in report submissions. For senior management and external stakeholder reporting, this holds true however the P&C Risk Section may make the RADAR wording more concise to align with the level of detail required in the specific reporting vehicle.

Examples of reporting vehicles for risk include:

- Program Reports
- Quad Chart
- NOC (Nuclear Oversight Committee) Reports
- Quarterly ERM (Enterprise Risk Management) Reports.

2.5.2.1 Risk Metrics

In order to assess the effectiveness of the NR Risk Management Program, the Risk Section, will prepare metrics. The Risk Dashboard will be the primary metric that will identify trends and allow comparisons of risk across the projects, functions, and the program as a whole. As the risk management practice in NR evolves and matures, additional metrics will be introduced.

3.0 INTRODUCTION TO CONTINGENCY DEVELOPMENT

Contingency is a project management tool to manage the uncertainties throughout the life of a project. Contingency development is an integral part of estimating, scheduling and risk management processes. Contingent funds to address uncertainties in a

project should be proportionate to the project size, duration and complexity, risk exposure and tolerance, organization's prior experience with the work, and confidence levels set by management. In all cases, contingency development is predicated on a high quality base plan and a high quality risk register. Without a high quality base plan, one cannot effectively identify risks. Without a high quality risk register, one cannot effectively identify contingency.

3.1 Characterization of Uncertainties

Uncertainties in a project can be characterized as *knowns*, *known unknown* and *unknown unknown* situations or conditions. Depending on the outcome, uncertainties may manifest as risks or opportunities.

- When we are aware of a range of potential outcomes inherent in an activity, these situations are *knowns*. For example, an estimate built upon conceptual design information is assumed as inaccurate, but with an expected range of potential outcomes based on past experiences.

- A *known unknown* is an acknowledged situation that could affect the activity, but its potential for occurrence is not immediate, nor would one normally expect it in the course of the activity. For example, the potential for a serious safety incident is known, but would not be expected based on the safety measures taken at the work site.

- The *unknown unknown* situations are extraordinary events that one cannot have foreseen. For example, the eruption of an Icelandic volcano interrupting airline traffic across Europe for several days was not expected in the airline industry.

The overall principle of contingency determination and contingency management at NR is that all contingency allocation and contingency drawdown must be justified and approved. No "general" or "unallocated" contingency is permitted except for addressing *unknown unknowns* in NR.

3.2 Classification of Contingent Funds

There are two main classifications of contingent funds to address different types of uncertainties – contingency and management reserve.

3.2.2 Contingency

Contingency is used to cover the *knowns* and *known unknowns* in a project. Specifically, these are the uncertainty and variability associated with a schedule and cost estimate, as well as the discrete risk events identified in the risk register.

Risk owners are accountable for selecting the most appropriate risk response and executing the mitigation strategy with the goal to eliminate or lower the probability and impact of a risk. Contingency is only allocated for the accepted risks and residual risks, which are the remaining impacts of an event despite mitigation attempts,

assuming that the mitigation strategy is executed successfully. Further, the risk owner should not carry contingency for risk items that:

a) would result in a fundamental change to the base plan (e.g. directed change, scope change) where the change control process should be used.

b) could not be recovered or fixed via application of additional project funding.

Contingency at NR is further sub-divided into Project Contingency and Program Contingency to address uncertainties in project bundles and functional groups, respectively. It is not intended for changes in scope or extraordinary major social or natural events such as war, strikes, flood and earthquakes, which are addressed by Management Reserve.

3.2.2.1 Estimate Uncertainty

Estimate uncertainties are the *knowns* in a project, and are fundamental contributors to cost growth. They are a function of, but not limited to, the quality of the project scope definition, the project's life-cycle status, and the degree to which the project uses new or unique technologies.

The uncertainty in estimates is expected to decrease over time as the project definition improves and the project matures. Appendix D illustrates how estimate accuracy changes as the project gains maturity in the definition of their project deliverables. The determination of the size of contingency must take into the account the estimate accuracy and project phase. As the project progresses, the high and low ranges of the estimate should converge on the final cost.

Costs typically covered by contingency due to estimate uncertainty are:

- Minor errors in omissions in the estimating process (e.g. precise quantification is only known during execution)
- Variability of productivity (e.g. estimating based on execution in the summer, but actually executed in the winter)
- Variability in wages (e.g. labour agreements expiring during execution)
- Variability in prices (e.g. material prices assumed)

Note that estimate uncertainty does not cover variability in scope.

3.2.2.2 Discrete Risk Events

Risk events are the *known unknowns* in a project. These can be represented as probabilistic distributions that identify the likelihood of the risk event occurring with separate distributions that describe the consequence or impact to the project if the event occurs. Risk events have cost and schedule consequences. The schedule

consequences identified on the risk register should indicate the impact to a project's critical path, usually expressed in "days". The cost consequence should indicate the direct cost resulting from the realization of the risk, as well as the indirect overhead costs incurred during the critical path delay. (For example, the schedule impact to the risk of dropping a turbine spindle into the ocean is 30 days of critical path delay. The cost impact is the sum of the cost to send the spindle for repair and the overhead cost of retaining resources while waiting for work to continue)

3.2.3 Management Reserve

Management Reserve is the contingent funds for *unknown unknowns, or* unplanned changes to project scope and cost, such as natural disasters or prolonged labour strikes. It is an amount for discretionary management purposes outside the defined scope of the project.

3.3 Risk Tolerance and Confidence Levels

Risk tolerance is the level of uncertainty that an organization is willing to accept. It is often expressed in a percentage value called a confidence level. (E.g. a P50 value on a contingency estimate means a project manager is 50% confident that the contingency allocated is sufficient to address the risks in the project). Confidence levels are also useful in managing a program of different projects. For example, a project can be assigned a P50 level of contingency, and the difference between P70 and P50 can be kept at the program level as added assurance in case the project manager runs out of contingency funds.

3.4 Guidelines to Contingent Fund Development

Contingency fund determination should be conducted before each request for contingency funding, including gate submission and during the release planning process.

3.5 Project Contingency Constituents

The Project Manager, with support from Planning and Control (P&C) Leads matrixed to them, is responsible for determining the amount of Project Contingency required. Project contingency is made up of the following constituents:

(1) Cost uncertainty of the project work scope (identified by project bundle and by gate)

(2) Discrete risks (identified by project bundle and by gate) in the project risk register

The amount of contingency required for each constituent should be determined with inputs from knowledgeable personnel.

3.6 Program Contingency Constituents

The Risk section, P&C is responsible for determining the amount of Program Contingency required. Program contingency is made up of the following constituents:

(1) Cost uncertainty of the functional work scope (identified by release and function)

(2) Discrete risks in the program risk register (identified by release and function)

(3) Assurance on the Project Contingency already released (i.e. if a P50 confidence level contingency is released to the project manager to manage discrete risks, then the program may retain the difference between a P70 and P50 value as added assurance)

(4) Unreleased portions of Project Contingency yet to be released.

The amount of contingency required for each constituent should be determined with inputs from knowledgeable personnel.

3.7 Management Reserve Constituents

Management Reserve will be determined by calculating the amount of funds required to reach the confidence level specified by senior management of NR. Management reserve will also consider overall schedule uncertainty of the NR Program.

3.8 Summary of Contingent Fund Structure

Table 1 summarizes the constituents of the contingent fund structure at NR.

Item	Construct Elements
Management Reserve	Additional assurance to achieve a targeted confidence level on total NR Program Cost.
Program Contingency	Functional cost uncertainty, residual risk of select discrete functional risks, additional assurance on project uncertainty.
Project Contingency	Project bundle cost uncertainty, residual risks of select discrete project bundle risks.

Table 1 - NR Contingent Fund Structure

3.8.2 Probabilistic Analysis of Uncertainties

Monte Carlo simulation, or probabillistic analysis is a method to analyze the impact of risk and uncertainities using multiples simulations. Gathering information for the Monte

Carlo method must be done carefully with input from knowledgeable personnel. Poor quality inputs to the Monte Carlo (including choosing a misrepresentative probability distribution) will produce misleading results. Contact the P&C Risk Section for guidance on which probability distribution function to use.

Whether it is the contingency to address estimate uncertainty or risk events, the general steps of the Monte Carlo method include:

(1) Confirm the basis of analysis. The base plan (cost/scope/schedule) should be well defined/finalized.

(2) Conduct risk screening to determine which risks are warranted to have contingency allocated against them. Not all risks are suitable for contingency allocation. Appendix E provides a guideline on how risk screening should be conducted.

(3) Gather input for probabilistic analysis. This involves obtaining three point estimates (Most Likely, Optimistic, and Pessimistic) for residual risk impacts and cost and schedule estimates. Contact the P&C Risk and Estimating groups for support.

(4) Run Monte Carlo simulations using software and analyze the results. The results can be presented as a cumulative probability distribution of total cost, in the shape of an S-curve, similar to the one depicted in Figure 5-5.

(5) Determine the size of contingency based on the acceptable level of confidence that the overall cost of the project/function will not be exceeded.

3.8.3 Correlations between Cost Elements

Some risks are mutually independent, where the occurrence of either is independent of the occurrence of the other.

Correlation can be a result of:

(1) A common influence that impacts two (or more) cost elements together. For example, the weather could affect the amount of heating required in a building as well as transportation costs.

(2) One cost element may depend on the other. For example, risks associated with manufacturing will often be dependent of quality assurance requirements.

The correlation coefficient r, which can vary between -1 and +1 depending upon the level of correlation. Three important values of r on the scale -1 to +1 are:

- r = +1: two risks are 100% positively correlated: if one risk happens, the other one will happen as well
- r = 0: two risks are completely independent of each other
- r= -1: two risks are 100% negatively correlated: if one risk happens, the other one would not

In practice, project managers may only be able to quantify the correlation in terms of 'high, medium or low'. During risk analysis, the corresponding r value of 0.95, 0.87 and 0.71 may be used.

3.9 Monte Carlo Analysis

Monte Carlo analysis involves determining the impact of the identified risks by running simulations to identify the range of possible outcomes for a number of scenarios. A random sampling is performed by using uncertain risk variable inputs to generate the range of outcomes with a confidence measure for each outcome. This is typically done by establishing a mathematical model and then running simulations using this model to estimate the impact of project risks. This technique helps in forecasting the likely outcome of an event and thereby helps in making informed project decisions.See Appendix F for Outputs of the Monte Carlo Method

3.10 Guidelines to Contingency Funding Management

Contingent fund management is part of the risks management process to monitor and control risks. The usage of contingent funds must be carefully tracked, monitored and reported to ensure that there are sufficient funds to address NR risks throughout its life cycle. Since the risk profile of the NR program is constantly changing through completing work, realizing risks, identifying new risks and completion of mitigation plans, the contingent funds should also be subjected to regular reviews and adjustments.

3.10.2 Monitoring/Oversight of Contingent Funds

Contingent funds at NR are finite resources, so its use must be monitored, tracked and evaluated as a part of the project control and monitoring cycles. At a minimum, a contingency adequacy review should be conducted semi-annually. It should also be conducted whenever the risk profile of a project or function undergoes a significant change to determine if the remaining contingent funds can adequately address the remaining risks in the project. The P&C Risk Section will perform oversight of contingency use, drawdown, etc. and will summarize to NR senior management the status of contingency. For more information on contingency drawdown, refer to N-MAN-00120-10001 Sheet PC-12.

3.10.3 Contingency Adequacy Review

The owner of contingent funds should ensure that guidelines for contingency development are followed rigorously and re-evaluate the amount of contingent funds required as the project progresses.

Contingency reviews should be conducted at the following checkpoints:

(1) Gate submission, including gate refreshes;

(2) Release planning;

(3) Risk realization, especially a risk with high demands for funds;

(4) Unexpected event requiring high demands for funds;

(5) Significant change in the risk register;

(6) Significant deviation from the expected usage of contingency allocated to a function or bundle under items (1) or (2).

Note that the contingency adequacy review may reveal that there is too much contingency or not enough contingency. The project or function manager should return contingent funds that are no longer required via a CCF. If additional funds beyond what has been approved at the gate or release are required, then the function manager or project manager should request additional funds via a CCF or a gate refresh, respectively. See N-MAN-00120-10001 Sheet PC-12 for additional information.

4.0 ACRONYMS

BOE	Basis of Estimate
CII	Construction Industry Institute
EAC	Executive Advisory Committee
ERM	Executive Risk Management Team
NR	Nuclear Refurbishment
OPEX	Nuclear Oversight Committee
PDRI	Project Definition Rating Index
P&C	Planning and Control Organization, Nuclear Refurbishment
RADAR	Risk Assessment Database and Register
RBS	Risk Breakdown Structure
RMP	Risk Management Plan
CCF	Change Control Form
WBS	Work Breakdown Structure
AACE	The Association for the Advancement of Cost Engineering

5.0 RECORDS AND REFERENCES

5.1 Records

Any records which may be produced as a result of this document should be managed in accordance with N-PROC-AS-0042, Quality Assurance Records.

The following records may be generated by use of this document and shall be registered in an appropriate document management system in accordance with the following table.

Record Created	Associated Form Number	QA Record? Y/N	Filing Information/Retention (Asset Suite Type/ Sub-Type)
Risk Management Plan	N-TMP-10010	N	Indexed in Asset Suite Controlled Document N-PLAN-SCI-xxxxx RRC NO2-0049 Retention: 10 years after completion of the overall Refurbishment program

5.2 References

5.2.1 Performance References

N-MAN-00120-10001-RISK	Darlington Refurbishment Risk Management
OPG-PROC-0094	Enterprise Risk Management Process
N-MAN-00120-10001-RISK-07	NR Actions, Issues, Decisions, and Key Assumptions Management
N-MAN-00120-10001-GRB	Nuclear Projects Gated Process

5.2.2 Developmental References

Construction Industry Institute. Applying Probabilistic Risk Management in Design and Construction Projects. Implementation Resource 280-2. June 2012.

Project Management Institute. Project Management Body of Knowledge (PMBOK Guide), Fourth Edition. 2008

US Department of Energy. Risk Management Guide. DOE G413.3-A. January 12, 2011.

Rodgers, Chris & Petch, Jason. Uncertainty and Risk Analysis. PriceWaterHouseCoopers. April 1999.

Appendix A: Create, Update and Close Risks in RADAR

A.1.0 INITIATING AND ONGOING MANAGEMENT OF A RISK

Risks may be documented by any NR staff with permitted access to RADAR (Sharepoint List):

(a) Initiator:

(1) Confirms that the identified risk does not contradict or duplicate any existing risks in the Program and Project RADAR. Consults local Risk SPOC for assistance on Project Risks and the NR P&C Risk Section for Program Risks if assistance is required.

(2) Consults with internal team members, the P&C Risk Section, and other stakeholders to help characterize the risk and select the appropriate response.

(3) Selects the appropriate list in Sharepoint to enter the risk information.

- Program Risks → Program RADAR
- Project Risks → Project RADAR

(4) Selects “New Item”, and then characterizes the risk by filling out all available information. See Appendix B for a guide to fields in RADAR.

(5) Assigns one single owner to the risk and confirm their acceptance of the ownership. For Program Risks, the risk owner should be a Strat V or above, and the delegate of the risks should be a Strat IV or above. For Project Risks, risk owner should be a Strat IV or above, and the delegate of the risks should be a Strat III or Strat II or above

(6) Once the risk has been entered into RADAR, Click “OK” to save and return to the list of risks.

(b) The Risk Owner with the support of Risk Delegate and Risk SPOC:

(1) Monitors and periodically reviews the risk monthly, at a minimum, as per this process.

(2) Develops and assigns actions with target completion dates to action owners according to the risk response, as required.

(3) Raises new and/or updates existing Key Assumptions, Actions, Issues and Decisions as a result of the approved risk. Ensures Key

Assumptions, Actions, Issues and Decisions are identified and managed in alignment with N-MAN-00120-10001-RISK-07 Actions, Issues, Decisions and Key Assumptions.

(4) Notifies other impacted organizations and/or the P&C Risk section if there is a significant change to the risk profile or a significant new risk.

