Calandria Vault Inspections 13 - 46537

Superseding Business Case N - BCS - 30673 - 10001 – R00

1/ RECOMMENDATION:

We recommend an additional release of **2,524k$** (including 1,091k$ contingency) to complete the deliverables for the Calandria Vault Inspection Project, bringing the total release of funds to 26,397k$.

The business objective of this Project is to develop the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components.

Repair capability is outside the scope of this Project.

The execution of an inspection campaign is outside the scope of this Project and is being addressed by Project 46606 – Calandria Vault Inspection Execution.

Project 46552 was initiated (developmental release) in 2005 with the major deliverables being two vendor proposals for the design and fabrication of a calandria vault (CV) manipulator arm for use as a platform for inspection and repair of CV components.

Subsequently, a full release of 23,873k$ was approved in August 2006 as Project 46537, with an expected completion date of February, 2008. In order to meet the business objective to develop the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components, the following set of major deliverables were included:

- 2 CV manipulator arms, with the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components
- Ultrasonic and video inspection end effectors for the CV manipulator arms
- Mockups for tool testing and training
- Horizontal and vertical video on extension booms to provide overview visuals of the CV internals and for field of view cameras during the CV manipulator arm operations
- Non-arm tooling including: Robotic vehicle and associated video/ultrasonic end effectors, Ion Chamber Cooling Line inspection equipment
- Site preparations for unit inspections (station assessments and modifications were not included)
- Field testing of all inspection equipment in Unit 2 (schedule permitting)
- Training and procedures
- Project management and engineering

This release did not include funding for repair capability or repair end effectors.

This superseding request is driven by a major schedule variance caused by technical design issues that the robotic arm vendor has encountered. Additional funding is required to address this cost and scope variance noted below. The status of the major deliverables on the Project, as of March 31, 2009, is also included:

Deliverables from 2006 Full Release	Redefinition of Deliverables during Project Execution and Rationale	Status (March 31, 2009)
2 CV manipulator arms, with the capability to deliver a platform for inspection and repair end effectors to all (100%) of the specified calandria vault components	○ 2 CV manipulator arms, with the capability to deliver a platform for inspection and repair end effectors to most (89%) of the specified calandria vault components. ○ A concession to the manipulator arm CV accessibility was accepted from the robotic arm vendor due to several factors.	Takeover of 2 CV manipulator arms scheduled for January 2010 (1st arm) and March 2010 (2nd arm)
Ultrasonic and video inspection end effectors for the CV manipulator arms	○ None.	In progress; 75% complete
Mockups for tool testing and training	○ Full scale CV mockup was created to test and commission full CV accessibility of manipulator arms. ○ Now used to test and commission all equipment before deployment due to cancellation of Unit 2 field test.	Complete
Horizontal & vertical video on extension booms to provide overview visuals of the CV internals and for field of view cameras during the CV manipulator arm operations	○ Common platform created for both horizontal and vertical video cameras and booms, not originally considered in 2006 Full Release	In progress; 75% complete

Deliverables from 2006 Full Release	Redefinition of Deliverables during Project Execution and Rationale	Status (March 31, 2009)
Non-arm tooling including: Robotic vehicle and associated video/ultrasonic end effectors, Ion Chamber Cooling Line inspection equipment	○ Robotic vehicle ultrasonic inspection end effectors cancelled due to redefined accessibility of personnel to associated components.	In progress; 90% complete
Site preparations for unit inspection (station assessments and modifications were not included)	○ None.	Complete
Field testing of all inspection equipment in Unit 2 (schedule permitting)	○ The schedule did not permit the use of Unit 2 for field testing. Instead, the CV full scale mockup has and will be used to test and commission all equipment before deployment in a working unit.	Not applicable
Training and procedures	○ Staff training and procedure preparation necessary to close this project will be prepared. Detailed staff training, procedures, and site preparation, required for first inspection use are covered under Project 46606 – Calandria Vault Inspection Execution.	In progress; 25% Complete
Project management and engineering	○ None.	In progress; 65% complete

Project life to date (LTD) spending, as of March 31, 2009, was 16,698k$. Project committed costs, as of March 31, 2009, were 5,378k$. The Project LTD plus committed costs, as of March 31, 2009, were 22,076k$.

The revised estimate to completion includes a 13% contingency allowance on the remaining work, re-estimated by the Project team in May, 2009. Significant Project risks have been retired since the full release in August 2006, however, there are project risks, despite mitigation, that will remain high for the duration of this Project. The remaining risks to the Project are detailed in section 6.

The completion of this Project will provide a capability to deliver a platform for inspection and repair end effectors to most (89%) of the specified calandria vault components. A significant portion of the inspection/repair platform developed under Project 46537 will be exercised under Project 46606 – Calandria Vault Inspection Execution, confirming its suitability for future inspection and/or repair campaigns.

$000's (Incl contingency)	Type	LTD 2008	2009	2010	2011	2012	2013	Later	Total
Currently Released	Full	14,576	7,324	1,973					23,873
Requested Now	Superseding		544	1,868	112				2,524
Future Funding Req'd	None								-
Total Project Costs		14,576	7,868	3,841	112	-	-	-	26,397
Non Project Costs									-
Grand Total		14,576	7,868	3,841	112	-	-	-	26,397
Investment Type: Sustaining		Class: Capital		NPV: +6,178 $k		IRR: 25%		Discounted Payback: 5.7	

Submitted By:

M. Elliott
SVP, Pickering A

July 19/09
Date:

Finance Approval:

D. Hanbidge
SVP and CFO

Aug 4 5/09
Date:

Line Approval (Per OAR Element 1.1 Project in Budget):

T. Mitchell
President and CEO

10 Aug 2009
Date:

2/ BACKGROUND & ISSUES

The Pickering A calandria vaults were originally designed to be vented to atmosphere through the station stack, but early in the life of the reactors these vents were sealed off to reduce station noble gas emissions. As a result, humidity levels within the stagnant vaults became high, which was worsened by chronic leakage from the biological shield cooling system within the vaults. The biological shield cooling system, which includes the carbon steel ring thermal shield (RTS), is unique to Pickering A and these systems must be in service during reactor operation to protect and maintain the integrity of concrete structures. Later designs for Pickering B, Bruce A&B, and Darlington utilize water filled Calandria Vault environment.

The combination of high humidity, air and radiation created a nitric acid environment, resulting in substantial corrosion of carbon steel components within the calandria vault of each unit. Corrosion-induced leaks in the mid-1990s required that the carbon steel RTS inlet and outlet lines be removed and replaced with stainless steel flexible hoses using remotely operated robotic equipment. The CV is an inaccessible room with high radiation fields that houses the reactor vessel and dump tank in the Pickering A units - remote tooling is the only option for inspection and repair work in this area.

Sporadic leaks from the biological shield cooling system have occurred up to the present time, with the most recent leak occurring in Unit 1 in April 2008. The leakage is being controlled presently by the application of on-line sealant, which is being added proactively on an annual basis with the hope of minimizing minor leakage into the calandria vault.

The installation of air dryers was undertaken in the early-1990s to reduce corrosion in the Pickering A calandria vaults. However, these dryers were only partially successful in maintaining the dew point below a specified value because of reliability issues stemming from the corrosive nitric acid condensate. To minimize further corrosion in the Unit 1 and 4 calandria vaults, Project 49252 is near completion to improve the reliability of the Calandria vault drying system by replacing the drying units. The new dryers were installed in Unit 4 in Spring 2009 and are expected to be installed in Unit 1 in Q3 2009.

For Pickering A units 1 and 4, OPG's Reactor Assembly Aging Management Plan has identified many components within the calandria vault to be inspected. To complete these inspections, and to implement repairs should the need be identified, remote tooling must be developed to deliver inspection and repair end-effectors to the internal areas of the calandria vaults.

Previously, approximately 660k$ was spent on Project Scoping using funding from the Pickering A Return to Service budget.

Subsequently, Project 46552 was initiated (developmental release) in 2005 with the major deliverables being two vendor proposals for the design and fabrication of a calandria vault (CV) manipulator arm for use as a platform for inspection and repair of CV components.

Following Project 46552, a full release of 23,873k$ was approved in August 2006 as Project 46537, with an expected completion date of February, 2008. In order to meet the business objective to develop the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components, the following set of major deliverables were included:

- 2 CV manipulator arms, with the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components
- Ultrasonic and video inspection end effectors for the CV manipulator arms
- Mockups for tool testing and training
- Horizontal and vertical video on extension booms to provide overview visuals of the CV internals and for field of view cameras during the CV manipulator arm operations
- Non-arm tooling including: Robotic vehicle and associated video/ultrasonic end effectors, Ion Chamber Cooling Line inspection equipment
- Site preparations for unit inspections (station assessments and modifications were not included)
- Field testing of all inspection equipment in Unit 2 (schedule permitting)
- Training and procedures
- Project management and engineering

The targeted scope of work included the following components:

- Quantitative arm-based inspection of a subset of the 32 RTS waterbox support brackets in each unit, including the suspect 16 west RTS bracket in Unit 1, previously found to have an indication of a potential defect in the weld
- Quantitative arm-based inspection of a subset of cooling lines, including several hairpins and the two reactivity mechanism lines
- Quantitative inspection of all Ion Chamber Cooling Lines
- Qualitative (visual) inspection of a subset of hatch interspace lines
- Qualitative (visual) arm and non-arm based inspection of many calandria vault components

- Qualitative (visual) non-arm based inspection of the dump tank flexible supports

The capability to deliver a platform for inspection and repair end effectors to most (89%) or all of the specified calandria vault components is being addressed by this capital Project 46537.

Previous qualitative (visual) inspection of the CV cooling lines during P711 and confirmed during P941 showed significant corrosion and as a result, a no-touch inspection policy was decreed for any cooling lines in the absence of repair capability. Repair capability is currently beyond the scope of Project 46537.

Cost considerations, reduced accessibility, and the no-touch policy have necessitated a reduction in a proposed inspection scope of Unit 1 during P1011 to the following:

- Quantitative arm-based inspection of accessible RTS brackets through one of four CV penetrations, including the 16 west RTS bracket in Unit 1, previously found to have an indication of a potential defect in the weld
- Quantitative inspection of Ion Chamber Cooling Lines
- Qualitative (visual) arm and non-arm based inspection of biological shield cooling lines (hairpins, reactivity mechanism plug line, hatch interspace lines) and other calandria vault components

The present strategy is to inspect Unit 1 only. The scope of subsequent inspections would be dependent on inspection results from the Unit 1 inspections identified above.

The need to inspect the calandria vault components is driven by:

- OPG's desire to re-assure itself that the Calandria Vault components are not in danger of imminent failure, potentially resulting in serious process or structural failures in the Pickering A units.
- OPG's commitment to manage its nuclear fleet in a manner which enhances the confidence of employees, the public and regulatory authorities in the safety of its nuclear reactors.
- OPG's desire to make commercially sound decisions about future investments in Pickering A, by assuring itself of the condition and life expectancy of all of the major components in the units, prior to making significant on-going investments in other components

There are two compelling reasons for completing Project 46537 in time to allow inspections in the P1011 outage:

- Firstly, there is a pressing need to understand the condition of Pickering A calandria vaults, specifically the condition of the RTS waterbox support brackets. The RTS waterbox support brackets are considered to be irreparable. An inspection in the P1011 outage provides an opportunity to inspect a RTS bracket previously found in 1994 to have an indication of a potential defect in the weld, that may have the potential of growth in the calandria vault environment. Although the probability of failure is judged to be low, the significant consequence of RTS bracket failure is premature shutdown of a unit and possible process system upset due to the 3365 pound waterbox damaging other components in the vault. The significant consequence of RTS bracket failure is reflected in the Pickering A Site Management Board decision to ultrasonically inspect a limited number of RTS brackets from one penetration opening in the CV.
- Secondly, there is a lack of recent calandria vault condition information. If recent inspection data is gathered, further decisions can be made about the condition of the CV components thus resulting in possible mitigation of unexpected failures and/or non-sealable leaks of CV components.

This superseding request is driven by a major schedule variance caused by technical design issues that the robotic arm vendor has encountered. Additional funding is required to address this cost and scope variance.

3/ ALTERNATIVES AND ECONOMIC ANALYSIS

Engineering has estimated that the probability of a non sealable coolant line leak remains above 20% for the remainder of Pickering A units 1 and 4 operating lifetime. In all of the alternatives below a non sealable coolant line leak is assumed to occur in 2014 (approximately mid way between now and end of life (EOL)). The resultant forced outage would have a duration composed of two distinct parts; preparation for inspection and repair, and the actual repair itself. The actual repair time is assumed consistent across all alternatives and is not included in this economic analysis. The time and cost for preparation is unique for each of the alternatives.