(c) NR P&C Risk Section

(1) Provides oversight and support throughout.

A.2.0 CLOSING A RISK

Risks may be closed when they are entered in error, are no longer relevant to NR, have expired (not anticipated to happen), or if the risk has been realized (event should now be recorded as an Issue with a recovery plan). When closing a risk, the following process should be followed:

(a) Local Risk SPOC, P&C Lead, Delegate or Risk Owner:

(1) Selects the risk entry in RADAR and select “Edit Item”.

(2) Updates the risk, set the Risk Status field to “Closed”, and provides written justification for closure in the “Status Notes” field.

(3) Raises new and/or updates existing or initiates new Key Assumptions, Actions, Issues and Decisions as a result of the approved closure of the risk as per N-MAN-00120-10001-RISK-07. Risks should be generated and/or updated in alignment with this process.

(b) The risk owner with the support or Risk Delegate or Risk SPOC:

(1) Ensures that the risk closure is justified.

(2) Ensures that the risk response plans, strategies and actions are completed and statused accordingly.

(c) NR P&C Risk Section:

Provides oversight and support to the initiator.

Appendix B: RADAR Field Guide

Fields	Definition and Guidelines
Action #	Reference action numbers from the Actions Log related to the risk
Assumption #	Reference Key Assumption numbers from the Actions Log related to the risk
Comments	Miscellaneous comments.
Current Financial	Current Financial Impact Score (1 to 5)
Current Probability	Current Probability of risk occurrence (1 to 5)
Current Schedule	Current Schedule Impact Score (1 to 5)
Current Score	Current Risk Score (Probability x higher of Financial or Schedule Impact Score)
Decision #	Reference Decision numbers from the Actions Log related to the risk
ERM Risk	Check this box if this risk is reported to the ERM.
Gate	The gate number associated with the source of funding for contingency.
Impacted NR Organizations	Information regarding Risks affecting multiple Organizations is captured here.
Initiator	The employee who requested for the Risk to be created
Issue #	Reference issue numbers from the Actions Log related to the risk
NOC Risk	Check this box if this risk is reported to the NOC.
NR Owner Organization	The NR organization that the risk owner belongs to
P6 Activity ID	Reference Activity ID from theP6 Schedule related to the risk
Phase	The NR project phase in which the risk is expected to realize
Post Response Financial	Financial Impact Score (1 to 5) after application of risk response plan
Post Response Probability	Probability of risk occurrence (1 to 5) after application of risk response plan
Post Response Schedule	Schedule Impact Score (1 to 5) after application of risk response plan
Post Score	The anticipated Risk Score (Probability x higher of Financial or Schedule Impact Score) after the risk response plan has been successfully implemented. Also known as the residual risk score.
Pre Response Financial	Financial Impact Score (1 to 5) before application of risk response plan.
Pre Response Probability	Probability of risk occurrence (1 to 5) before application of risk response plan
Pre Response Schedule	Schedule Impact Score (1 to 5) before application of risk response plan
Pre Response Score	Risk Score (Probability x higher of Financial or Schedule Impact Score) before application of risk response plan
RBS 1	Risk Breakdown Structure Field #1. Can be used to differentiate sub-bundles or however the project/function chooses to categorize risks.

Fields	Definition and Guidelines
RBS 2	Risk Breakdown Structure Field #2
Risk Delegate	The Strat IV for Program and Start III or II for Project Risks (at a minimum) that has been delegated risk owner's responsibilities.
Risk Description	A detailed description of the risk, consisting of the event, the context of the event, and the adverse impacts should the risk realizes.
Risk Impact Post Response	Brief description of the residual risk. Align description with the "Post Financial", "Post Probability", "Post Schedule", and "Post Score" fields.
Risk Impact Pre-Response	Brief description of the risk if nothing is done or if risk was accepted "as-is". The description should align with the "Pre Financial", "Pre Probability", "Pre Schedule", and "Pre Score" fields.
Risk Owner	The Strat V for Program and Strat IV for Project Risks (at a minimum) accountable for the risk - also responsible for developing the risk response and assigning actions to actions owner as part of the risk response plan
Risk Response Status	Status of the Risk Response as Not Started, In Progress (On Track, At Risk or Late) or Complete.
Risk Response Strategy & Status Notes	A summary of the overall risk response strategy. The action to mitigate the risk is attributable to the strategy. This strategy will also be presented in risk reports.
Risk Response TCD	The potential date when the risk response is expected to be complete
Risk Response Type	Avoid, Transfer, Accept, Mitigate, Monitor
Risk Status	Status of the Risk as Active, Pending Approval, Closed or Closed-BAU.
Risk Status Notes	Brief explanation on the current status of the risk.
Risk Trigger End Date	The potential end date when the risk is expected to expire.
Risk Trigger Start Date	The potential start date when the risk is expected to realize.
Risk Trigger Event	A future event or milestone that signifies risk realization. (e.g. If there is a risk of not having work scheduled into the VBO, then the VBO scope freeze date may be the trigger event.
Station Risk	Apply to Station-Related Risks only. Reference Station Risk Title.
Station Risk ID	Apply to Station-Related Risks only. Reference Station Risk ID.
Station Risk Owner	Apply to Station-Related Risks only.
Title	Short title of the risk consisting of the event and the context of the event.
Urgency	Scale based on when the Risk in question needs to be mitigated. Used to assist with Risk prioritization.

Appendix C: Risk Assessment Criteria/Scale

C.1.0 PROGRAM AND FUNCTIONAL RISK ASSESSMENT CRITERIA/SCALE

Risk Attribute	Definition	1 (Minimal)	2 (Minor)	3 (Notable)	4 (Substantial)	5 (Major)
Probability	The probability that a risk will occur	Improbable (<20%)	Unlikely (20%-40%)	Possible (40%-60%)	Likely (60%-80%)	Probable (>80%)
Financial Impact	The financial consequences of a risk should it occur (**including the cost due to schedule delay**)	Minimal (<$50M)	Minor ($50M-$100M)	Notable ($100M - $200M)	Substantial ($200M - $400M)	Major (>$400M)
Schedule Impact	The impact that a risk would have on the schedule and on overall project duration, should it occur	Minimal (No impact to critical path)	Minor (<2 weeks delay to critical path)	Notable (2 weeks – 2 months delay to critical path)	Substantial (2-6 months delay to critical path)	Major (>6 months to critical path)

C.2.0 PROJECT EXECUTION RISK ASSESSMENT CRITERIA/SCALE

Risk Attribute	Definition	1 (Minimal)	2 (Minor)	3 (Notable)	4 (Substantial)	5 (Major)
Probability	The probability that a risk will occur	Improbable (<20%)	Unlikely (20%-40%)	Possible (40%-60%)	Likely (60%-80%)	Probable (>80%)
Financial Impact	The financial consequences of a risk should it occur (**including the cost due to schedule delay**)	Minimal (<$1M)	Minor ($1M-$10M)	Notable ($10M - $50M)	Substantial ($50M - $200M)	Major (>$200M)
Schedule Impact	The impact that a risk would have on the schedule and on overall project duration, should it occur	Minimal (No impact to critical path)	Minor (<1 weeks delay to critical path)	Notable (1 weeks – 2 weeks delay to critical path)	Substantial (2-6 weeks delay to critical path)	Major (>6 weeks to critical path)

C.3.0 URGENCY ASSESSMENT CRITERIA/SCALE

Urgency Score	NR Timeline for risk response	Urgency Assessment Criteria
1	>1yr	Risk treatment activities complete or risk not required to be addressed for the foreseeable future
2	6 months – 1 yr	Risk may still be addressed in the long term and risk treatment will still be effective
3	1-6 months	Risk should be addressed in the medium-term for risk treatment to be effective
4	Within 1 month	Risk must be addressed immediately for the risk treatment to be effective

Appendix D: AACE Estimate Class and Expected Accuracy Ranges

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Notes: [a] The state of process technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

Table 2 - AACE Estimate Class and Expected Accuracy Ranges

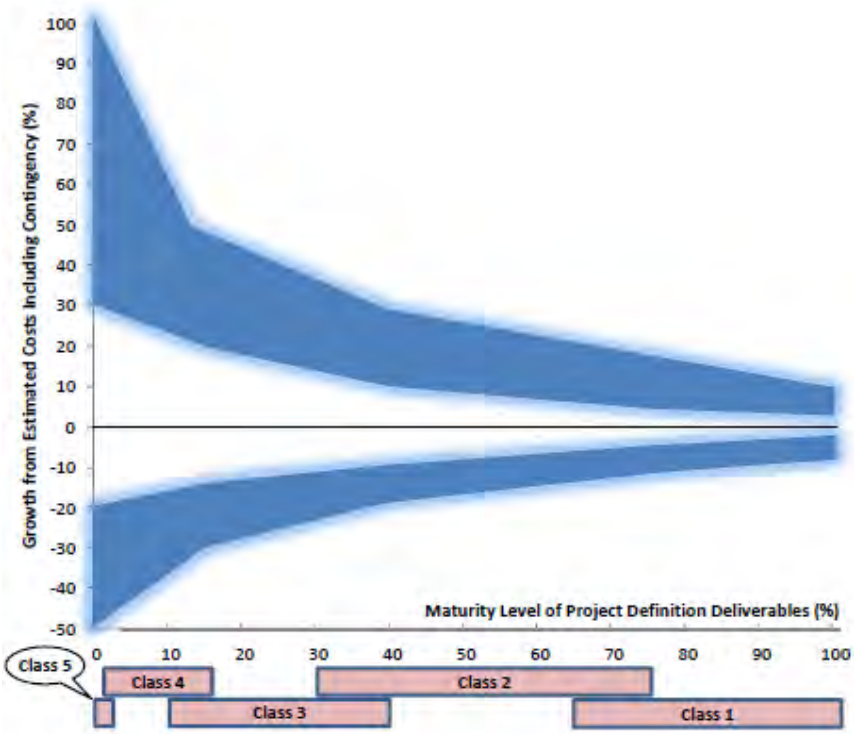


Figure 5-1 AACE Estimate Class and Expected Accuracy Ranges

Appendix E: Guidelines to Risk Screening

Following the identification of risks that can potentially affect the project, it is important to differentiate those risks that are minor and thus should not require significant further attention from those that require follow-up, analysis, active mitigation and management. Similarly, not all risks are warranted for contingency allocation. One commonly used risk tool is shown in figure 8-2 .It allows assigning a risk to one of four quadrants based on a qualitative assessment of its relative impact and the probability of its occurrence. Table 4 summarizes the optimal risk response dependent on the qualitative assessment.

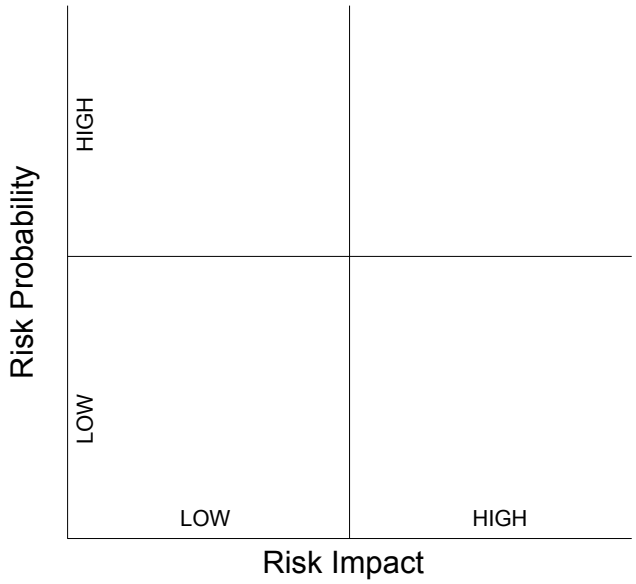


Figure 5-2 Risk Probability and Impact Matrix

Quadrant	Description	Optimal Response	Contingent Funds Assignment?
Low Impact, Low Probability	• Essentially negligible • In the unlikely condition that it does arise it should be possible to deal with it simply and with minimal impact	• Monitored to determine that the impact or likelihood does not increase	No
High Impact, High Probability	• Management should determine if project should proceed or if the benefits of taking the risks is justified	• Budget for mitigating actions in the project scope to lower the probability and impact of the risk	Yes – for the residual risk post-mitigation

Quadrant	Description	Optimal Response	Contingent Funds Assignment?
Low Impact, High Probability	• Uncertainties from common sources in a project (e.g. cost of labour, materials, actual duration of activities, productivity, etc.) • Each of these uncertainties alone would have little impact, but the cumulative effects may have impact	• Reduce uncertainties in estimates by obtaining additional information or improving work processes • Budget for mitigating actions in the project scope to lower the probability and impact of the risk, if reasonable to do so	Yes – for the residual risk post-mitigation
High Impact, Low Probability	• Rare occurrences • Difficult to assign probabilities based on past events • Cannot be effectively funded by contingency, especially if maximum impact is realized	• Budget for mitigating actions in the project scope to lower the probability and impact of the risk, if reasonable to do so	Case-by-case basis. If yes, should be covered by Management Reserve

Table 3 Optimal Response based on Risk Probability and Impact

Appendix F: Outputs of the Monte Carlo Method

Several standard outputs are available to provide project managers with insights to cost, and even schedule predictability in their projects. These graphical representations of results allows for robust means of communicating risk, and provides additional data to support decision making and identify the possible outcome of decisions.

Range of Cost or ScheduleError! Reference source not found. and 5-2 are graphs epicting the results of a Monte Carlo simulation defining the probability distribution of cost and schedule outcomes based on input assumptions. This type of information is useful for understanding the expected cost/duration and the range/dispersion of the projected cost and durations.

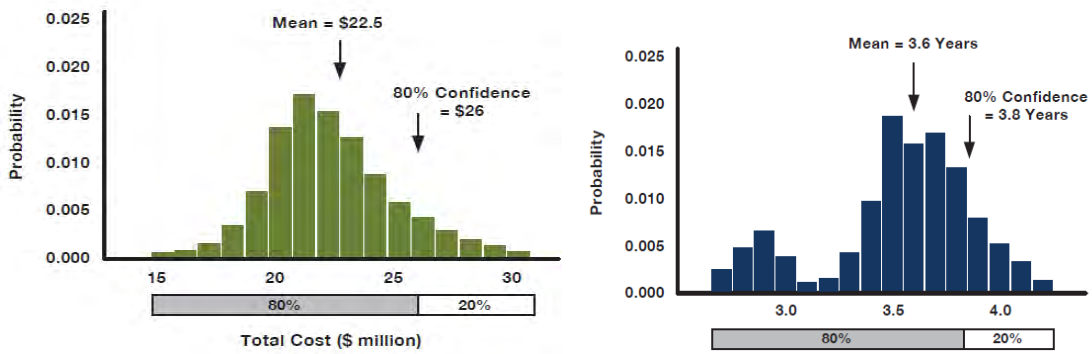
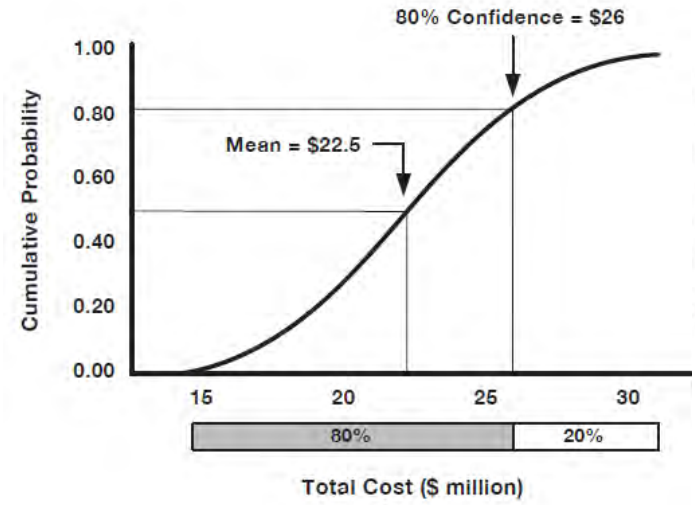


Figure 5-3 Sample Probability Mass Function on Project Costs; Figure 5-4 Sample Probability Mass Function on Schedule Duration

Confidence in Cost or Schedule

The cumulative probability functions shows in Figure 3-3 and Figure 3-4 provide the same information shown in Figure 3-2, but in a cumulative manner. The cumulative functions provide a quick reference for the mean (P50) and a confidence level in the estimate or schedule.