An assumed failure probability of 0.5% was confirmed by engineering for the risk of a RTS bracket failure between now and the EOL. It is assumed that a RTS bracket failure is irreparable and would require a permanent unit shutdown ahead of its EOL (The EOL for Pickering A units 1 and 4 is Q1 2020 for investment evaluation purposes).

Development of the capability to deliver a platform inspection and repair end effectors to most (89%) or all of the specified calandria vault components can reduce the forced outage duration. The reduction of forced outage revenue loss is compared against the project cost to acquire the inspection capability and possible repair tooling delivery, and comprises this economic assessment.

$000's	Base Case	Alt 1 Recommended		Alt 2 Do More	Alt 3 Do More
	No Arm Non-Arm Tools Completed	Full Cost Get Arm and Stop Non-Arm Tools Completed	Incr Cost Get Arm and Stop Non-Arm Tools Completed	Full vault coverage Non-Arm Tools Completed	Full vault coverage + Repair Non-Arm Tools Completed
Forced Outage Extension resulting from non sealable cooling line leak	(89,024)	(75,819)	(75,819)	(74,187)	(29,675)
Early EOL from RTS Bracket Failure	(15,943)	(15,943)	(15,943)	(15,943)	(15,943)
Total Revenue	(104,968)	(91,763)	(91,763)	(90,130)	(45,618)
Total OM&A	(1,270)	(1,270)	(1,270)	(1,270)	(1,270)
Capital Expenditures	(17,900)	(29,156)	(15,594)	(21,379)	(36,979)
Present Value (PV)	(67,012)	(72,419)	(60,834)	(64,694)	(53,997)
Net Present Value (NPV)	N/A	(5,407)	6,178	2,319	13,015
IRR%	N/A	N/A	25%	10%	17%
Discounted Payback (Yrs)	N/A	N/A	5.7	5.9	5.5

The sensitivity to the assumed probability of failure, and its assumed timing (2014) has been assessed for the Recommended Alternative.

Base Case: Not Recommended - Abandon Project, abandon arm contract, non-arm tools completed, no repair capability developed

The Do Nothing option (i.e. abandon arm contract, non-arm tools completed, no inspection and or repair capability developed) makes no attempt to finish developing the capability to deliver a platform for inspection and repair end effectors to most (89%) or all of the specified calandria vault components. There would be no "insurance policy" for inspecting or repairing a non-sealable leak should one occur. There would be no capability to perform an arm-based inspection of the specified calandria vault components in a future outage, such as the next planned Unit 1 outage in P1011. The impact of a non-sealable leak is a forced outage of 24 months to develop the capability to deliver a platform for inspection and repair end

effectors and create repair tooling for a repairable failure or a permanent shutdown of the unit for an irreparable failure. The duration for repairs during a forced outage is not considered to be part of the 24 months.

The current plan in P1011 is to perform an arm-based inspection to attempt to assess the possibility of an irreparable RTS waterbox bracket failure in the calandria vault, which would require immediate shutdown of the unit with essentially no warning. If a failure of the bracket occurred, the waterbox may move, and may fall, which may damage other components in the vault such that the unit would be shut down permanently in advance of its normal EOL. The impact is a permanent shutdown of the unit for an irreparable failure.

The Do Nothing option subjects OPG to ongoing uncertainty in assessing the probability of calandria vault component failures between now and the EOL for Pickering A units 1 and 4.

The Do Nothing option subjects OPG to ongoing risk of not having the capability to deliver a platform for end effectors to inspect and repair certain components between now and the EOL for Pickering A units 1 and 4.

There is regulatory risk associated with the Do Nothing option as the CNSC has expressed an interest in the state of the Pickering A calandria vaults. While the overall risk to the public is judged to be acceptably low, certain failures could result in a serious process failure and the probability of serious process failures must be kept acceptably low as part of our licensing requirements. For example, failure of certain RTS brackets could lead to an RTS segment falling on moderator system piping inside the calandria vault resulting in a loss of moderator inventory accident.

There is reputational risk associated with the Do Nothing option. Should a CV component fail requiring a protracted outage to repair there could be negative public perceptions of OPG's ability to manage the nuclear fleet.

The Base Case Present Value (-67,012 k$), is composed of an assumed risk adjusted revenue loss from a non-sealable cooling line leak, assumed risk adjusted revenue loss from an RTS bracket failure, and assumed risk adjusted capital expenditure required to find and repair a non-sealable cooling line leak.

Alt. 1: Recommended - Completion of Project, 89% vault component accessibility, non-arm tools completed, no inspection execution training, no station preparations, no repair capability developed

This alternative includes the completion of this Project and will provide the capability to deliver a platform for inspection and repair end effectors to most (89%) of the specified calandria vault components. Due to very tight design margins, the calandria vault component accessibility scope will be limited to 89% of the specified components in the vault. The non-arm tools will be completed. Staff training and procedure preparation necessary to close this project will be prepared. Detailed staff training, procedures, and site preparation, required for first inspection use are covered under Project 46606 – Calandria Vault Inspection Execution.

The completed equipment capability with this alternative will provide OPG with an "insurance policy" for inspecting, but not repairing, a non-sealable leak should one occur. There will be the capability to perform an arm-based inspection of the specified calandria vault components in a future outage, such as the next planned Unit 1 outage in P1011. The impact of a non-sealable leak is a forced outage of 20 to 24 months, depending on accessibility, to create repair tooling for a repairable failure or a permanent shutdown of the unit for an irreparable failure. The duration for repairs during a forced outage is not considered to be part of the 20 to 24 months.

The current plan in P1011 is to perform an arm-based inspection to attempt to assess the possibility of an irreparable RTS waterbox bracket failure in the calandria vault, which would require immediate shutdown of the unit with essentially no warning. If a failure of the bracket occurred, the waterbox may move, and may fall, which may damage other components in the vault such that the unit would be shut down permanently in advance of its normal EOL. The impact is a permanent shutdown of the unit for an irreparable failure.

This alternative addresses the Do Nothing regulatory and reputation risks discussed in the base case. A reduction in forced outage duration is assumed once the development of the capability to deliver a platform for inspection and repair end effectors to most (89%) of the specified calandria vault components is completed.

To ascertain the failure probability at which a non sealable coolant leak in this alternative would break even, the failure probability within the financial model was reduced until the Net Present Value (NPV) of the alternative approached zero.

Failure probabilities in excess of approximately 6% ensured the NPV remained positive. The sensitivity to the assumed 2014 failure was also assessed. No matter when the assumed failure occurs during the period 2010 to EOL the resulting NPV from the financial model remains positive. However, near the EOL of the units, should there be a major failure, OPG would be unlikely to invest in major tooling to fix the failure unless there was a strong financial case to be made. An economic assessment would be made at that time.

Alt. 2: Not Recommended - Completion of Project, 100% vault component accessibility, non-arm tools completed, no inspection execution training, no station preparations, no repair capability developed

This alternative is similar to alternative 1 except that the vault component accessibility is increased from 89% to 100%.

This alternative includes the completion of this Project and will provide the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components. The non-arm tools will be completed. Staff training and procedure preparation necessary to close this project will be prepared. Detailed staff training, procedures, and site preparation, required for first inspection use are covered under Project 46606 – Calandria Vault Inspection Execution.

The completed equipment capability with this alternative will provide OPG with an "enhanced insurance policy" for inspecting, but not repairing, a non-sealable leak should one occur. There will be the capability to perform an arm-based inspection of the specified calandria vault components in a future outage, such as the next planned Unit 4 outage in P1141. Selecting this alternative may put the current plan for a P1011 inspection at risk since the arm may be required by the vendor to retrofit the enhanced accessibility capability. The impact of a non-sealable leak is a forced outage of 20 months to create repair tooling for a repairable failure or a permanent shutdown of the unit for an irreparable failure. The duration for repairs during a forced outage is not considered to be part of the 20 months.

The current plan in P1011 is to perform an arm-based inspection to attempt to assess the possibility of an irreparable RTS waterbox bracket failure in the calandria vault, which would require immediate shutdown of the unit with essentially no warning. If a failure of the bracket occurred, the waterbox may move, and may fall, which may damage other components in the vault such that the unit would be shut down permanently in advance of its normal EOL. The impact is a permanent shutdown of the unit for an irreparable failure.

This alternative addresses the Do Nothing regulatory and reputation risks discussed in the base case. A reduction in forced outage duration is assumed once the development of the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components is completed.

The estimated additional capital cost of 6.5 $M to achieve 100 % accessibility should be considered as conceptual quality (+60% to -25%).

Alt. 3: Not Recommended - Completion of Project, 100% vault component accessibility, non-arm tools completed, no inspection execution training, no station preparations, new Project started to develop full repair capability for a non-sealable leak of cooling lines

This alternative is similar to alternative 2 except that a new capital Project is started to develop full repair capability for a non-sealable leak of cooling lines.

This alternative includes the completion of this Project and will provide the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components. The non-arm tools will be completed. Staff training and procedure preparation necessary to close this project will be prepared. Detailed staff training, procedures, and site preparation, required for first inspection use are covered under Project 46606 – Calandria Vault Inspection Execution. A new Project will be started to develop full repair capability for a non-sealable leak of cooling lines.

The completed equipment capability with this alternative will provide OPG with a "very enhanced insurance policy" for inspecting and repairing a non-sealable leak should one occur. There will be the capability to perform an arm-based inspection of the specified calandria vault components in a future outage, such as the next planned Unit 4 outage in P1141. There will be the capability to perform an arm-based repair of a non-sealable cooling line leak in approximately 2012. Selecting this alternative may put the current plan for a P1011 inspection at risk since the arm may be required by the vendor to retrofit the enhanced accessibility capability. The impact of a non-sealable leak is a forced outage of approximately 8 months to prepare for deployment of the repair tooling for a repairable failure or a permanent shutdown of the unit for an irreparable failure. The duration for repairs during a forced outage is not considered to be part of the 8 months.

The current plan in P1011 is to perform an arm-based inspection to attempt to assess the possibility of an irreparable RTS waterbox bracket failure in the calandria vault, which would require immediate shutdown of the unit with essentially no warning. If a failure of the bracket occurred, the waterbox may move, and may fall, which may damage other components in the vault such that the unit would be shut down permanently in advance of its normal EOL. The impact is a permanent shutdown of the unit for an irreparable failure.

This alternative addresses the Do Nothing regulatory and reputation risks discussed in the base case. A significant reduction in forced outage duration is assumed once the development of the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components and with the capability to repair a non-sealable leak from cooling lines is completed.

The estimated additional capital costs of 6.5 $M to achieve 100 % accessibility and 19.5 $M to achieve repair capability should be considered as conceptual quality (+60% to -25%).

This alternative is not being recommended because of the significant schedule risk performing this alternative would add to the preparations for the P1011 inspection. Also, it is desired that prior to committing additional funding to perform this alternative, inspection data be gathered as early as possible to enable the preparation of an assessment on vault equipment conditions.

The incremental NPV for this alternative, in comparison to the recommended, is eroded, but remains positive, if the costs to achieve 100% accessibility and repair capability are at the high end of the conceptual quality estimate. If this were to occur, the recommended alternative provides better economic benefit.

Alt 4:

Alt. 5:

4/ THE PROPOSAL

We recommend an additional release of **2,524k$** (including 1,091k$ contingency) to complete the deliverables for the Calandria Vault Inspection Project, bringing the total release of funds to 26,397k$.

This proposal involves the completion of this Project and will provide the capability to deliver a platform for inspection and repair end effectors to most (89%) of the specified calandria vault components. Due to very tight design margins, the calandria vault component accessibility scope will be limited to 89% of the specified components in the vault. The non-arm tools will be completed. There will be minimal training and procedures. The majority of training and procedures will be covered by a separate Project 46606 – Calandria Vault Inspection Execution. No further station preparations will be performed. Any further station preparations will be covered by a separate Project 46606 – Calandria Vault Inspection Execution.

Repair capability is outside the scope of Project.

The execution of an inspection is outside the scope of this Project and is being addressed by Project 46606 – Calandria Vault Inspection Execution.

The recommended alternative attempts to balance the risk of not being ready to repair an unexpected failure in a Calandria Vault component with the potential of spending too much up-front, only to find that conditions are better (i.e. no need for repairs) or worse (i.e. irreparable flaws) than expected. Repairable failures include most cooling water lines, RTS segment vent lines, helium line anchors, and ion chamber cooling lines. Failure of an RTS bracket resulting in displacement of the RTS waterbox segment is considered irreparable.