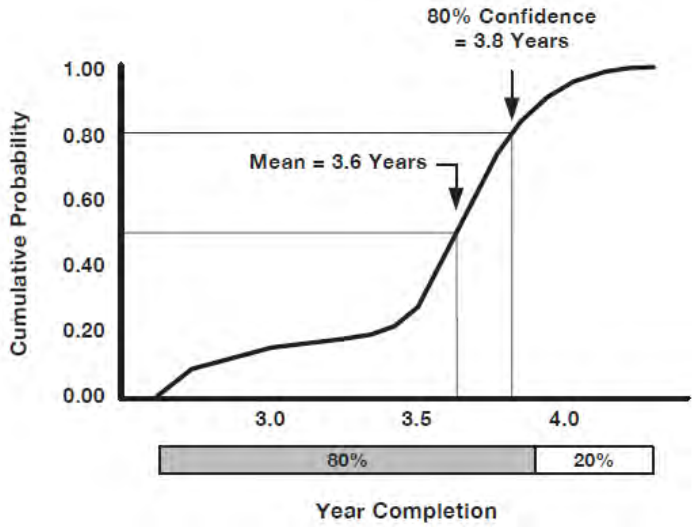


Figure 5-5 Sample Cumulative Probability Function on Project Costs; Figure 5-6 Sample Cumulative Probability Function on Schedule Duration

Identification of Risks with the Greatest Impact

Sensitivity analysis is a primary modelling output that can be used in the valuation of the impacts of individual risks. Figure 3-5 Sample Senstivity Analysis on Project Risks provides a sensitivity analysis in the form of a “tornado diagram”. Tornado diagrams depict the influence of individual risks and highlight the greater contributors to the overall risk. Using this information, project managers or function managers can spend more effort on mitigating the risks that has the higher impact on the success of the project/function.

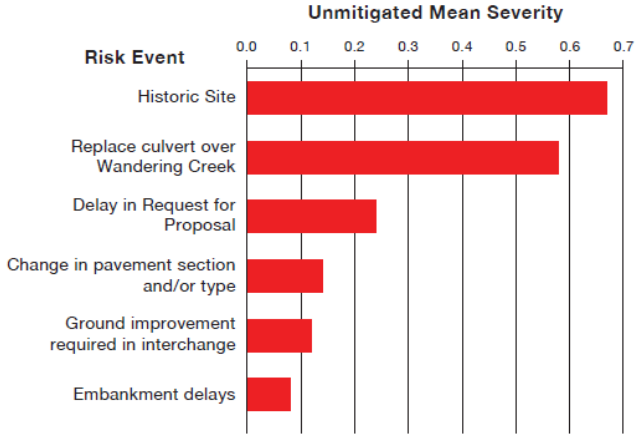


Figure 5-7 Sample Sensitivity Analysis on Project Risks

ELECTRONIC VERSION ONLY

Full column headings: ID | Title | Description | Risk Type | Urgency | Report Risk to Quad Chart | Initiator | Owner | Delegate | Response Type | Response Status | Date Last Reviewed | Trigger Date | Trigger Event | Pre Prob | Pre Financial | Pre Schedule | Pre Score | Current Prob | Current Financial | Current Schedule | Current Score | Post Prob | Post Financial | Post Sched | Post Score | Post Mitigation Score TCD | Status | Risk Close Date | Comments | RBS 1 | RBS 2 | Risk Assumptions | P6 Activity ID | Station Risk | ERM Risk | NOC Risk | Gate | Phase | Response Strategy and Justification | Station Risk ID Number | Modified By | Modified Date | Version | Created By | Created Date | Impacted Organizations | Sub Bundle/Project #s | Owner Org Code | Owner Org Title | Actions | Assumptions | Decisions | Daily Logs | Lessons Learned | OPEX | Oversight Findings | Oversight Activities | Issues