The deliverables for this proposal include:

- 2 CV manipulator arms, with the capability to deliver a platform for inspection and repair end effectors to most (89%) of the specified calandria vault components – **In Progress**
- Ultrasonic and video inspection end effectors for the CV manipulator arms – **In Progress**
- Mockups for tool testing and training – **Completed**
- Horizontal and vertical video on extension booms to provide overview visuals of the CV internals and for field of view cameras during the CV manipulator arm operations – **In Progress**
- Non-arm tooling including: Robotic vehicle and associated video end effectors, Ion Chamber Cooling Line inspection equipment – **In Progress**
- Minimal training and procedures – **In Progress**
- Shipping and storage containers for the equipment developed in this Project – **In Progress**
- Project management and engineering – **In Progress**

This proposal does not include funding for repair capability or repair end effectors.

5/ QUALITATIVE FACTORS

Pickering A Life Cycle Planning

Proceeding with the recommended alternative will allow the Project to complete the development of the capability to reach and deliver inspection and repair end effectors to most (89%) of the specified calandria vault components at Pickering A units 1 and 4. The tools could be used to perform inspections, repair activities, and identification of all non-sealable leak locations. The equipment developed can be used to provide a general assessment on vault conditions and provide quantitative inspection data of a subset of the calandria vault components, specifically the RTS waterbox support brackets and carbon steel cooling lines. This information will allow OPG to better understand the risk of premature shutdown of the Pickering A units. It is expected that periodic inspections may be performed in the future for degradation rate determination and funded through OM&A.

Benefits to Public/Regulator Relations

Proceeding with the recommended alternative will allow OPG to address the risk of potential significant failures of calandria vault components. Proactive inspection and failure risk assessment of the critical components would avert the significant negative consequences on OPG's public image that would arise from a permanent shutdown of the unit from an irreparable RTS waterbox bracket failure or a forced outage from a non-sealable leak of a cooling line.

Future inspection and condition assessment of critical CV components would prove beneficial from a regulatory perspective, as the CNSC has recently expressed interest in the condition of the Pickering A calandria vaults.

6/ RISKS (see Attachment E for details)

Low = 1 to 3	Medium = 4 to 9	High = 10 to 25

Probability \ Impact	1	2	3	4	5
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

Risk Description	Mitigating Activities	Probability x Impact – Before Mitigation									Probability x Impact – After Mitigation								
		Finance	Schedule	Quality	Corporate Reputation	Regulatory	Health & Safety	Environment	Nuclear Safety	Risk Rating (1 to 25)	Finance	Schedule	Quality	Corporate Reputation	Regulatory	Health & Safety	Environment	Nuclear Safety	Risk Rating (1 to 25)
Quality: A robotic arm deficiency is discovered after acceptance by OPG	Maximize scope of factory and full scale mockup acceptance tests Timely vendor support available for part replacement and maintenance/training support A significant portion of the inspection/repair platform developed will be exercised under Project 46606 – Calandria Vault Inspection Execution, confirming its suitability for future inspection and/or repair campaigns.	8	16	20					16	**20**	4	12	12					4	**12**
Quality / Cost: Equipment changes required after receipt and prior to in-service declaration, not part of current requirements or warranty claims.	Maximize scope of factory and full scale mockup acceptance tests Test/commission with end effectors to identify potential deficiencies A significant portion of the inspection/repair platform developed will be exercised under Project 46606 – Calandria Vault Inspection Execution, confirming its suitability for future inspection and/or repair campaigns Include funding in this superseding business case summary to make minor changes.	2	4	12	-	-	-	-	-	**12**	2	4	4	-	-	-	-	-	**4**
Schedule / Cost: Significant delays in delivery of the inspection equipment, including the remote manipulator arm, such that estimate to complete Project is too low.	Include contingency in this superseding business case summary to address this risk.	6	10	-	-	-	-	-	-	**10**	6	8	-	-	-	-	-	-	**8**

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Low = 1 to 3	Medium = 4 to 9	High = 10 to 25

Probability \ Impact	1	2	3	4	5
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

Risk Description	Mitigating Activities	Before Mitigation: Probability x Impact									After Mitigation: Probability x Impact								
		Finance	Schedule	Quality	Corporate Reputation	Regulatory	Health & Safety	Environment	Nuclear Safety	Risk Rating (1 to 25)	Finance	Schedule	Quality	Corporate Reputation	Regulatory	Health & Safety	Environment	Nuclear Safety	Risk Rating (1 to 25)
Schedule / Cost: Scope additions not originally considered such as the need to categorize the control software provided with the robotic arm to a more strict standard (CAT III) than is being provided currently (CAT IV)	Prove software is appropriately categorized as CAT IV. There is a contingency amount identified to address the risk of the software being categorized as CAT III.	3	15	6					15	**15**	3	6	6					3	**6**
Schedule / Cost: Vendor work stoppage as a result of labour disruption or financial claim(s).	Once it occurs, negotiate a resolution of labour or financial claim(s) with vendor This risk is not funded by this release	8	20	-	4	-	-	-	-	**20**	12	12	-	4	-	-	-	-	**12**
Technical: Inspection equipment unable to provide desired results because of material surface condition or other factors	Performance test of surface prep, ultrasonic, and visual equipment on prepared surfaces simulating anticipated surface conditions Test/commission with end effectors in simulated full scale mockup environment to identify deficiencies A significant portion of the inspection/repair platform developed will be exercised under Project 46606 – Calandria Vault Inspection Execution, confirming its suitability for future inspection and/or repair campaigns	12	15	15						**15**	3	15	9						**15**
Technical: Inspection equipment fails to meet design requirements and cannot be accepted from the vendor.	Do not accept inspection equipment and default vendor, if no other resolution can be reached.	15	15	15	9	6	-	-	-	**15**	15	15	15	9	6	-	-	-	**15**
Technical: Arm's 89% reach capability means there are a minimum number of targets which cannot be accessed for quantitative (ultrasonic) inspection or repair.	If required, select alternative to fund vendor to provide 100% reach capability The 11% impairment may be recoverable through the use of custom end effectors for the manipulator arm, however, this scope has not been included in this Project.	8	15	4	-	4	-	-	-	**15**	8	15	4	-	4	-	-	-	**15**

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Low = 1 to 3	Medium = 4 to 9	High = 10 to 25

Probability \ Impact	1	2	3	4	5
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

Risk Description	Mitigating Activities	Probability x Impact — Before Mitigation									Probability x Impact — After Mitigation								
		Finance	Schedule	Quality	Corporate Reputation	Regulatory	Health & Safety	Environment	Nuclear Safety	Risk Rating (1 to 25)	Finance	Schedule	Quality	Corporate Reputation	Regulatory	Health & Safety	Environment	Nuclear Safety	Risk Rating (1 to 25)
Technical: Arm end effectors not built by the arm manufacturer may have integration issues	The manufacturers for end effectors were provided with the necessary interface information during their design process. The Project requested that prototype tooling be developed and tested in the mockups prior to finalizing the design. Integration testing is being performed in the full scale mockup prior to deployment in the field. Include contingency in this superseding business case summary to address this risk.	3	12	12						**12**	3	6	3						**6**
Environmental: No significant environmental risks associated with this Project.																			
Investment: Arm vendor does not fulfill contractual obligations and is in a position of default. Arm portion of Project is cancelled resulting in a write-off to OM&A of 7,573k$.	If this occurs, work with vendor to negotiate another amendment to the contract to avoid complete default. Contract default provisions are in the contract.	6	15							**15**	3	12							**12**

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7/ POST IMPLEMENTATION REVIEW PLAN

Type of PIR:	Targeted Final AFS Date:	Targeted PIR Approval Date:	PIR Responsibility (Sponsor Title)
Comprehensive	Apr 2011	Sep 2012	Director – Station Engineering Pickering A

- An independent Comprehensive Post Implementation Review (CPIR) will be conducted, consistent with the corporate PIR procedure
- The CPIR will be an independent and systematic performance evaluation of the project against these objectives:
  - Assess the realization of the project benefits
  - Review project intent, plan, implementation and operational performance
  - Review BCS – major assumptions, economic and financial evaluation look back from results, for future decisions
  - Review project risk management
  - Identify lessons learned
- Lessons learned on the technology development, contracting strategy, and planning will be captured in addition to the project execution lessons

	Measurable Parameter	Current Baseline	Targeted Result	How will it be measured?	Who will measure it? (person / group)
1.	All partial AFS declarations of non-arm equipment completed	Several partial AFS declarations completed to date	All partial AFS declarations completed	AFS declaration forms for non-arm equipment	IM&CS Project Team
2.	Acceptance test of manipulator arms and equipment against OPG design requirements	Acceptance test not started	All acceptance test results accepted or dispositioned	Vendor report – Line Item Verification Completion Notice (LIVCN) accepted by OPG	IM&CS Project Team
3.	Partial AFS declaration of manipulator arms and equipment	Partial AFS declaration not started	Partial AFS declaration completed	AFS declaration form for arm equipment	IM&CS Project Team
4.	Final AFS declaration for all equipment	Final AFS declaration not started	Final AFS declaration competed	Final AFS declaration form for all equipment	IM&CS Project Team
5.	6 out 6 financial in-service declarations for Project completed	2 out of 6 in-service financial declarations completed to date	6 out of 6 in-service financial declarations completed	Financial in-service declaration forms	IM&CS Project Team

Appendix "A" Glossary (acronyms, codes, technical terms)

AFS	Available For Service
CNSC	Canadian Nuclear Safety Commission
COMS	Constructability, Operability, Maintainability, and Safety
CPIR	Comprehensive Post Implementation Review
CV	Calandria Vault
CVI	Calandria Vault Inspection
DA	Design Authority
EC	Engineering Change
EOL	End of Life
IM&CS	Inspection, Maintenance and Commercial Services
IRR	Internal Rate of Return
ISD	In Service Declaration (Also known as REIS)
KWH	Kilowatt Hours
LIVCN	Line Item Verification Completion Notice
LTD	Life to Date
NDE	Non Destructive Examination
NPV	Net Present Value
OEB	Ontario Energy Board
OM&A	Operating, Maintenance and Administration
OPG	Ontario Power Generation
OPGN	Ontario Power Generation, Nuclear
P711	The first planned outage in 2007 in Pickering A Unit 1
P941	The first planned outage in 2009 in Pickering A Unit 4
P1011	The first planned outage in 2010 in Pickering A Unit 1
PEP	Project Execution Plan
PIR	Post Implementation Review
REIS	Report of Equipment In Service (Also known as ISD)
RTS	Ring Thermal Shield
UT	Ultrasonic – one method of NDE
YTD	Year To Date

CAT III	Category III is assigned to software that, while important, can be implemented with a less rigorous design process than Category I or II software. This could be software where the failure has a less direct impact on risk or where the impact is on a system of lower significance.
CAT IV	Category IV is assigned to software where a *software failure* has no nuclear safety impact and impacts on risks identified in the risk-based ECC are very limited. While the Category IV software design process can be less rigorous than that of Category III software, a systematic design process should still be used.

Appendix "B"

Project Funding History

$ 000's		All Existing and Planned Releases (incl contingency) Cumulative Values									
Release Type	Month	Year	2005	2006	2007	2008	2009	2010	2011	Later	Total
Developmental	Aug	2005	232	449							681
Full	Aug	2006	1,806	8,994	3,776	7,324	1,973				23,873
Superseding	Jun	2009	1,806	8,994	3,776	7,868	3,841	112			26,397
											0
											0
											0
											0
											0
LTD Spent	Mar	2009				16,698					16,698

Comments:

Previously, approximately 660k$ was spent on Project Scoping using funding from the Pickering A Return to Service budget.

Subsequently, Project 46552 was initiated (developmental release) in 2005 with the major deliverables being two vendor proposals for the design and fabrication of a calandria vault (CV) manipulator arm for use as a platform for inspection and repair of CV components.

Following Project 46552, a full release of 23,873k$ was approved in August 2006 as Project 46537, with an expected completion date of February, 2008. In order to meet the business objective to develop the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components, the following set of major deliverables were included:

- 2 CV manipulator arms, with the capability to deliver a platform for inspection and repair end effectors to all of the specified calandria vault components
- Ultrasonic and video inspection end effectors for the CV manipulator arms
- Mockups for tool testing and training
- Horizontal and vertical video on extension booms to provide overview visuals of the CV internals and for field of view cameras during the CV manipulator arm operations
- Non-arm tooling including: Robotic vehicle and associated video/ultrasonic end effectors, Ion Chamber Cooling Line inspection equipment
- Site preparations for unit inspections (station assessments and modifications were not included)
- Field testing of all inspection equipment in Unit 2 (schedule permitting)
- Training and procedures
- Project management and engineering

This release did not include funding for repair capability or repair end effectors.