ID	Title	Description	Risk Type	Urgency	Report Risk to Quad Chart	Initiator	Owner	Delegate	Response Type	Response Status	Date Last Reviewed
00014447	HTS Vacuum Dry (Window 029)	Event: HTS Vacuum Dry is a FOAK. A contingency plan	Project		N	Daniel SAWYER	Roy BROWN				
00014446	RFR Window Alignment	Event: Without the RFR window's being agreed to, this w	Project		N	Daniel SAWYER	Roy BROWN				
00014445	Vault Coordinator	Event: The logistics associated with coordinating the non-f	Project		N	Daniel SAWYER	Roy BROWN				
00014437	Lateness of Moderator Calandria Purging may affe	Event: Calandria purge details are not complete. JV Timin	Project		N	Daniel SAWYER	Roy BROWN				
00014436	Vacuum drying	Event: Currently very little logic is in P6 concerning this	Project		N	Daniel SAWYER	Roy BROWN				
00014434	Bulkhead Installation	Event: This is a FOAK installation that requires all the appr	Project		N	Daniel SAWYER	Roy BROWN				
00014433	RTP Removal & Bridge Replacement	Event: This is critical path work. The current JV CWP's re	Project		N	Daniel SAWYER	Roy BROWN				
00014432	Containment pressure test work plan	Event: This is critical path work. The plan is in draft form	Project		N	Daniel SAWYER	Roy BROWN				
00014431	Containment pressure test contingencies	Event: Contingency for bulkhead failing the leak test nee	Project		N	Daniel SAWYER	Roy BROWN				
00014430	Bulkhead installation window numbers drop to les	Event: Use of Purge Drier (F5) is the only method of keep	Project		N	Daniel SAWYER	Roy BROWN				
00014429	Bulk Interference removal	Event: This is critical path work. The current JV CWP's re	Project		N	Daniel SAWYER	Roy BROWN				
00014428	Airlock opening strategy	Event: Current JV LFD shows Al opening after shielding.	Project		N	Daniel SAWYER	Roy BROWN				
00014425	Failure to Upgrade Unqualified Source Material for	Event: There is a risk that the supplier of Flow Elements	Project	LT1MTH	N	Andre SIDIROPOULOS	Andrew CERILLI		Mitigate	Not Started	2016/05/03
00014423	Hardprep CWPs/Work Plans Delayed	[Execution Risk] Event: Delays to the current Hardprep C	Project		N	Rahim LAKHANI	Ken BROWN	Sudhakar PULAGAM	Monitor	In Progress - On Tr	2016/05/02
00014387	Annulus Spacers damaged on retrieval limits the v	Project 80112 requires undamaged ex-service spacers to b	Project	6TO12MTHS	N	Jian JIANG	Kathy CHARETTE	Jian JIANG	Mitigate	In Progress - On Tr	
00014319	Spread of Contamination during RFR Waste Proce	[Execution Phase Risk: Event: There is a residual risks t	Project	1TO6MTHS	N	Michael HERSCH	Michael HERSCH	Sean CARPENAY	Monitor	In Progress - On Tr	2016/04/04
00014280	Schedule delay to receipt of Intermediate Level W	The intermediate level waste containers may slip on the sc	Project	1TO6MTHS	N	Cole STARK	Andrew CERILLI		Monitor	Complete	2016/03/08
00014260	Vault communications between RPCs and RFR (JV	There is a risk of lack of vault communications between R	Project	1TO6MTHS	N	Jeff JOHANSSON	Johnathon HASH	Ian EDWARDS	Mitigate	Complete	2016/05/11
00014253	ILW Transfer Flask may not be delivered on time	[Execution Phase] Event: Delays to ordering, schedule co	Project	1TO6MTHS	N	Karna SHUKLA	Andrew CERILLI	Cole STARK	Monitor	In Progress - On Tr	2016/04/19
00014164	There is a risk that Liner Spacers and Liner Latch A	[Execution Phase] Event: There is a risk that Fuel Channe	Project	1TO6MTHS	N	Geoff COLLING	Andrew CERILLI	Andre SIDIROPOULOS	Transfer	In Progress - On Tr	2016/04/19
00014161	Manufacturing delay possible for Feeder Flow Elen	[Execution Phase] Event: The feeder flow elements (FEs)	Project	LT1MTH	N	Cole STARK	Andrew CERILLI	Cole STARK	Transfer	In Progress - At Ris	2016/04/19
00014136	RFR Schedule assumptions for reduced RPPE (Wind	[Execution Phase] Event: The project schedule currently	Project	6TO12MTHS	N	Johnathon HASH	Johnathon HASH	Ian EDWARDS	Mitigate	In Progress - On Tr	2016/01/25
00014121	In-Station Transfer Vehicle Design Driving Extensiv	Event The RFR Joint Venture is currently in the process of	Project		N	Ian WILCOX	Andrew CERILLI	Ian WILCOX	Monitor	In Progress - On Tr	2016/03/02
00014118	Fuel Channel DEC DCAVR delay due to Positioning	[Definition Phase] Event: The DCAVR for DEC 124966 (Fu	Project		N	Andre SIDIROPOULOS	Andrew CERILLI	Andre SIDIROPOULOS	Monitor	Complete	2016/05/06
00014117	Condensate Line Relocation (DEC123638)- Materia	[Definition Phase] Event: This item documents the risk ass	Project	LT1MTH	N	Ian WILCOX	Andrew CERILLI	Ian WILCOX	Monitor	In Progress - On Tr	2016/05/09
00014115	Feeder fabrication schedule delay as a result of flo	[Execution Phase] Event: There is a risk that delays to feede	Project	6TO12MTHS	Y	Andre SIDIROPOULOS	Andrew CERILLI	Andre SIDIROPOULOS	Transfer	Not Started	2016/04/19
00014038	Failure of Pressure Tube PPQs	Lack of experience from Pressure Tube supplier may caus	Project		N	Adam CZIRAKY	Roy BROWN	Andrew CERILLI	Mitigate	Complete	2016/01/12
00014034	Disagreement on Contractual Terms Surrounding	NO LONGER A RISK. MOVED TO ISSUE 00000180.	Project	1TO6MTHS	N	Ian WILCOX	Andrew CERILLI	Ian WILCOX	Monitor	In Progress - On Tr	2016/01/15
00014016	Toolset Modification due to Station Status Docume	[Execution] Event: There is a risk that Station Status Doc	Project	1TO6MTHS	N	David KURPJUWEIT	Michael HERSCH		Monitor	Not Started	2016/04/04
00014015	WTS - Retube Waste Processing Building Too Hun	[Execution Phase] Event: There is a risks that electrical e	Project	GT12MTHS	N	David KURPJUWEIT	Michael HERSCH	Sean CARPENAY	Monitor	In Progress - On Tr	2016/04/04
00013992	RWPB Procurement - in general being late	[Definition Phase] For PO to be late, the entire procureme	Project		N	Steve WONG	Roy BROWN	John HAMILTON	Monitor	Complete	2016/01/12
00013991	RWPB - Rework [Not Window Related]	[Definition Phase] Event: Vendor Rework Cause: Ineffec	Project		N	Steve WONG	John HAMILTON	Adam COYLE	Monitor	In Progress - On Tr	2016/04/13
00013990	RWPB - Potential Conflicts in Co-ordination of Wo	[Definition Phase] Event: Schedule misalignment on Mech	Project		N	Steve WONG	John HAMILTON	Peter KEMPTON	Monitor	In Progress - On Tr	2016/04/13
00013989	RWPB - Waste Tooling System (WTS) Schedule In	[Definition Phase] Event: Improper WTS Install schedule	Project		N	Steve WONG	John HAMILTON	Khai NGO	Monitor	In Progress - On Tr	2016/04/13
00013987	RWPB Project Management - Schedule Cost & Re	[Definition Phase] Event: misalignment of JV Reporting	Project		N	Steve WONG	John HAMILTON	Peter KEMPTON	Monitor	In Progress - On Tr	2016/04/13
00013986	RWPB Construction - Safety [No Window Related]	[Definition Phase] Event: Any safety incident on site ma	Project		N	Steve WONG	John HAMILTON	Peter KEMPTON	Monitor	In Progress - On Tr	2016/04/13
00013985	RWPB Construction - Crane Install Strategy [No W	[Definition Phase] Event: Crane install does not account	Project		N	Steve WONG	John HAMILTON	Peter KEMPTON	Mitigate	Not Started	2016/04/13
00013984	RWPB Construction - Winter Construction Strateg	Definition Phase: As winter elements may have an impact	Project		N	Steve WONG	Roy BROWN	John HAMILTON	Accept	Complete	2016/01/12
00013983	RWPB Construction - Storm / Weather Delay [Wir	[Definition Phase] As weather elements may have an impa	Project		N	Steve WONG	John HAMILTON	Peter KEMPTON	Accept	Complete	2016/03/14
00013982	RWPB Procurement - Crane Late Delivery [Not Wi	[Definition Phase] Event: Crane delivery past install requ	Project	6TO12MTHS	N	Steve WONG	John HAMILTON	Peter KEMPTON	Mitigate	In Progress - On Tr	2016/04/13
00013981	RWPB Procurement - Structural Steel Late Deliver	[Definition Phase] Event: Late delivery of Structural Steel	Project	6TO12MTHS	N	Steve WONG	John HAMILTON	Peter KEMPTON	Mitigate	In Progress - On Tr	2016/04/13
00013980	RWPB Engineering - Delay or Schedule inaccurac	[Definition Phase] Event: delay to Engineering or inaccu	Project	1TO6MTHS	N	Steve WONG	John HAMILTON	Peter KEMPTON	Mitigate	In Progress - On Tr	2016/05/03
00013979	RWPB Engineering - FCN Process Too Long and	[Definition Phase] Event: As a result of the Design Intent	Project	LT1MTH	N	Steve WONG	John HAMILTON	Peter KEMPTON	Mitigate	In Progress - On Tr	2016/04/13
00013935	RWPB - CNSC Acceptance of Alternate Complianc	[Definition Phase] Event: The Retube Waste Processing B	Project		Y	Adam COYLE	John HAMILTON	Khai NGO	Mitigate	In Progress - On Tr	2016/04/13
00013917	Insufficient Tool Quantities or Spares for RFR Exe	Execution Risk. This risk combines four risks related to To	Project	6TO12MTHS	Y	Sudhakar PULAGAM	Michael HERSCH	Kevin HILL	Mitigate	In Progress - On Tr	2016/04/12
00013911	Risk of need to procure additional pressure tubes	[Execution Phase] Event: An additional set of pressure tub	Project	1TO6MTHS	N	Marc PAIMENT	Andrew CERILLI	Andre SIDIROPOULOS	Mitigate	In Progress - On Tr	2016/04/05
00013892	End Fittings will not be available in time to support	[Execution Phase] EVENT: There is a risk that End Fitting	Project		N	Andre SIDIROPOULOS	Andrew CERILLI	Andre SIDIROPOULOS	Transfer	In Progress - On Tr	2016/04/08
00013860	Owner Specified Material (OSM) pricing from Unit	[EXECUTION PHASE] EVENT: There is a risk of cost esc	Project	GT12MTHS	N	Steve WONG	Andrew CERILLI	Bill DONOVAN	Monitor	In Progress - On Tr	2016/04/28
00013834	Failure of containment pressure test	[EXECUTION PHASE] Bulkhead Containment Test If unit	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Luca MUCCIARONE	Monitor	In Progress - On Tr	
00013833	Feeder Cabinet Insulation is deteriorated/degrade	Class 2 Rev -01 submittal assumes integrity of Feeder Cabi	Project		N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Monitor	In Progress - At Ris	2016/03/01
00013744	Risk of Damage During Transportation and Handli	Event: Baseline inspections are required for the fuel chan	Project		N	Hayden MURRAY	Paul ROSS	Brian BARCLAY	Monitor	In Progress - On Tr	2016/03/02
00013742	Waste - Tie-In Schedule for Retube Waste Process	Difficulty in finding intervals to complete tie-in field activi	Project		N	Peter KEMPTON	Roy BROWN	John HAMILTON	Monitor	In Progress - On Tr	2015/11/16
00013740	Waste - Procurement of Material for Retube Waste	Delay procurement of structural steel, active ventilation sy	Project		N	Peter KEMPTON	Roy BROWN	John HAMILTON	Mitigate	Complete	2015/11/16
00013571	Quality issues of JV work causing extra rework [W	Execution Phase Event: Extra rework (including higher w	Project	GT12MTHS	N	Jeffrey PALMATEER	Roy BROWN	Tara REHSI	Mitigate	In Progress - On Tr	2016/04/28
00013570	Damages to tools during transitions and shipping	Risk closed to RFR Risk #13917 as cleanup of RFR tooling	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Michael HERSCH	Mitigate	Not Started	2015/07/13
00013569	Interruption from False Alarms of Safety Events [F	Execution Phase: Event: The risk of false alarms of Safety	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Monitor	Not Started	2016/04/28
00013568	Non EF Waste Processing not Meeting Demand [W	Execution Phase Risk: Event: There is a risk that if Waste P	Project	6TO12MTHS	N	Steve WONG	Michael HERSCH	Sean CARPENAY	Monitor	In Progress - On Tr	2016/04/04
00013567	Tech Spec Not Thoroughly Vetted	Execution Phase: As Tech Spec not thoroughly vetted (c	Project	1TO6MTHS	N	Steve WONG	Roy BROWN	Perrik LE DREFF	Monitor	In Progress - On Tr	2015/08/07
00013566	Frequent Tool Failure before end of their Life Cycl	Risk closed to RFR Risk #13917 as cleanup of RFR tooling	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Michael HERSCH	Mitigate	Not Started	2015/12/01
00013565	Productivity risks on 3rd and 4th Units	Execution Phase: Due to increased schedule pressure and	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Perrik LE DREFF	Mitigate	Not Started	2015/08/07
00013564	More Expensive Pressure Tubes for subsequent u	[Execution Phase]: Event: There is a risk that if only one	Project	GT12MTHS	N	Steve WONG	Andrew CERILLI	Bill DONOVAN	Monitor	In Progress - On Tr	2016/04/28
00013563	Significant Radiation Exposure without Optimal Sh	[Execution Phase] Event: Risk of radiation exposure may	Project	GT12MTHS	N	Jeffrey PALMATEER	Johnathon HASH	Kwok TSANG	Mitigate	In Progress - On Tr	2016/05/11
00013562	As-found Conditions not Known [Potential Window	[Execution Phase] Event: Risk of no evidence to support	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Mitigate	Not Started	2016/03/29
00013561	Contamination Events in Retube Waste Processing	[Execution Phase]: Due to many first-of-a-kind activities in	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Lonnie SCHOFIELD	Mitigate	Not Started	2015/08/10
00013560	Unforeseen Challenges / Complications in installing	Execution Phase: Event: Unforeseen challenges / compli	Project		N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Mitigate	In Progress - On Tr	2016/03/01
00013559	Imperfect Procedures	Execution Phase: Due to imperfect procedures, procedure	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Mitigate	In Progress - On Tr	2015/08/10
00013557	Damaged Airlock Vertical Striker Plate [Potential W	[Definition Phase] Event: the Vertical Striker Plate (sides ar	Project	GT12MTHS	N	Jeffrey PALMATEER	Roy BROWN	Richard PETTET	Mitigate	Not Started	2016/04/27
00013556	Reactor Core Components demand more RWC/DS	[Definition Phase] Event: As results of characteristics of F	Project	GT12MTHS	N	Steve WONG	Andrew CERILLI	Cole STARK	Transfer	In Progress - On Tr	2016/04/05
00013555	Extra Bellows Need Replacement - all units	[Execution Phase] Event: Not enough spare bellows for a	Project	GT12MTHS	N	Steve WONG	Andrew CERILLI	Cole STARK	Mitigate	In Progress - On Tr	2016/04/18
00013554	Rebar being hit causing Additional PMOD or Safet	[Execution Phase]: Due to JV underestimating the impacts o	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Lonnie SCHOFIELD	Mitigate	Not Started	2015/08/10
00013553	New Annulus Spacer design may not be used for	[Definition Phase] Event: The new annulus spacer design	Project	GT12MTHS	N	Geoff COLLING	Roy BROWN	Geoff COLLING	Mitigate	In Progress - On Tr	2016/04/19
00013442	Not able to dry PHT System with Bulk Dry Propos	[Execution Phase] Event: The joint venture has decide	Project	6TO12MTHS	N	Justin COLE	Michael HERSCH	Sean CARPENAY	Monitor	Complete	2016/04/04
00013430	Failure of Procedures	Due to imperfect procedures which are brand new and th	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Lonnie SCHOFIELD	Mitigate	Not Started	2015/05/29
00013429	Cancelled	Cancelled due to error.	Project		N	Steve WONG	Roy BROWN		Avoid	Not Started	2015/05/29
00013428	JV Performance Exceeds P50 Target Schedule	Execution Phase: Due to unexpected performance, the ris	Project	GT12MTHS	N	Steve WONG	Roy BROWN		Monitor	In Progress - On Tr	2015/05/29
00013427	Extra Duration Caused By 3% Rework [Potential W	[Execution Phase] Event: Risk of Rework to correct wor	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Mitigate	In Progress - On Tr	2016/03/22
00013426	Restriction for Craft to Enter the Vault [Potential W	Execution Phase: Event: Imposing restriction on craft to	Project	GT12MTHS	N	Jeffrey PALMATEER	Roy BROWN	Kwok TSANG	Monitor	Not Started	2016/03/29
00013421	Qualification of Existing Bellows	Definition Phase: The existing bellows are not currently q	Project	GT12MTHS	N	Geoff COLLING	Roy BROWN	Andrew CERILLI	Mitigate	In Progress - On Tr	2015/10/22
00013339	Not Enough Staging Area for Installation Series	Execution Phase: Due to limited available space available	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Lonnie SCHOFIELD	Mitigate	Not Started	2015/08/10
00013338	Not Enough commissioning / training Time for Vol	Execution Phase: Event: Due to RWPB construction bein	Project	6TO12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Mitigate	In Progress - On Tr	2016/04/27
00013337	Not Able to Access Data and System	As JV operations interrupted due to bankruptcy by exam	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Perrik LE DREFF	Accept	In Progress - On Tr	2015/07/13
00013336	Calandria TubeSheet Bore (CTSB) Needs to be Mil	Execution Phase: Event: Calandria Tube Sheet Bore need	Project	GT12MTHS	N	Jeffrey PALMATEER	Michael HERSCH	Martin GEARY	Monitor	In Progress - On Tr	2016/05/10