Appendix "C" Financial Model – Assumptions

Financial Assumptions:

Discount Rate	7%	Cost Escalation (yr)	3%	SR & D Opportunity	Yes
Progress Payments	Yes	Foreign Currency	N/A	Retainer Fee	
Income Tax Rate	Generation	PST		Interest Rate (Capital)	6%
Depreciation Rate (Capital)	Generating Equipment 8%	Leasing		Indexed Priced Contract	No

Comments:

Project Cost Estimate:

Design Complete	100%	Quality of Estimate	Release + 15% to - 10%	3rd Party Estimate	No
Reviewed by Sponsor	Yes	OPEX used	Yes	Lessons Learned	Yes
Similar Projects	Nothing Similar	Budgetary Quote(s)	N/A	First Unit Actual Used	No
Cost Sharing	No	Contracts in place	All in place	Competitive Bid	Yes
Fixed Price Contract	Yes	Fee for Service	Yes	Firm Vendor Proposal	Yes

Comments:

Alternative	Forced Outage (Months) [Leak is Accessible]	Forced Outage (Months) [Leak is Not Accessible]	Probability leak is accessible	Inspection Cost if Leak is accessible ($M) [without 30% premium]	Inspection Cost if Leak is Not Accessible ($M) [without 30% premium]	Repair Cost ($M) [without 30% premium]
Base Case	24	24	0.00	N/A	25	15
Alt 1 (Recommended)	20	24	0.89	0	25	15
Alt 2	20	24	1.00	0	N/A	15
Alt 3	8	24	1.00	0	N/A	N/A

The duration for repairs during a forced outage is not considered to be part of the Forced Outage Months in the table.

Rationale for Cost Classification:

Generation Plan Assumptions:

Station	Unit	EOL		MW	Capacity	Planned Outages for Project Work (eg P1071)						
Pickering A	1	Mar	2020	513	85%	P1011						
	4	Mar	2020									
Pickering B	5											
	6											
	7											
	8											
Darlington	1											
	2											
	3											
	4											

Comments:

Appendix "C"

Financial Model – Assumptions
Impact on Operations

Impact on Revenue

$000's	Present	2010	2011	2012	2013	2014	2015	2016	Later	Total
Rate KWH										
Probability										0.0%
Consequence										0
Risk						(46,600)	(46,600)	(2,721)	(9,048)	(104,968)
Other										0
Base Case	0	0	0	0	0	(46,600)	(46,600)	(2,721)	(9,048)	(104,968)
Probability										0.0%
Consequence										0
Risk						(77,907)	(2,088)	(2,721)	(9,048)	(91,763)
Other										0
Recommendation	0	0	0	0	0	(77,907)	(2,088)	(2,721)	(9,048)	(91,763)
Net Impact	0	0	0	0	0	(31,307)	44,512	0	0	13,205

Comments:

FIN-TMP-PA-006, Revision R01 BCS Template is utilized for all PNGSA NPV calculations
The Template assumptions are used as is and are contained in the spreadsheet titled "Assumptions_Using Sheet"
For a non-sealable leak, it is assumed that the forced outage occurs in 2014, unless otherwise stated
The probabilities of failure for each case are as shown
It is assumed that if a non-sealable leak occurs, it is for one unit only, however, the repair capability would be applicable for both Unit 1 and Unit 4
It is assumed that the actual outage costs to perform a non-sealable leak repair are not included as these are assumed to be the same for all alternatives
It is assumed that if a forced outage occurs from a non-sealable leak, all OM&A and capital costs estimates will be escalated by a 30% premium to expedite material and labour
For a bracket failure, it is assumed that the failure occurs in 2014, unless otherwise stated
It is assumed that the Unit 1 and Unit 4 EOL is Q1 2020 for investment evaluation purposes.
It is assumed for the CVI options without repair capability that the repair capability Project and station assessments and modifications are carried out during the non-sealable leak forced outage
It is assumed that all CVI Project committed costs are sunk costs and not included in the various NPV calculations, except for the Alt 1 - Full Cost alternative
For the purpose of NPV calculations, it is assumed that the cost to develop inspection capability is $25M over the 24 month period
For the purpose of NPV calculations, it is assumed that the cost to develop repair capability is $15M over the 20 month period
LTD at Dec 31, 2008 is $14,576
Mar 31, 2009 YTD is $2,122
Project committed costs of $7.5M, used in Base Case
Additional Capital Cost to achieve 100 % accessibility is 6.5 $M, used in Alternative 2 and 3
Additional Capital Cost to achieve repair capability is 19.5 $M, used in Alternative 3

Impact on OM&A

$000's	Present	2009	2010	2011	2012	2013	2014	2015	Later	Total
Base OM&A										0
Outage OM&A			(750)							(750)
Project OM&A							(520)			(520)
Base Case	0	0	(750)	0	0	0	(520)	0	0	(1,270)
Base OM&A										0
Outage OM&A			(750)							(750)
Project OM&A							(520)			(520)
Recommendation	0	0	(750)	0	0	0	(520)	0	0	(1,270)
Net Impact	0	0	0	0	0	0	0	0	0	0

Comments:

All NPV calculations include P1011 non-arm inspection cost included at $750K
All NPV calculations exclude station assessments and modifications costs, unless they occur in 2014
It is assumed that the station assessments and modification costs in 2014 are as follows: $2.0M x 1.3 x probability of cooling line leak
All NPV calculations exclude arm training costs to be covered under Project 46606 – Calandria Vault Inspection Execution
All NPV calculations exclude arm station preps and equipment costs to be covered under Project 46606 – Calandria Vault Inspection Execution
All NPV calculations exclude arm inspection costs to be covered under Project 46606 – Calandria Vault Inspection Execution