00013335	OPG Oversight Needs Underestimated [Window A	Execution Phase: Event:Lack of OPG oversight process	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Mitigate	Not Started	2016/01/07
00013334	Radiation Exposure Higher Than Expectation	Execution Phase: Due to JV not having adequate Radiatio	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Lonnie SCHOFIELD	Accept	In Progress - On Tr	2015/08/07
00013333	Stop Work Order due to Safety Events [Potential	Execution Phase: Event: OPG stopping the work order	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Monitor	In Progress - On Tr	2016/03/29
00013332	Ineffective Practices in Maintaining the Tools	Risk closed to RFR Risk #13917 as cleanup of RFR tooling	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Michael HERSCH	Mitigate	In Progress - On Tr	2015/11/13
00013331	Cancelled	Due to the unique environment inside the Vault, the Oper	Project		N	Steve WONG	Roy BROWN		Avoid	Not Started	
00013330	RTP first-of-a-kind in Darlington Vault [Window B	Execution Phase Risk: Event/Cause/Impact: As results of	Project	GT12MTHS	N	Steve WONG	Michael HERSCH	Sean CARPENAY	Monitor	In Progress - On Tr	2016/04/04
00013329	Claims from Retube and Feeder Replacement (RFR	Execution Phase: As a result of OPG not meeting its obliga	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Cameron MACLEOD	Monitor	In Progress - On Tr	2016/04/21
00013328	Cancelled		Project		N	Steve WONG	Roy BROWN		Accept	Complete	2015/05/29
00013327	Above and Beyond Assumed Escalation Cost [Pote	[Execution Phase] Event: Due to some costs that are unce	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Monitor	In Progress - On Tr	2016/03/22
00013326	Excusable Delays [Windows All]	Execution Phase: Due to conditions beyond the control o	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Cameron MACLEOD	Mitigate	In Progress - On Tr	2016/03/11
00013325	Concealed Conditions [Potential Window 160-188]	Execution Phase: Due to the uncontrolled and unknown con	Project	GT12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Accept	In Progress - On Tr	2016/03/29
00013266	Waste - ILW containers for non-standard waste st	Definition Phase: There may be a requirement for ILW co	Project	1TO6MTHS	N	John HAMILTON	Cameron WEBB	Yung CHEUNG	Mitigate	In Progress - On Tr	2016/03/29
00013259	Contamination of Soil requires Higher Cost of Disp	Soil will be removed from the RWPB site during caisson d	Project	1TO6MTHS	N	John HAMILTON	Roy BROWN	John HAMILTON	Mitigate	In Progress - On Tr	2015/05/29
00013258	N291 Criteria on Concrete and Rebar for Radioacti	Due to N291 criteria, the procurement of concrete and reb	Project	1TO6MTHS	N	John HAMILTON	Roy BROWN	John HAMILTON	Monitor	Complete	2015/04/24
00013257	Unanticipated buried services impacting Caisson In	As a result of unanticipated buried services, the Caisson in	Project	1TO6MTHS	N	John HAMILTON	Roy BROWN	John HAMILTON	Mitigate	In Progress - On Tr	2015/05/29
00013256	Re-design of Superstructure for Radioactive Waste	As a result of CNSC classification and safety assessment, th	Project	1TO6MTHS	N	John HAMILTON	Roy BROWN	John HAMILTON	Mitigate	In Progress - On Tr	2015/04/13
00013255	Waste - Construction of RWPB being on Critical P	With the Retube Waste Processing Building (RWPB) Exten	Project	1TO6MTHS	Y	John HAMILTON	Roy BROWN	John HAMILTON	Mitigate	Complete	2015/05/06
00012446	Scope Creep on Diverting material/components fr	As a result of requests from Station to divert additional ma	Project	6TO12MTHS	N	Lonnie SCHOFIELD	Roy BROWN	Lonnie SCHOFIELD	Mitigate	In Progress - On Tr	2014/12/23
00012442	A new degradation mechanism drives new require	Execution Phase: As a result of a new degradation mecha	Project	1TO6MTHS	N	Lonnie SCHOFIELD	Roy BROWN	Marc PAIMENT	Mitigate	In Progress - On Tr	2015/09/21
00012441	Inadequate Breathing Air Supply during Refurb	Execution Phase: As the Breathing Air Supply is a require	Project	1TO6MTHS	N	Lonnie SCHOFIELD	Roy BROWN	Jeffrey PALMATEER	Mitigate	In Progress - On Tr	2016/02/03
00012440	Inadequate Spares of Airlock during Refurb	As the Airlocks are critical parts of Containment until Bulk	Project	1TO6MTHS	N	Scott MACDONALD	Roy BROWN	Scott MACDONALD	Mitigate	Complete	2014/12/17
00012439	PWU/Society/BTU Labour Issues causing Disrupti	Execution Phase: As negotiation of Collective Agreements	Project	1TO6MTHS	N	Lonnie SCHOFIELD	Roy BROWN	Lonnie SCHOFIELD	Transfer	In Progress - On Tr	2015/07/27
00012420	OPG Foreign Material Exclusion (FME) Events Cor	Execution Phase: Events: FME items sitting inside Concea	Project	1TO6MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Accept	In Progress - On Tr	2016/03/29
00012412	RWPB - Retube Waste Processing Building Not Me	[Definition Phase] Event: Retube Waste Processing Build	Project	1TO6MTHS	N	Bob MAHARAJ	John HAMILTON	Adam COYLE	Mitigate	In Progress - On Tr	2016/04/13
00012404	OPG Formal Rejection of Class 2 Estimate	Definition Phase: As a result of poor quality of deliverable	Project	1TO6MTHS	Y	Lonnie SCHOFIELD	Roy BROWN	Perrik LE DREFF	Mitigate	In Progress - On Tr	2015/09/30
00012360	Additional Calandria TubeSheet Boring (CTSB) Po	As a result of removal of the Calandria TubeSheet Boring	Project	1TO6MTHS	N	Roy BROWN	Roy BROWN	Marc PAIMENT	Mitigate	In Progress - On Tr	2015/03/04
00012359	Support Services requires Additional people-hour	As a result ofthe Support Servicesadoptingthe 10 hour shi	Project	GT12MTHS	N	Roy BROWN	Roy BROWN		Mitigate	Not Started	2015/01/29
00012358	Direct Field Labour requires Extra people-hours u	As a result ofthe Direct Field Labour by adopting	Project	GT12MTHS	N	Roy BROWN	Roy BROWN		Mitigate	Not Started	2015/01/29
00012357	Feeder Warehouse (FW) Requirement Not Met	As a result of inefficient erection of the Feeder Warehou	Project	6TO12MTHS	N	Roy BROWN	Roy BROWN	Lonnie SCHOFIELD	Mitigate	Not Started	2015/02/25
00012356	Contaminated Equipment Storage Building (CESB	As a result ofinefficient erection of theContaminated Equip	Project	6TO12MTHS	N	Roy BROWN	Roy BROWN	Lonnie SCHOFIELD	Mitigate	Not Started	2015/02/25
00012355	Bad Calandria Seals Encountered	As a result of removing the work of "replacing the Caland	Project	GT12MTHS	N	Roy BROWN	Roy BROWN	Bert BOSTON	Monitor	Not Started	2015/01/29
00012352	Heavy Water Left in Channels after Drain & Dry	As a result of replacing "Channel-by-Channel Drain" with	Project	GT12MTHS	N	Roy BROWN	Roy BROWN		Mitigate	Not Started	2015/01/29
00012351	Unanticipated Significantly More Rework	As a result of unanticipated significantly more Rework b	Project	GT12MTHS	N	Roy BROWN	Roy BROWN	Lonnie SCHOFIELD	Accept	Complete	2015/02/25
00012344	Waste - Darlington Refurbishment Shielded Type A	Definition Phase: Joint Venture has identified through the	Project	1TO6MTHS	N	John HAMILTON	Cameron WEBB	Yung CHEUNG	Mitigate	In Progress - On Tr	2016/01/28
00012342	Waste - Footprint Conflict between Retube Waste	The Retube Waste Processing Building (RWPB) Extension	Project	LT1MTH	N	John HAMILTON	Roy BROWN	John HAMILTON	Mitigate	Complete	2014/12/17
00012341	RWPB - Retube Waste Processing Building Executi	[Definition Phase] Risk: The requirements of the NSA may dee	Project	1TO6MTHS	Y	John HAMILTON	John HAMILTON	Khai NGO	Mitigate	In Progress - On Tr	2016/04/13
00012322	End Fitting Waste Processing - First of a kind risks	Execution Phase Risk: EVENT: As a result of the first of a	Project	1TO6MTHS	Y	Perrik LE DREFF	Michael HERSCH	Sean CARPENAY	Monitor	In Progress - On Tr	2016/04/04
00012312	Water Present in the Annulus Gas System (AGS)	If pressure tubes leaked while operating, then it could lea	Project	6TO12MTHS	N	Steve WONG	Roy BROWN	Lonnie SCHOFIELD	Accept	In Progress - On Tr	2015/03/05
00012300	Re-designed Closure Plug failure in Leak Testing	Results from the GE-Hitachi (GEH) scheduled testing of th	Project	6TO12MTHS	N	Geoff COLLING	Roy BROWN	Geoff COLLING	Mitigate	In Progress - On Tr	2014/10/09
00012293	JV Foreign Material Exclusion (FME) Events	Execution Phase: As a result of Defective Work - Tooling	Project	6TO12MTHS	N	Steve WONG	Roy BROWN	Jeffrey PALMATEER	Transfer	In Progress - On Tr	2016/01/05
00012262	Outstanding Tech Specs from the Subcontractors	As a result of delays to award of subcontractual work bet	Project	LT1MTH	N	David KURPJUWEIT	Roy BROWN	David KURPJUWEIT	Monitor	Complete	2014/11/27
00012261	New Seismic Requirements Imposed by CNSC [Wi	Definition Phase Risk. Event/Cause/Impact: Potential new	Project	1TO6MTHS	N	David KURPJUWEIT	Michael HERSCH	David KURPJUWEIT	Mitigate	In Progress - On Tr	2016/03/14
00012221	Duplicate Created in Error	Duplicate Created in Error	Project		N	Andre SIDIROPOULOS	Andre SIDIROPOULOS		Monitor	Not Started	2014/06/12
00012220	False Positive/Negative Findings from Feeder Field	There is a risk that misinterpretation of results of the Feed	Project	1TO6MTHS	N	Geoff COLLING	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/07/23
00012215	Not Reaching Agreements on Target Price, Target	As a result of NOT reaching agreements on Target Price,	Project	6TO12MTHS	N	Cameron MACLEOD	Roy BROWN	Cameron MACLEOD	Mitigate	Not Started	2014/10/28
00012214	Claims from Retube and Feeder Replacement (RFR	Definition Phase: As a result of OPG not meeting its obliga	Project	1TO6MTHS	N	Cameron MACLEOD	Roy BROWN	Cameron MACLEOD	Mitigate	In Progress - On Tr	2016/04/21
00012213	Joint Venture (JV) not complying to Terms and Co	The risk is that the JV is not complying to the T&Cs of the	Project	1TO6MTHS	N	Cameron MACLEOD	Roy BROWN	Cameron MACLEOD	Mitigate	In Progress - On Tr	2015/01/06
00012212	Joint Venture and Subcontractors' Disputes	There is a risk that disputes between the Joint Venture (co	Project	6TO12MTHS	N	Cameron MACLEOD	Roy BROWN	Cameron MACLEOD	Transfer	In Progress - On Tr	2015/01/06
00012003	Waste - Retube Waste Container / Darlington Stor	The Risk is that Retube Waste Container / Darlington Stor	Project	1TO6MTHS	N	Mario PIERIES	Roy BROWN	John HAMILTON	Mitigate	Complete	2014/12/12
00012002	Significant Variance between Class 3 and Class 4	As the result of Misalignment with AACEI standards, the r	Project		N	Patrick IEMMA	Roy BROWN	Patrick IEMMA	Mitigate	Complete	2014/06/17
00012001	Rework due to poor Class 3 Estimate	As the result of Poor Quality of Class 3 contents, the risk o	Project		N	Patrick IEMMA	Roy BROWN	Patrick IEMMA	Mitigate	Complete	2014/06/17
00011988	Inadequate Retube Waste Containers (RWC) Shiel	The risk is that inadequate Retube Waste Containers (RWC	Project	1TO6MTHS	N	Sudhakar PULAGAM	Roy BROWN	John HAMILTON	Mitigate	Complete	2014/09/15
00011987	Delay in Tooling schedule	Therisk is that delay in tooling current schedule progress,	Project	1TO6MTHS	N	Sudhakar PULAGAM	Roy BROWN	Tara REHSI	Mitigate	In Progress - On Tr	2015/04/21
00011986	Delay in Stage 1 CWP development	The risk is that delay in Stage 1 CWP development due to	Project		N	Sudhakar PULAGAM	Roy BROWN	Patrick IEMMA	Mitigate	In Progress - On Tr	
00011966	Lack of Pre-Production Qualification Strategy for	Definition Phase: There is a risk that a poorly defined Pre-	Project	1TO6MTHS	N	Bill DONOVAN	Andrew CERILLI	Bill DONOVAN	Monitor	In Progress - On Tr	2016/01/15
00011910	Spills in Vault due to work activities	The risk is that spills may occur within the vault when the	Project		N	Saieed AHMED	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/06/17
00011906	Insufficient Tool Quantities Leading to Critical Path	Risk is that insufficient quantities of tools will be procured	Project		N	Saieed AHMED	Roy BROWN	David KURPJUWEIT	Avoid	In Progress - On Tr	2014/06/10
00011905	Increased Troubleshooting Times on Removal Seri	Risk is that Extension of Critical Path will occurr ecause of	Project		N	Saieed AHMED	Roy BROWN	David KURPJUWEIT	Mitigate	In Progress - On Tr	
00011904	VRS Toolset not effectively reducing PTs and CTs	The risk is that the VRS tool set will not effectively volume	Project		N	Saieed AHMED	David KURPJUWEIT	Roy BROWN	Avoid		
00011903	VRS design impacting VRS throughput	The risk is that the VRS will employ a checkerboard press	Project		N	Saieed AHMED	Roy BROWN	David KURPJUWEIT	Mitigate	In Progress - On Tr	2014/06/10
00011902	EF Severing Performance Deficiency due to First-c	Risk is that end fitting severing in RWPB does not perform	Project		N	Saieed AHMED	David KURPJUWEIT	Roy BROWN	Mitigate		
00011901	EF Processing does not keep up with EF Removal	Risk is that End Fitting Processing does not keep up with	Project		N	Saieed AHMED	Roy BROWN	David KURPJUWEIT	Avoid	In Progress - On Tr	2014/06/10
00011900	Poor Bellows Cut Quality	Risk is that poor bellows cut quality, due to usage of Bruc	Project		N	Saieed AHMED	Roy BROWN	David KURPJUWEIT	Avoid	In Progress - On Tr	2014/06/10
00011823	RFR garter spring NRU irradiation testing delay du	There is a risk that material delay from Wah Chang will re	Project		N	Timothy QUONG	Roy BROWN	Geoff COLLING	Mitigate	In Progress - On Tr	
00011822	RFR garter spring design delay due to material del	There is a risk that material delay from Wah Chang will re	Project		N	Timothy QUONG	Roy BROWN	Geoff COLLING	Mitigate	In Progress - On Tr	
00011821	RFR Contractor Claims	The ris is that OPG does not meet its obligations resulting	Project		N	Cameron MACLEOD	Roy BROWN	Cameron MACLEOD	Accept	Complete	
00011820	Mockups Insurance	There is a risk that there will be a delay to Mockup Constr	Project		N		Roy BROWN		Mitigate		
00011819	JV Maintenance Platform Design Engineering Issue	The JV plans on using the existing design of the Darlingto	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate	Complete	
00011796	Insufficient Work Planning Capabilities	There is a risk that the JV has limited or insufficient Work	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr	
00011779	Epsca Trades Dose Management Issue During Exe	The Darlington Refurb will rely soley on the EPSCA or BT	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr	
00011776	Pressure Boundary Planning Risk	There is a risk that the RFR Vendor will not properly plan	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17
00011774	Mockups replica reactor components availability	There is a risk that due to the complexity of certain mocku	Project		N	Scott xWATERS	Roy BROWN	Scott xWATERS	Mitigate	Complete	
00011773	Mockups Building Permit take longer than planned	There is a risk that the mockups building permit takes longe	Project		N	Scott xWATERS	Roy BROWN				
00011768	Engineering Product Quality	As a result of the cause of compressed Engineering and M	Project	1TO6MTHS	N	Mario PIERIES	Roy BROWN	Rosemary HERNANDEZ	Monitor	Complete	2014/09/23
00011767	Non Long Lead Materials	There is a risk that the milestone for ordering non long le	Project		N	Bill DONOVAN	Roy BROWN	Bill DONOVAN	Mitigate	In Progress - On Tr	2014/06/17
00011766	Project External Oversight	The risk is that external project oversight will cause a	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Accept	In Progress - On Tr	
00011763	PLGS OPEX - Manually installed Closure Plugs are	OPEX from Point Lepreau has indicated challenges with th	Project		N	Cole STARK	Roy BROWN	Geoff COLLING	Avoid	In Progress - On Tr	
00011762	JV unable to demonstrate compliance of N285.6 du	The JV's procurement organization will not be able to dem	Project		N	Cole STARK	Roy BROWN		Avoid		
00011761	No qualified suppliers exist for DNGS type end fitti	Currently no qualified supplier is available to manufacture	Project		N	Cole STARK	Roy BROWN		Avoid		
00011760	Risk of inexperienced component manufacturer be	The risk is that the contractor's multiple source supply stra	Project		N	Cole STARK	Roy BROWN	Roy BROWN	Avoid		
00011759	Conflict with RWPB site	There is a potential conflict for the RWPB site - planned us	Project		N	Mario PIERIES	Roy BROWN	John HAMILTON	Mitigate	Complete	
00011743	Large Number of Flow Restricting Orifice Bung (FR	Execution Phase: There is a risk that the number of numb	Project	6TO12MTHS	N	David KURPJUWEIT	Michael HERSCH	Martin GEARY	Monitor	In Progress - On Tr	2016/05/10
00011736	Lack of ECC expertise at JV	The risk is that the JV does not have adequate ECC exper	Project		N	Amar JOLLY	Roy BROWN	Mario PIERIES	Mitigate	Complete	

ID	Title	Description	Risk Type	Urgency	Report Risk to Quad Chart	Initiator	Owner	Delegate	Response Type	Response Status	Date Last Reviewed	Trigger Date	Trigger Event
00011192	Lack of a highly trained workforce on PT Install	The risk is that lack of a highly trained workforce leads to	Project		N		Roy BROWN		Mitigate				
00011191	Heavy Work Table Realignment and recalibration (	The risk is that Heavy Work table alignment issues leads to	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate				
00011190	Heavy Work Table Realignment and recalibration (	The risk is that Heavy Work table alignment issues leads to	Project		N		Roy BROWN						
00011189	Qualified people (QS, Leak test tool operator) not	The risk is that Qualified people not available leads to incre	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011188	Improper use of Bore Guages	The risk is that improper use of bore guages leads to incre	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate				
00011187	Polishing Head Tool frequent replacements and de	The risk is that polishing head replacement leads to increas	Project		N	David KURPJUWEIT	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/06/17		
00011186	Failure of Leak Test Tool	The risk is that leak test tooling issues leads to increased ex	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate				
00011185	Calandria Tube Sheet Bore Inspections equipment	The risk is that inspection tooling (CTSB) leads to increased	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate				
00011184	Camera breakdowns	The risk is that camera breakdowns leads to schedule dela	Project		N	David KURPJUWEIT	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011183	VRS Press problems and gripper issues	The risk is that tooling breakdowns leads to increased exe	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011182	VRS machines constant O ring problems from deg	The risk is that inferior parts leads to equipment breakdow	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011181	Vision System does not work properly	The risk is that the vision alignment downtime leads to res	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate				
00011180	Alignment and Gripper issues on CTI Release and (	The risk is that alignment and gripper issues leads to loss o	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate				
00011179	Non Realistic Inspection Times on Bellows Inspectio	The risk is that non realistic inspection times leads to an ex	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011177	Bellows Cuts issues with Homing device	The risk is that equipment issues leads to equipment and w	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate				
00011176	Fuel Channel Platform install disruptions	The risk is that FCP install disruptions leads to equipment (	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011175	Unplanned Event During Definition - Catastrophy	The risk is that a Catstropy at the DEC leads to an inability	Project		N		Roy BROWN						
00011174	Presoaking of PA Hardware prior to removal	The risk is that not soaking PA Hardware leads to downtim	Project		N	David KURPJUWEIT	Roy BROWN		Mitigate				
00011173	Poor lighting in Feeder Cabinet	The risk is that poor lighting in the feeder cabinets leads to	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011172	Feeder Removal Scaffolders not scheduled proper	The risk is that scaffold builds not being scheduled proper	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Transfer	In Progress - On Tr	2014/06/17		
00011171	Wrong Info / Assumptions for Basis of Estimate	The risk is that Incorrect Information and/or Poor Assump	Project		N		Roy BROWN						
00011170	CWP's for series not completed on time	The risk is that Construction Work Packages not complete	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/06/17		
00011169	Vault Crane Risk - BP U3/4 OPEX	The risk is that the Vault Crane may need refurbishment a	Project		N		Roy BROWN						
00011168	Issues Discovered During Execution are Devalued	"The risk is that problems discovered will be ""de-valued""	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011167	Breaker Open Milestone Changes	The risk is that the unit Breaker Open milestone will slip wi	Project		N		Roy BROWN		Mitigate				
00011166	DEC Truck Entrance may be Insufficient	The risk is that current DEC truck entry location and size	Project		N		Roy BROWN						
00011165	Vault Cleanup prior to turnover to Contractor is n	The risk is that Vault Preparation prior to turn over to the	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011164	Liss Nozzle / Waste Container incompatability	The risk is that Liss Nozzles may not be able to be accomo	Project		N		Roy BROWN		Accept				
00011163	Inaccurately Estimated RFR DSRs	The risk is that Gate 1 estimate for additional DSR scope in	Project		N		Roy BROWN						
00011162	Inaccurately Estimated RFR Cost Estimates - OPG	The risk is that Gate estimates will be inaccurate leading to	Project		N	Sudhakar PULAGAM	Roy BROWN	Sudhakar PULAGAM	Mitigate	In Progress - On Tr			
00011161	Contractor Definition Phase ReWork	The risk is that as the definition phase increases and the co	Project		N		Roy BROWN		Mitigate				
00011160	Scope Increase during Definition Phase	The risk is that there will be significant RFR core scope cre	Project		N		Roy BROWN		Mitigate				
00011159	OPG Influencing Design	The risk is that OPG will influence the design process leadi	Project		N		Roy BROWN						
00011158	Contractor Rampup too Slow - Definition	The risk is that the RFR Contractor takes too long to fully	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr			
00011157	Labour Strikes	The risk is that labour strikes leads to schedule delay and f	Project		N		Roy BROWN						
00011156	Skillset of workforce	The risk is that a limited skillset of contracted workforce le	Project		N		Roy BROWN						
00011155	Labour Relation Issues during Definition and Prep	The risk is that labour relation issues lead to delays and th	Project		N		Roy BROWN		Accept				
00011154	The risk is that increase project knowledge by O	The risk is that increase project knowledge by OPG durin	Project		N		Roy BROWN		Mitigate				
00011153	Schedule Float Impacts Business Plan	The risk is that variations in the contractors schedule (due	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr			
00011152	Inability to attract and retain resources	The risk is that the R&FR contractor may have an inability	Project		N		Roy BROWN						
00011151	Contractor to Self Supply Materials Sole Source	The risk is that the R&FR Contractor may sole source mate	Project		N	Bill DONOVAN	Roy BROWN	Bill DONOVAN	Mitigate	In Progress - On Tr	2014/06/17		
00011150	Risk of Vendor Default/Business Continuity [Poten	Definition Phase / Execution Phase: Due to vendor default	Project	1TO6MTHS	N	Cameron MACLEOD	Roy BROWN	Cameron MACLEOD	Monitor	In Progress - On Tr	2016/04/21		
00011149	Insufficient OPG Funding and Cashflows to suppo	The risk is that insufficient OPG Funding and Cashflows e	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Transfer	In Progress - On Tr			
00011148	Unplanned Event During Definition - Government	The risk is that government Direction leads to Project Can	Project		N		Roy BROWN						
00011147	Risk Transfer not reasonable - OPG may be in bett	The risk is that the risk transfer to the R&FR Contractor is	Project		N		Roy BROWN						
00011146	Pricing Model Risk - Target portion has too much	The risk is that the Target portion of the R&FR contract is	Project		N		Roy BROWN						
00011145	Pricing Model Risk - Fixed portion too expensive	The risk is that the Fixed portion of the R&FR contract is m	Project		N		Roy BROWN						
00011144	Wrong T&C's / contracting model	The risk is that negotiated R&FR Contractor Terms and C	Project		N		Roy BROWN						
00011143	Emergent scope or new knowledge impacts Projec	The risk is that effort outside the RFR project or additional	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Accept	In Progress - On Tr			
00011142	OPG Resources of limited Skillset	The risk is that a limited skillset of the workforce leads to p	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr			
00011141	Lack of OPG Process for EPC Oversight	The risk is that a lack of OPG processes for EPC oversight	Project		N		Roy BROWN						
00011140	Incorrect Estimates by Contractor	The risk is that Contractor Estimates are too low leading t	Project		N	Roy BROWN	Roy BROWN	Patrick IEMMA	Mitigate	In Progress - On Tr			
00011139	Lack of Engineering Support during Definition / P	The risk is that a lack of Engineering support leads to dela	Project		N		Roy BROWN						
00011138	OPG RFR Engineering Support (Non conformanc	The risk is that OPG will not be able to process NCRs effec	Project		N	Mario PIERIES	Roy BROWN	Rosemary HERNANDEZ	Mitigate	In Progress - On Tr			
00011137	OPG Directing Contractor	The risk is that OPG will direct the R&FR Contractor leadin	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr			
00011136	No OPG Alignment to EPC model	The risk is that OPGs Processes and work practices are no	Project		N		Roy BROWN		Mitigate				
00011135	OPG Cannot Provide Deliverables to RFR Contract	The risk is that OPG will not be able to provide deliverable	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Accept	In Progress - On Tr			
00011134	OPG Cannot Meet Review Cycles	The risk is that OPG will not be able to meet the document	Project		N		Roy BROWN		Mitigate				
00011133	OPG Underestimates oversignt needs	The risk is that OPG will underestimate R&FR Contractor o	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr			
00011132	Unplanned Event during Transport of Tools	The risk is that an Unplanned event occurs during the tra	Project		N	Perrik LE DREFF	Roy BROWN	Perrik LE DREFF	Mitigate	In Progress - On Tr			
00011131	PRFR - Tooling	There is a risk that Project Performance will be negatively	Project		N	David KURPJUWEIT	Roy BROWN		Accept	Complete			
00011130	PRFR - Mockup	There is a risk that Project Performance will be negatively	Project		N	Sudhakar PULAGAM	Roy BROWN	Scott xWATERS	Mitigate	Complete			
00011129	PRFR - Procurement	There is a risk that Project Performance will be negatively	Project		N	Bill DONOVAN	Roy BROWN	Bill DONOVAN	Mitigate	In Progress - On Tr			
00011128	PRFR - Contract	There is a risk that Project Performance will be negatively	Project		N	Cameron MACLEOD	Roy BROWN	Cameron MACLEOD	Mitigate	Complete			
00011127	PRFR - PM - P&C	There is a risk that Project Performance will be negatively	Project		N	Sudhakar PULAGAM	Roy BROWN	Sudhakar PULAGAM	Mitigate	In Progress - On Tr			
00011126	PRFR - PM - Estimate	There is a risk that Project Performance will be negatively	Project		N	Patrick IEMMA	Roy BROWN	Patrick IEMMA	Mitigate	In Progress - On Tr			
00011125	PRFR - PM	There is a risk that Project Performance will be negatively	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr			
00011124	Bulkhead interferes with retube tools	Containment isolation bulkhead design may not account f	Project		N	Andy IRELAND	Roy BROWN		Transfer				
00011122	Retube Waste Storage Building AFS delayed	Delay in the availability of the Retube Waste Storage buildi	Project	1TO6MTHS	N	Andy IRELAND	Roy BROWN	John HAMILTON	Accept	Complete	2014/09/15		
00011121	Lunchroom / Changeroom AFS delayed	Delay in the availability of the Lunchroom / Changroom b	Project		N	Andy IRELAND	Roy BROWN	Nicolle BUTCHER	Transfer				
00011120	Refurb Island Annex AFS delayed	Delay in the availability of the Refurb Island Annex buildin	Project		N	Andy IRELAND	Roy BROWN	Nicolle BUTCHER	Transfer				
00011119	D2O Storage Building AFS delayed	Unavailability of D2O storage building may cause delay to	Project		N	Andy IRELAND	Roy BROWN	Nicolle BUTCHER	Transfer				
00011118	West Security / Office Building AFS delayed	Delay in the availability of the West Security / Office buildi	Project		N	Andy IRELAND	Roy BROWN	Nicolle BUTCHER	Transfer				
00011117	Post Installation rework	The risk is that replaced components or existing systems,	Project		N	Scott xWATERS	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011116	Execution Series Schedule Delays	The risk is that one or more Execution series take longer t	Project	1TO6MTHS	N	Scott xWATERS	Roy BROWN	Roy BROWN	Mitigate	Not Started	2014/07/17		
00011115	Regulatory issues cause delay	The risk is that regulatory issues, changes in Code/ Law, c	Project		N	Roy BROWN	Roy BROWN	Marcia SANDERSON	Transfer	In Progress - On Tr			
00011114	Unplanned Event Impacts	The risk is that unplanned events have significant adverse	Project		N	Roy BROWN	Roy BROWN						
00011113	Site events or accidents by OPG leads to stop wor	"Risk is that increased involvement by external agencies ((	Project		N		Roy BROWN						
00011112	Uncertainties on Execution Logistics	The risk is that uncertainties remain around the physical lo	Project		N	Roy BROWN	Roy BROWN						
00011111	Tool change control and management [Potential W	Execution Phase Risk. Event/Cause/Impact: As a result of	Project	1TO6MTHS	N	Andy IRELAND	Michael HERSCH	David KURPJUWEIT	Mitigate	Not Started	2016/03/15		Risk is trigge
00011110	Lack of Engineering Support during execution	This risk has been identified as a result of Bruce 1 & 2 Lea	Project	1TO6MTHS	N	Andy IRELAND	Roy BROWN	Rosemary HERNANDEZ	Transfer	In Progress - On Tr	2014/08/14		
00011109	Insufficient training facilities	"Lack of adequate training facilities close to the station ma	Project		N	Andy IRELAND	Roy BROWN	Roy BROWN	Accept	In Progress - On Tr			
00011108	Insufficient station LLW processing / off-gassing /	The risk is that there is not enough space to process the a	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Transfer	In Progress - On Tr	2014/06/17		
00011106	RWC/DSO may not be delivered on-time [Window	[Execution Phase] Event: RWC's will not be delivered on t	Project	1TO6MTHS	N	Vasile BOSTAN	Andrew CERILLI	Cole STARK	Monitor	In Progress - On Tr	2016/04/05		
00011093	OEB prevents early cost recovery	The risk is that early project cost recovery will be disallowe	Project		N		Roy BROWN		Mitigate				
00011092	Non-conformance of components or equipment	The risk is that components or equipment do not conform	Project		N	Bill DONOVAN	Roy BROWN	Bill DONOVAN	Mitigate	Complete	2014/06/17		
00011091	Tooling intellectual property	Risk that intellectual property claims between contractors	Project		N		Roy BROWN		Transfer				
00011090	Heat Transport System alpha contamination	Heat Transport System alpha contamination is greater tha	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011089	Delay of bins delivery	The risk is that delay of bins delivery may delay the proje	Project		N		Roy BROWN						
00011088	Lack of waste bins / appropriate waste segregation	The risk is that more bins are required than anticipated. Th	Project		N		Roy BROWN		Mitigate				
00011087	Information security during data transfer	The risk is that information technology security is compro	Project		N		Roy BROWN						
00011086	Modifications to Owner Specified Materials	The risk is that over-specifying materials and/or material c	Project		N	Marcia SANDERSON	Roy BROWN	Geoff COLLING	Mitigate	In Progress - On Tr	2014/06/10		
00011085	Unapproved mods by contractor	The risk is that unapproved modifications (i.e. changes m	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011084	Labour relations issues	"The risk is that labour relations issues lead to delays and t	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Transfer	In Progress - On Tr			
00011083	Radiological event during R&FR execution by OPG	The risk is that, radiological event during execution may	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Transfer	In Progress - On Tr			
00011082	DEC does not have space for trailers	Insufficient space / services for mock-up contractor trailer	Project		N		Roy BROWN		Mitigate				
00011081	Contractor does not manage H&S to contractual r	Risk is that ongoing safety performance is not adequately	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Accept	In Progress - On Tr			
00011080	DEC not sufficient to support RFR	Given that the Darlington Energy Complex (DEC) design	Project		N	Andy IRELAND	Roy BROWN	Scott xWATERS	Mitigate	Not Started			
00011078	Project related Fatality / Serious injury	"Risk is that such injuries/fatalities may affect the project s	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Transfer	In Progress - On Tr			
00011077	Unanticipated Changes to H&S legislation and stan	"Risk is that changes cause schedule delays (e.g. impacts f	Project	GT12MTHS	N	Roy BROWN	Roy BROWN	Roy BROWN	Accept	Not Started	2014/07/23		
00011076	Site events or accidents by contractor leads to sto	"Risk is that increased involvement by external agencies (	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Transfer	In Progress - On Tr			
00011075	Risk of a significant event (electrical contact, dropp	"A significant event results in regulatory involvement (CN	Project		N		Roy BROWN		Mitigate				
00011074	Insufficient Retube Waste Containers, or Incompat	There is a risk that there may be an inadequate number of	Project	1TO6MTHS	N	Vasile BOSTAN	Roy BROWN	John HAMILTON	Mitigate	In Progress - On Tr	2014/09/26		
00011073	Excessive discovery scope during execution	"The risk is that excessive discovery scope during executi	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Transfer	In Progress - On Tr			
00011072	Planned schedule duration improvements on subse	The risk is that planned schedule duration (units staggere	Project		N	Gary ROSE	ARNONE Mark	Roy BROWN	Mitigate				
00011071	Load handling capacity of Reactor Area bridge	The risk is that the Reactor Area Bridge is not suited to ha	Project		N		Roy BROWN		Mitigate				
00011070	DEC warehouse racking undefined	The risk is that DEC RFP will be issued without warehouse	Project		N		Nicolle BUTCHER	Roy BROWN	Mitigate				
00011068	Equipment or material late	Equipment or material prepared and not available per con	Project		N		Roy BROWN		Mitigate				
00011065	Contractors cannot produce satisfactory deliverab	The risk is that contractors are not capable of producing s	Project		N		Roy BROWN		Transfer				
00011064	Contractor under estimates the work (Definition)	"The risk is that the contractor significantly underestimate	Project		N		Roy BROWN		Mitigate				
00011063	Radiological event during R&FR execution by RFR	"The risk is that, radiological event during execution may	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Transfer	In Progress - On Tr	2014/06/17		
00011062	Issues with plant configuration at completion affec	"The risk is that the paper plant is different from the real p	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011061	Accidental damage of RFR equipment / componen	"The risk is that accidental damage of equipment / compo	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011060	Contractor damage to plant equipment	There is risk that the contractor may damage plant equip	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Transfer	Not Started	2014/06/17		
00011059	Outage Timing Changes	"Any schedule changes regarding unit outage sequence, d	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Transfer	In Progress - On Tr			
00011058	Change of AECL ownership may impact R&FR tim	The risk is that the change of AECL ownership may impact	Project		N		Roy BROWN		Mitigate				
00011057	Unit islanding may cause unplanned impact to the	Established barriers for refurbishment unit islanding from	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/06/17		
00011056	RFR allocated in-plant RFR laydown area Insufficie	Space inside the powerhouse is limited and may not afford	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Transfer	In Progress - On Tr	2014/06/17		
00011055	RFR allocated outdoor laydown area insufficient	Protected area space outside the powerhouse is limited an	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Transfer	Not Started	2014/06/17		
00011054	Insufficient RFR information available for RQE - To	"Incomplete or insufficient tool set design will delay RFR st	Project		N	David KURPJUWEIT	Roy BROWN		Transfer	Complete			
00011053	OPG and RFR consortium cannot work as a team	Risk that OPG and RFR consortium cannot work in partne	Project		N	Meg TIMBERG	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr			
00011052	R&FR contractor estimates not complete at RQE	The risk is that the RFR Contractor estimates are not comp	Project		N		Roy BROWN	Gary ROSE	Transfer				
00011051	Inadequate qualified RFR resources	The risk is that sufficient qualified RFR resources may not	Project		N		Roy BROWN						
00011049	Rework issues	"The risk is that due to quality of supply/work/human per	Project	6TO12MTHS	N	Gary ROSE	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/07/11		
00011048	Contractor QA program not executed adequately	The risk is that QA program not implemented adequately	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	In Progress - On Tr			
00011047	Material risks	The risk is that incomplete identification of Long Lead item	Project		N	Gary ROSE	Roy BROWN	Bill DONOVAN	Accept	In Progress - On Tr	2014/06/17		
00011046	Calandria structural integrity repairs required	The risk is that structural defects from initial Calandria (spe	Project		N		Roy BROWN						
00011045	Adequacy of Header nozzles for extended life due	The risk is the Header nozzles thinning, due to being expo	Project		N		Roy BROWN						
00011044	LISS Nozzle-Calandria Tube contact requiring LISS	The risk is that the combination of creep-sag of the Liss No	Project	6TO12MTHS	N	David KURPJUWEIT	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/07/02		
00011043	PHT headers Pressure Boundary compromised	The risk is that the PHTS Pressure Boundary is comprom	Project		N		Roy BROWN						
00011042	PHTS pressure levels issues	The risk is that after refurbishment, the PHTS is not retain	Project		N		Roy BROWN						
00011041	D2O leak	The risk is that a possible D2O leak through new compon	Project		N		Roy BROWN						
00011040	Work interference between feeder cabinet and Re	The risk is that work interference between feeder cabinet	Project		N		Roy BROWN						
00011039	Pressure Boundary compromised through poor se	The risk is that the Pressure Boundary is compromised, ca	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate	Not Started			
00011038	Fuel Channel installation issues	The risk is that fit related issues with installation of fuel cha	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/06/17		
00011037	Welding Radiography interferes with shift schedule	The risk is that welding radiography tests interfere with sh	Project		N		Roy BROWN		Avoid				
00011036	Vault Congestion causes schedule delays	"Vault congestion may interfere with new feeder installatio	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/06/17		
00011035	Repair to header nozzles.	"Degradation of the nozzle may need repair, causing delay	Project		N		Roy BROWN		Transfer				
00011034	Calandria tube insert seal	The risk is that the CTI is not sealed against existing bore,	Project		N		Roy BROWN						
00011033	Tubesheet bore does not meet requirements	"The risk is that the inboard tubesheet is found out of spe	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/06/17		
00011032	Foreign material discovered during removal or rep	The risk is that foreign material is discovered in calandria,	Project	6TO12MTHS	N	David KURPJUWEIT	Roy BROWN	Scott MACDONALD	Accept	In Progress - On Tr	2014/11/27		
00011031	CTI is not properly released	The risk is that Calandria Tube Insert (CTI) is not properly	Project		N		Roy BROWN		Mitigate				
00011030	Feeder contamination control problems	The risk is that the level of contamination is not known be	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/08/14		
00011029	Residual tritium exposure upon feeder disconnect/	The risk is that residual tritium exposure upon feeder disco	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/08/14		
00011028	High tritium concentration	The risk is that tritium concentration in air exceeds 1Mpca	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/08/14		
00011027	Bulkhead requirements	The risk is that the Bulkhead does not meet requirements (	Project		N		Roy BROWN						
00011026	D2O spill in the containment	The risk is that tritiated D2O spills into containment from P	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/08/14		
00011025	Poor or insufficient design requirement definition -	The risk is that inadequately identified design requirements	Project		N	Saieed AHMED	Roy BROWN		Mitigate				
00011024	Equipment tooling failures during reactor compone	The risk is that equipment tooling failures while radiologic	Project		N	Sudhakar PULAGAM	Roy BROWN	Scott MACDONALD	Mitigate	Not Started	2014/08/14		
00011023	Material unavailability and/or long lead time	"Material may be unavailable and/or material has a longer	Project		N	Bill DONOVAN	Roy BROWN	Bill DONOVAN	Accept	In Progress - On Tr			
00011021	R&FR Contractor will not have time to fully develo	The risk is that delays in awarding a retube contract cause	Project		N		Roy BROWN						
00011020	CNSC issues request for action to CANDU licensee	"The risk is that the CNSC issues a request for more string	Project		N	ARNONE Mark	Roy BROWN		Transfer				
00011019	Excessive / unexpected radiation dose	The risk is that excessive / unexpected radiation dose lead	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/08/14		
00011018	Issues with technology, tooling or construction me	The risk is that tooling/ technology does not function as e	Project		N		Roy BROWN						
00011016	Primary Heat Transport (PHT) header/nozzle cond	"The risk is that the a significant number of reactor outlet	Project		N	Marcia SANDERSON	Roy BROWN	Marcia SANDERSON	Mitigate	In Progress - On Tr			
00011015	Reactor inlet & outlet Header Nozzles	The risk is that the Reactor inlet header nozzles and/or out	Project		N		Roy BROWN						
00011014	Negative impact on retube schedule	"The risk is that the entire retube schedule will be impacte	Project		N		Roy BROWN		Mitigate				
00011013	Sole-sources and off-shore material in case of retu	"The risk is that the procurement of a number of replacem	Project		N		Roy BROWN						
00011012	Site preparations delayed - Campus Plan	The risk is that delays on site preparations (e.g. WSB, Ann	Project		N		Roy BROWN	Nicolle BUTCHER	Mitigate				
00011011	Price of raw materials	The risk is that the price of raw materials may increase du	Project		N	Bill DONOVAN	Roy BROWN	Bill DONOVAN	Mitigate	In Progress - On Tr			
00011010	State of calandria internals is unknown	The inside of Calandria has not been inspected and condi	Project		N	Marcia SANDERSON	Roy BROWN	Marcia SANDERSON	Mitigate	In Progress - On Tr			
00011009	Non-conforming components or inspections	The risk is that non-conforming components or inspection	Project		N		Roy BROWN		Transfer				
00011008	Weld and rolled joints repairs on Fuel Channels	The risk is that the need for weld and rolled joints repairs	Project		N		Roy BROWN						
00011005	All physical interferences in Unit not identified	Execution Phase: Due to unforseen discoveries, there is a	Project	1TO6MTHS	N	Steve WONG	Andrew CERILLI	Rosemary HERNANDEZ	Monitor	In Progress - On Tr	2016/02/09		Trigger ever
00011004	Alternative to long lead items are not properly con	"The risk is that the baseline schedule may be built on the	Project		N	Roy BROWN	Roy BROWN		Mitigate				
00011003	Uncertainties in on-site active material transfers and	The risk is that active material transfers may cause delays (	Project		N	Roy BROWN	Roy BROWN	Scott MACDONALD	Mitigate	In Progress - On Tr	2014/08/14		
00011002	Inappropriate oversight of contractors/ vendors -	"The risk is that inappropriate level of OPG oversight may	Project		N		Roy BROWN	Gary ROSE	Mitigate				
00011001	Conflicts between OPG processes and contractors	The risk is that OPG processes may impact contracted wo	Project		N		Roy BROWN		Mitigate				
00011000	Delays in specifications for materials	Delays in establishing the specifications impact material deli	Project		N	Roy BROWN	Roy BROWN	Roy BROWN	Mitigate				

ID	Pre Prob	Pre Financial	Pre Schedule	Pre Score	Current Prob	Current Financial	Current Schedule	Current Score	Post Prob	Post Financial	Post Sched	Post Score	Post Mitigation Score TCD	Status	Risk Close Date	Comments	RBS 1	RBS 2	Risk Assumptions
00011192				0	3	2	2	6				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			The EPC Contractor will be responsible risk mitigat
00011191	2	2	2	4	1	1	1	1	1		1	1	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011190				0	5	3	3	15				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011189	3	1	2	6	3	1	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011188	1	1	1	1	1	1	1	1	1		1	1	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011187	3	2	2	6	3	2	2	6	2	2	2	4	2014/05/01	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011186	2	1	1	2	2	2	2	4	1		1	1	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011185	2	2	2	4	1	1	1	1	1		1	1	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011184	3	1	1	3	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011183	3	3	4	12	3	3	4	12	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011182	3	1	2	6	3	1	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011181	2	2	2	4	1	1	1	1	1		1	1	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011180	2	2	2	4	3	1	1	3	1		1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011179	3	1	2	6	3	1	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011177	2	2	2	4	4	1	2	8	1		1	1	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011176	3	2	3	9	3	2	3	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011175				0	2	3	5	10				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011174	1	1	1	1	1	1	1	1	1		1	1	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011173	3	1	1	3	3	1	1	3	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011172	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011171				0	3	4	3	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011170	3	3	2	9	3	2	3	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011169				0	4	2	4	16				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011168	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011167				0	3	3	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011166				0	5	1	2	10				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011165	2	2	3	6	2	2	3	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011164				0	1	2	2	2				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			May Not Be In Scope
00011163				0	4	4	3	16				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011162	3	2	1	6	3	2	1	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - P&C (11127)		
00011161				0	4	2	4	16				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Rework risk for tooling, submittals, estimating, mo
00011160				0	3	2	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011159				0	5	3	4	20				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011158	3	1	2	6	3	1	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011157				0	2	2	4	8				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011156				0	2	2	4	8				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011155				0	2	2	4	8				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Risk 11084 covers a similar risk during Execution
00011154				0	3	2	3	9				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011153	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011152				0	3	2	3	9				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011151	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement (11		
00011150	5	5	5	25	1	2	4	4	1	2	4	4	2026/01/01	Active		Comments Roy B 2014-08-14: This risk shall be clo	RFR - Contract (11128)	Vendor Perf	Cost Impact based on negotiation of new contract
00011149	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011148				0	2	5	5	10				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011147				0	3	4	1	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011146				0	3	3	1	9				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011145				0	3	5	1	15				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011144				0	2	5	5	10				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011143	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011142	2	1	2	4	2	1	2	4	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011141				0	4	4	5	20				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011140	2	2	4	8	2	4	2	8	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Estimate (11126)		
00011139				0	5	3	4	20				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011138	3	3	3	9	3	3	3	9	1	1	1	1	2015/06/30	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Mods/Engineerin		
00011137	3	3	2	9	3	3	2	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011136				0	3	2	3	9				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011135	2	2	2	4	2	2	2	4	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011134				0	2	2	2	4				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011133	2	2	3	6	2	2	3	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011132	1	3	3	3	1	3	3	3	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Tooling (11131)		
00011131	1	1	1	1	1	1	1	1	1	1	1	1	2014/01/31	Cancelled	2014/02/07	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Tooling (11131)		All Level 2 Tooling Risks to the RFR Project are lin
00011130	3	2	3	9	3	2	3	9	1	1	1	1	2014/01/31	Closed	2014/02/26	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Mock-up (11130)		All Level 2 Mockup Risks to the RFR Project are lin
00011129	3	3	3	9	3	3	4	12	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement (11		All Level 2 Procurement Risks to the RFR Project a
00011128	3	3	4	12	3	3	4	12	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Contract (11128)		All Level 2 Contract Risks to the RFR Project are li
00011127	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - P&C (11127)		All Level 2 Project Control Risks to the RFR Projec
00011126	2	2	4	8	2	4	2	8	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Estimate (11126)		All Level 2 Estimation Risks to the RFR Project are
00011125	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		All Level 2 Project Management Risks to the RFR P
00011124	2	2	2	4	2	3	3	6	1		1	1	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Tooling (11131)		
00011122	2	3	2	6	2	3	2	6	1	1	1	1	2014/01/31	Closed	2014/04/08	Risk Impact Pre-Response Program Risk #474 cov	RFR - Waste (11644)		"Split from 11012. Ref program risk 474 Assume 2
00011121				0	3	3	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			"Split from 11012. Ref program risk 474 Assume 2
00011120				0	3	3	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			"Split from 11012. Ref program risk 474 Assume 2
00011119				0	3	3	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			"Split from 11012. Ref program risk 474 Assume 2
00011118				0	3	3	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			"Split from 11012. Ref program risk 474 Assume 2
00011117	2	3	3	6	2	3	3	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011116	3	3	3	9	3	3	3	9	1	1	1	1	2016/10/16	Closed	2014/07/23	Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011115	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Regulatory (1164		
00011114				0	3	4	5	15				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011113				0	3	2	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011112				0	5	4	5	25				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Risk Assessment based on max of each category (p
00011111	2	1	5	10	4	1	3	12	1	1	1	1	2016/09/30	Active		Risk Impact Pre-Response Risk Impact Post Respo	RFR - Tooling (11131)		Risk is in execution that the tool will cause unexpe
00011110	2	2	3	6	2	2	3	6	1	1	1	1	2015/06/30	Closed-BAU	2014/08/14	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Mods/Engineerin		
00011109	2	2	2	4	2	2	2	4	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011108	2	2	2	4	2	2	2	4	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011106	2	3	4	8	1	3	4	4	1	3	4	4	2016/04/30	Active		Risk Impact Pre-Response 1. Fabrication of the re	OSM	Material Mar	The Reference Plan is the accepted concept for ret
00011093				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011092	3	2	2	6	1	1	1	1	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement (11		
00011091				0	3	2	3	9				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011090	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011089				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011088				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011087				0	1	1	1	1				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011086	2	2	1	4	2	2	1	4	1	1	1	1	2015/06/15	Closed	2014/06/10	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement End		
00011085	2	2	2	4	2	2	2	4	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011084	2	2	3	6	2	2	3	6	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		"Assumed over duration of the project - collective
00011083	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		see risk 11063
00011082				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011081	3	1	1	3	3	1	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011080	2	1	2	4	2	2	1	4	2	1	1	2	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Mock-up (11130)		
00011078	1	1	1	1	1	1	1	1	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011077	1	1	1	1	1	1	1	1	1	1	1	1	2016/10/16	Closed	2014/07/23	Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)	Regulatory	
00011076	3	2	3	9	3	2	3	9	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011075				0	2	1	4	8				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011074	2	2	1	4	2	2	1	4	1	1	1	1	2015/06/30	Closed		Risk Impact Pre-Response "1. Design of the retub	RFR - Waste (11644)		"The design study of the containers is currently pr
00011073	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011072	1	1	1	1	2	2	3	6	1	1	1	1	2015/05/01	Closed	2014/04/17	Risk is managed under program risk 486 Risk Imp	RFR - PM (11125)		
00011071				0	2	2	2	4				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			The EPC Contractor will be responsible risk mitigat
00011070				0	1	1	1	1				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Racking will not be done during warehouse timefr
00011068				0	3	3	3	9				0		Closed	2014/10/31	Risk Impact Pre-Response "If risk occurs: OPG			"- spec complete; order placed; items do not arriv
00011065				0	3	2	3	9				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Corrections will take place as project progresses.
00011064				0	2	2	3	6				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011063	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011062	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Need to consider when this risk could occur - e.g.
00011061	1	4	5	5	1	4	5	5	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011060	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		This includes non negligent errors and above and
00011059	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011058				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011057	2	2	3	6	2	2	3	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Ref. prog risk 59
00011056	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011055	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011054	3	2	3	9	2	3	3	6	2	3	3	6	2014/01/31	Closed	2014/02/04	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Tooling (11131)		RFR project agreement section 3.4 and Definition R
00011053	2	3	3	6	2	3	3	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		Contracting strategy is based on assumption that v
00011052				0	5	3	5	25				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011051				0	5	4	5	25				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Risk Assessment based on max of each category (p
00011049	3	3	4	12	3	3	4	12	1	1	1	1	2015/06/16	Closed	2014/07/23	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11	Contractor	Risk Assessment based on max of each category (p
00011048	3	2	3	9	3	2	3	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - PM (11125)		
00011047	2	3	3	6	2	3	3	6	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement (11		
00011046				0	1	4	4	4				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011045				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011044	2	3	2	6	3	2	2	6	2	1	2	4	2015/07/30	Closed	2014/07/23	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11	Scope and E	
00011043				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011042				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011041				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011040				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011039	3	2	3	9	3	2	3	9	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Assumed the aggregate of multiple rework inciden
00011038	2	1	1	2	2	1	1	2	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Reference for Risk Transfer required. The EPC Co
00011037				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011036	3	3	2	9	3	2	3	9	1	1	1	1	2015/03/30	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Risk 11040 on work interference between feeder c
00011035				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011034				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011033	1	3	4	4	1	3	4	4	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Move 'damaged during removal series' to 11031 w
00011032	1	1	2	2	1	1	2	2	1	1	2	2	2026/01/01	Closed	2014/11/27	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011031				0	1	1	2	2				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			The EPC Contractor will be responsible risk mitigat
00011030	3	1	1	3	3	1	1	3	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Need to review the OPEX from other retube proje
00011029	2	2	2	4	2	2	2	4	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011028	3	1	1	3	3	1	1	3	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Assumed to occur during execution.
00011027				0				0				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011026	3	2	2	6	3	1	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		
00011025	3	3	3	9	3	2	3	9	3		3	9	2014/01/31	Closed	2013/12/11	Risk Impact Pre-Response Risk Impact Post Resp	RFR - Tooling (11131)		Assumed process & resources are good
00011024	3	2	2	6	3	2	2	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		The EPC Contractor will be responsible risk mitigat
00011023	2	3	3	6	2	3	3	6	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement (11		
00011021				0	3	2	5	15				0		Closed	2014/10/31	Risk Impact Pre-Response Strain on resource, lac			"Precursors to retube contract award are slipping.
00011020				0	3	3	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Assumption: This action could lead to a primary H
00011019	3	2	3	9	3	2	3	9	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Financial and Schedule impact based on 4 units.
00011018				0	3	3	3	9				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			"Assumptions: - This has been a problem before c
00011016	2	3	3	6	2	3	3	6	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement End		
00011015				0	3	2	2	6				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011014				0	3	2	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011013				0	4	1	2	8				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011012				0	3	2	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			"Ref program risk 314 Assume 2015 breaker open
00011011	3	2	1	6	3	2	1	6	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement (11		75% raw cost = 75% of component cost
00011010	3	3	3	9	3	3	3	9	1	1	1	1	2014/01/31	Closed		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Procurement End		
00011009				0	2	2	2	4				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Transfer to vendor
00011008				0	3	3	3	9				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Transfer to vendors. QA program in contracts.
00011005	2	1	5	10	2	1	3	6	2	1	2	4	2016/10/14	Closed	2016/03/03	Originally initiated by PIERIES Mario. Risk Impact	RFR - Mods/Engineerin	Cost and Sc	That not all potential interfaces were identified by t
00011004				0	3	2	4	12				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011003	2	2	3	6	2	2	3	6	1	1	1	1	2014/01/31	Closed-BAU		Risk Impact Pre-Response Risk Impact Post Resp	RFR - Construction (11		Assumed delay over all units. The EPC Contractor
00011002				0	2	2	2	4				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			Assuming fully competent staff.
00011001				0	4	2	4	16				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			
00011000				0	4	3	5	20				0		Closed	2014/10/31	Risk Impact Pre-Response Risk Impact Post Resp			

ID	P6 Activity ID	Station Risk	ERM Risk	NOC Risk	Gate	Phase	Response Strategy and Justification	Station Risk ID Number	Modified By	Modified Date	Version	Created By	Created Date	Impacted Organizations	Sub Bundle/Project #s	Owner Org Code	Owner Org Title	Actions	Assumptions	Decisions	Daily Logs	Lessons Learned	OPEX	Oversight Findings	Oversight Activities	Issues
00011192		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: Risk		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011191		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: align		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011190		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: Dupl		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011189		N	N	N	Gate 4		Risk Response Strategy: JV BAU Risk Status Notes		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011188		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: use o		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011187		N	N	N	Gate 4		Risk Response Strategy: JV Risk Risk Status Notes		WONGST	2014/06/17	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011186		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: The		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011185		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: The		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011184		N	N	N	Gate 4		Risk Response Strategy: Review quantities to ensu		WONGST	2014/06/17	23	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011183		N	N	N	Gate 4		Risk Response Strategy: JV Risk Risk Status Note		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011182		N	N	N	Gate 4		Risk Response Strategy: JV Risk Risk Status Note		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011181		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: OPE		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011180		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: Dem		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011179		N	N	N	Gate 4		Risk Response Strategy: JV Risk Risk Status Note		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011177		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: risk		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011176		N	N	N	Gate 4		Risk Response Strategy: JV Risk Risk Status Note		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011175		N	N	N	Gate 2		Risk Response Strategy: Risk Status Notes: Forc		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011174		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: This		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011173		N	N	N	Gate 4		Risk Response Strategy: JV Risk Risk Status Note		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011172		N	N	N	Gate 4		Risk Response Strategy: JV Risk Risk Status Note		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011171		N	N	N	Gate 2		Risk Response Strategy: Risk Status Notes: Dupl		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011170		N	N	N	Gate 4		Risk Response Strategy: COntractor's Risk. This ri		WONGST	2014/06/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011169		N	N	N	Gate 3		Risk Response Strategy: Activ		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011168		N	N	N	Gate 4		Risk Response Strategy: BAU for JV Risk Status N		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011167		N	N	N	Gate 3		Risk Response Strategy: Follow Contract Terms an		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011166		N	N	N	Gate 2		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011165		N	N	N	Gate 4		Risk Response Strategy: Incorporate vault clean u		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011164		N	N	N	Gate 3		Risk Response Strategy: Perform an assessment to		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011163		N	N	N	Gate 2		Risk Response Strategy: Risk Status Notes: dupli		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011162		N	N	N	Gate 2		Risk Response Strategy: Independent verification		SIDDIQM	2014/03/13	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011161		N	N	N	Gate 2		Risk Response Strategy: Mitigated by Contracting		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011160		N	N	N	Gate 2		Risk Response Strategy: Ensure that contractor ov		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011159		N	N	N	Gate 2		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011158		N	N	N	Gate 2		Risk Response Strategy: Weekly Meeting of Team		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011157		N	N	N	Gate 1		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011156		N	N	N	Gate 1		Risk Response Strategy: Risk Status Notes: Risk		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011155		N	N	N	Gate 3		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011154		N	N	N	Gate 2		Risk Response Strategy: Increase staffing to appro		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011153		N	N	N	Gate 1		Risk Response Strategy: BAU Risk Status Notes		SIDDIQM	2014/03/13	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011152		N	N	N	Gate 1		Risk Response Strategy: Risk Status Notes: Dupl		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011151		N	N	N	Gate 1		Risk Response Strategy: RFR Action 159 - Create F		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011150		N	N	N	Definition ar		Risk Response Strategy: Information is Commercia		WONGST	2016/04/21	53	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011149		N	N	N	Gate 1		Risk Response Strategy: BAU Risk Status Notes:		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011148		N	N	N	Gate 2		Risk Response Strategy: Risk Status Notes: Forc		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011147		N	N	N	Gate 4		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011146		N	N	N	Gate 1		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011145		N	N	N	Gate 3		Risk Response Strategy: Risk Status Notes: No ir		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011144		N	N	N	Gate 1		Risk Response Strategy: Cross Functional Sourcin		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011143		N	N	N	Gate 1		Risk Response Strategy: Oversight Focus Provide		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011142		N	N	N	Gate 2		Risk Response Strategy: Provide proper resource		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011141		N	N	N	Gate 1		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011140		N	N	N	Gate 4		Risk Response Strategy: Provide Oversight (work		SIDDIQM	2014/03/13	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011139		N	N	N	Gate 1		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011138		N	N	N	Gate 1		Risk Response Strategy: For Tooling Obtain agre		WONGST	2014/06/12	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement	2268,2273,22								
00011137		N	N	N	Gate 1		Risk Response Strategy: Rollout of Contract to Fu		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011136		N	N	N	Gate 1		Risk Response Strategy: Provide oversigne followi		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011135		N	N	N	Gate 1		Risk Response Strategy: Strategy on Spec update		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011134		N	N	N	Gate 1		Risk Response Strategy: Clause in Contract determ		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011133		N	N	N	Gate 1		Risk Response Strategy: BAU Risk Status Notes:		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011132		N	N	N	Gate 3		Risk Response Strategy: Oversight Focus structur		WONGST	2014/06/17	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement	2300,2301								
00011131		N	N	N	Gate 1		Risk Response Strategy: Response and Mitigating		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011130		N	N	N	Gate 1		Risk Response Strategy: Response and Mitigating		SIDDIQM	2014/03/13	19	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011129		N	N	N	Gate 1		Risk Response Strategy: Response and Mitigating		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011128		N	N	N	Gate 1		Risk Response Strategy: Response and Mitigating		SIDDIQM	2014/03/13	19	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011127		N	N	N	Gate 1		Risk Response Strategy: Response and Mitigating		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011126		N	N	N	Gate 1		Risk Response Strategy: Response and Mitigating		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011125		N	N	N	Gate 1		Risk Response Strategy: Response and Mitigating		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011124		N	N	N	Gate 3		Risk Response Strategy: Change contract strategy		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011122		N	N	N	Gate 3		Risk Response Strategy: Ref program risk 474 R		NGOKHA	2014/09/19	26	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011121		N	N	N	Gate 3		Risk Response Strategy: Monitor Program Risk R		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011120		N	N	N	Gate 3		Risk Response Strategy: Monitor Program Risk R		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011119		N	N	N	Gate 3		Risk Response Strategy: Monitor Program Risk R		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011118		N	N	N	Gate 3		Risk Response Strategy: Monitor Program Risk R		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011117		N	N	N	Gate 4		Risk Response Strategy: BAU for JV Risk Status N		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011116		N	N	N	Gate 4		Risk Response Strategy: P6 RFR TFG 1000 P6 RFI		WONGST	2014/07/23	25	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement	2624								
00011115		N	N	N	Gate 4		Risk Response Strategy: Transferred to Program R		SIDDIQM	2014/03/13	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011114		N	N	N	Gate 3		Risk Response Strategy: Risk Status Notes: Forc		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011113		N	N	N	Gate 3		Risk Response Strategy: Risk Status Notes: Dupl		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011112		N	N	N	Gate 3		Risk Response Strategy: Risk Status Notes: Risk		SIDDIQM	2014/03/13	17	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011111		N	N	N	Execution		Strategy prior to 2016 was transfer this to JV TMO		COURTNMI	2016/04/15	55	STOZEKGJ	2013/10/31	RFR	TL	RFR	Retube and Feeder Replacement	2291,2292,22								
00011110		N	N	N	Gate 4		Risk Response Strategy: The risk response strateg		WONGST	2015/02/10	32	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011109		N	N	N	Gate 3		Risk Response Strategy: Oversight Focus Ensure D		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011108		N	N	N	Gate 4		Risk Response Strategy: JV Risk Risk Status Note		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011106		N	N	N	Gate 4		Risk Response Strategy: NWMD, in agreement wit		SHUKLAK	2016/04/05	72	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement				198				255	
00011093		N	N	N			Risk Response Strategy: Define financing mechani		SIDDIQM	2014/03/13	14	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011092		N	N	N	Gate 1		Risk Response Strategy: RFR Action ID 30 - done		WONGST	2014/06/17	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011091		N	N	N	Gate 3		Risk Response Strategy: Input Action into AIDA:		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011090		N	N	N	Gate 3		Risk Response Strategy: NK38SOW3110010016 sec		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011089		N	N	N			Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	14	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011088		N	N	N			Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	14	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011087		N	N	N	Gate 1		Risk Response Strategy: Risk Status Notes: Close		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011086		N	N	N	Gate 1		Risk Response Strategy: Use cost benefit analysis		WONGST	2014/06/10	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011085		N	N	N	Gate 4		Risk Response Strategy: Vender oversight by OPG		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011084		N	N	N	Gate 1		Risk Response Strategy: Transferred to Program		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011083		N	N	N	Gate 4		Risk Response Strategy: Excusable / reimbursable		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011082		N	N	N	Gate 1		Risk Response Strategy: Risk Status Notes: Spac		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011081		N	N	N	Gate 1		Risk Response Strategy: Oversight Focus monitor		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011080		N	N	N	Gate 2		Risk Response Strategy: Contractor to complete m		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011078		N	N	N	Gate 3		Risk Response Strategy: Ref. 2.6 Transferred to P		SIDDIQM	2014/03/13	23	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011077		N	N	N	Gate 4		Risk Response Strategy: Not known at this time. W		WONGST	2014/07/23	23	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011076		N	N	N	Gate 3		Risk Response Strategy: Develop integrated resou		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011075		N	N	N	Gate 2		Risk Response Strategy: Keep max. attention for s		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011074		N	N	N	Gate 3		Risk Response Strategy: RFR Action ID 124 NWM		NGOKHA	2014/09/26	31	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011073		N	N	N	Gate 3		Risk Response Strategy: Use gated process to vet		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011072		N	N	N	Gate 3		Risk Response Strategy: P6 RQE (DEFA6169) R		SOLIMAT	2014/04/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011071		N	N	N	Gate 4		Risk Response Strategy: Loading assessment on th		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011070		N	N	N	Gate 4		Risk Response Strategy: Develop terms of referen		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011068		N	N	N	Gate 2		Risk Response Strategy: All engineering must be fi		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011065		N	N	N	Gate 3		Risk Response Strategy: Mockup demonstration T		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011064		N	N	N	Gate 2		Risk Response Strategy: Contract is based on targ		SIDDIQM	2014/03/13	15	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011063		N	N	N	Gate 4		Risk Response Strategy: If caused by contractors		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011062		N	N	N	Gate 5		Risk Response Strategy: Business As usual Early to		WONGST	2014/06/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011061		N	N	N	Gate 4		Risk Response Strategy: OPG will maintain a great		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011060		N	N	N	Gate 4		Risk Response Strategy: Article 2.16(e) and cost all		WONGST	2014/06/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011059		N	N	N	Gate 1		Risk Response Strategy: Unit endoflife study Nov		SIDDIQM	2014/03/13	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011058		N	N	N	Gate 2		Risk Response Strategy: Risk Status Notes: Has c		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011057		N	N	N	Gate 4		Risk Response Strategy: Ref. RFR Project Agreeme		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011056		N	N	N	Gate 4		Risk Response Strategy: Contractor to mitigate as		WONGST	2014/06/17	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011055		N	N	N	Gate 4		Risk Response Strategy: Contractor to mitigate as		WONGST	2014/06/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011054		N	N	N	Gate 4		Risk Response Strategy: (AIDA# 11054) Monitor		SIDDIQM	2014/03/13	19	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011053		N	N	N	Gate 4		Risk Response Strategy: Article 15 'Dispute resolut		WONGST	2014/06/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011052		N	N	N	Gate 3		Risk Response Strategy: Tasks to be scheduled i		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011051		N	N	N	Gate 3		Risk Response Strategy: Risk Status Notes: Form		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011049		N	N	N	Gate 3		Risk Response Strategy: Include cost and scheduli		WONGST	2014/07/23	34	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement	2622								
00011048		N	N	N	Gate 4		Risk Response Strategy: QA Plan from Contractor		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011047		N	N	N	Gate 4		Risk Response Strategy: Oversight Focus BOM D		SIDDIQM	2014/03/13	23	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011046		N	N	N	Gate 2		Risk Response Strategy: NSS has conducted an as		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011045		N	N	N	Gate 2		Risk Response Strategy: B&W has conducted an a		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011044		N	N	N	Gate 4		Risk Response Strategy: Develop capability to adj		WONGST	2014/07/23	28	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement	2621								
00011043		N	N	N	Gate 2		Risk Response Strategy: The header, by code requ		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011042		N	N	N	Gate 2		Risk Response Strategy: It is recommended to per		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011041		N	N	N	Gate 2		Risk Response Strategy: Adherence to ECC proce		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011040		N	N	N	Gate 2		Risk Response Strategy: Schedule work accordin		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011039		N	N	N	Gate 4		Risk Response Strategy: Perform vacuum test or l		SIDDIQM	2014/03/13	19	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011038		N	N	N	Gate 4		Risk Response Strategy: Mockup rehearsal Testing		WONGST	2014/06/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011037		N	N	N	Gate 2		Risk Response Strategy: Ensure contingency plan		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011036		N	N	N	Gate 4		Risk Response Strategy: Perform telemetry and an		WONGST	2014/06/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011035		N	N	N	Gate 2		Risk Response Strategy: Have contingency repair		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011034		N	N	N	Gate 2		Risk Response Strategy: Ensure verification and te		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011033		N	N	N	Gate 4		Risk Response Strategy: Plan for compliance rewo		WONGST	2014/06/17	20	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011032		N	N	N	Gate 4		Risk Response Strategy: Concealed Condition is de		WONGST	2014/11/27	38	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement	2620								
00011031		N	N	N	Gate 4		Risk Response Strategy: Release verification. CTI (		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011030		N	N	N	Gate 4		Risk Response Strategy: Develop contingency me		PULAGAMS	2014/09/04	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011029		N	N	N	Gate 4		Risk Response Strategy: Perform staged draindry		PULAGAMS	2014/09/04	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011028		N	N	N	Gate 3		Risk Response Strategy: Identify and remove sour		PULAGAMS	2014/09/04	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011027		N	N	N	Gate 2		Risk Response Strategy: Bulkhead analysis is reco		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011026		N	N	N	Gate 3		Risk Response Strategy: Drain & Dry Develop ALA		PULAGAMS	2014/09/04	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011025		N	N	N	Gate 2		Risk Response Strategy: Early development of an		SIDDIQM	2014/03/13	18	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011024		N	N	N	Gate 4		Risk Response Strategy: Adopt shielding and trans		PULAGAMS	2014/09/04	23	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011023		N	N	N	Gate 1		Risk Response Strategy: Prepare a list of long lead		SIDDIQM	2014/03/13	22	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011021		N	N	N	Gate 2		Risk Response Strategy: Prepare conceptual sched		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011020		N	N	N	Gate 3		Risk Response Strategy: Risk Status Notes: Risk		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011019		N	N	N	Gate 4		Risk Response Strategy: Hire additional resources		PULAGAMS	2014/09/04	24	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011018		N	N	N	Gate 4		Risk Response Strategy: OPG plans to do majority		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011016		N	N	N	Gate 3		Risk Response Strategy: Header acceptance: NK38		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011015		N	N	N	Gate 2		Risk Response Strategy: Order materials Develop		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011014		N	N	N	Gate 3		Risk Response Strategy: Included in SOW3.5.1 an		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011013		N	N	N	Gate 3		Risk Response Strategy: Investigation of alternate		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011012		N	N	N	Gate 3		Risk Response Strategy: Article 3.10 indicates if mi		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011011		N	N	N	Gate 1		Risk Response Strategy: RFR Action ID 160 Refer 1		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011010		N	N	N	Gate 4		Risk Response Strategy: Include Vessel inspection		SIDDIQM	2014/03/13	21	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011009		N	N	N	Gate 3		Risk Response Strategy: Contractor quality oversi		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011008		N	N	N	Gate 4		Risk Response Strategy: Schedule (target) will incl		SIDDIQM	2014/03/13	16	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011005		N	N	N	Gate 3		Risk Response Strategy: Comprehensive mockup		SHUKLAK	2016/03/03	49	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011004		N	N	N	Gate 3		Risk Response Strategy: Due diligence of vendors		SIDDIQM	2014/03/13	17	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011003		N	N	N	Gate 4		Risk Response Strategy: Logistical plan to be laid o		PULAGAMS	2014/09/04	25	STOZEKGJ	2013/10/31	RFR		RFR	Retube and Feeder Replacement									
00011002		N	N	N	Gate 4		Risk Response Strategy: OPG Contract Mgmt guid		SIDDIQM	2014/03/13	17	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011001		N	N	N	Gate 1		Risk Response Strategy: Contractor will execute w		SIDDIQM	2014/03/13	17	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									
00011000		N	N	N	Gate 2		Risk Response Strategy: Strategy on Spec updates		SIDDIQM	2014/03/13	19	STOZEKGJ	2013/10/31			RFR	Retube and Feeder Replacement									