Calandria Vault Inspections 13 - 46537

Superseding Business Case N - BCS - 30673 - 10001 – R00

Attachment "A" **Project Cost Summary**

	$000's Capital	LTD 2008	YTD Mar2009	2009	2010	2011	2012	2013	2014	Later	Total
Scores Basis	Project Mgmnt & Engineering	2,245	243	697	578	62					3,825
	Permanent Materials	10,877	1,612	4,056	1,714	-					18,259
	Testing/Commissioning	195	61	345	175	-					776
	Training	121	79	219	-	-					419
	Expenses	124	5	31	11	-					171
											-
											-
											-
											-
	Interest (Capital Project Only)	1,014	122	398	272	50					1,856
	Project Costs	**14,576**	**2,122**	**5,746**	**2,750**	**112**	-	-	-	-	**25,306**
	General Contingency	-			1,091	-					1,091
	Specific Contingency	-			-	-					-
	Project Costs	**14,576**	**2,122**	**5,746**	**3,841**	**112**	-	-	-	-	**26,397**
Cash	**Adjust to Cash Basis + / -**									-	-
	Project Costs	**14,576**	**2,122**	**5,746**	**3,841**	**112**	-	-	-	-	**26,397**
Funding	**Currently Released**	14,576	7324	1,973							23,873
	This Release	-	544	1,868	112						2,524
	Future Release	-	0	-	-					-	-
	Project Funding	**14,576**	**7868**	**3,841**	**112**	-	-	-	-	-	**26,397**

Note: Scores Basis = Cash Basis = Funding Basis (Timing differences only)

Budget	2009-2013 Business Plan	13,200	8700	1,900							23,800
	Variance to Business Plan	**1,376**	**-832**	**850**	**112**	-	-	-	-	-	**1,506**

Other	**Removal Costs included above**										-
	Inventory to be written off										-
	Spare Parts in Inventory										-

The estimated variance(s) to the **2010-2014 Business Plan** will be addressed through the portfolio management process.
A PCRAF **was approved in Jan 2009.**

Reviewed By:
Marc Paiment Marc Paiment 15 July 2009
Name
Project Manager
Date:

Approved By:
DON JARRETT 15 July 2009
Name
Strat IV Manager
Date:

Calandria Vault Inspections 13 - 46537

Superseding Business Case N - BCS - 30673 - 10001 – R00

Attachment "B" **Project Variance Analysis**

	Capital	LTD Mar 2009	Total Project Last BCS Aug 2006	Total Project This BCS Jun 2009	Variance	Comments
Scores Basis	Project Mgmnt & Engineering	2488	4495	3825	-670	(See Note 1)
	Permanent Materials	12489	13550	18259	4709	(See Note 2)
	Testing/Commissioning	256	459	776	317	(See Note 3)
	Training	200	658	419	-239	(See Note 4)
	Expenses	129	580	171	-409	(See Note 5)
					0	
					0	
					0	
					0	
	Interest (Capital Project Only)	1136	1127	1856	729	(See Note 6)
	Project Costs (Scores Basis)	**16698**	**20869**	**25306**	**4437**	
	General Contingency		**3004**	**1091**	-1913	(See Note 7)
	Specific Contingency				0	
	Project Costs (Scores Basis)	**16698**	**23873**	**26397**	**2524**	
Other	**Removal Costs included above**				0	
	Inventory to be written off				0	
	Spare Parts in Inventory				0	

Comments:
Cost, schedule, and scope variances have occurred on this Project, resulting in a cost impact of **+7091k$**. However, through value engineering, the application of Project controls, and minimization of resources and expenses, the overall impact is **+2524k$**. The need for changes to the Scores Basis from the full release BCS to this superseding request are as follows:

NOTES:
1.
a) Delayed addition of resources on Project to accommodate delays
b) Redeployed existing resources on Project to accommodate delays

2.
a) Underestimated cost for the CV mockup for tool testing and training, impact **+1000$k**
b) Robotic arm costs increased over estimate due to delays and overspend by vendor resulting in an amendment to increase the firm fixed price contract, impact **+1700$k**

Background:

- Robotic arm vendor design difficulties resulting in major cost overruns and schedule delays on the firm fixed price contract. The design difficulties at the vendor were due to the design constraints of this Project such as: a) the extremely long reach required; b) the small cross-section of the penetration into the CV; c) the initial schedule for delivery; and d) vendor program management errors such as: i) sub-contracting the robotic arm to attempt to meet schedule demands; ii) following an internal non-standard process such as not building a prototype system first, then the final system; and iii) following an internal non-standard process such as

inadequate oversight during the design process and reviews

- Robotic arm vendor quality difficulties resulting in major cost overruns and schedule delays on the firm fixed price contract. The quality difficulties were as follows: i) design errors; ii) inadequate design margins; iii) lack of quality control and receipt inspection; and iv) infrequent sub-contractor oversight

c) Robotic arm costs increased, impact **+1200k$**, due to:

i) scope increases to vendor to address clarified design requirements
ii) address new design requirements required as part of discovery work during Project
iii) perform assessments of impact of discovery work

d) Added scope not originally considered such as an engineered tool to insert and remove station CV penetration shield plugs, impact **+200k$**

e) Added scope not originally considered such as the need to modify the end effectors and/or the robotic arm after receipt to ensure their effectiveness for use, impact **+900k$**

3. Performance of risk mitigation measures, not originally in scope, such as field measurements and vault field-run component configuration awareness and verification during the P711 outage, impact **+300k$**

4. Reduced training on robotic arm portion of Project

5. Minimized expenses on entire Project throughout life cycle through reducing scope where possible and applying value engineering

6. Underestimated interest costs due to delays on robotic arm contract resulting in delays of issuing of a report of equipment in service, impact **+700k$**

7. Used all of 3004k$, residual risk left is **+1091k$** based on current list of risks

Attachment "C" Milestones and In Service Declarations

Key Milestones

Completion Date			Description
Day	Mth	Yr	
	May	2006	Winning bid selected – **Completed** May 2006
	Jul	2006	PO issued to vendor – **Completed** Nov. 2006
	Dec	2006	Final Design of Manipulator arm complete – **Completed** May 2007
	Jan - Apr	2007	Field trial of non-arm inspection equipment in Unit 2 – **Completed** Nov. 2007 in P711
	Sep	2007	Delivery of first CV manipulator arm – Scheduled for Jan. 2010
	Nov	2007	Delivery of second CV manipulator arm – Scheduled for Mar. 2010
	Feb	2008	Field trial of CV manipulator arm in Unit 2 and in service declaration – Field trial in Unit 2 cancelled, trial will be in full scale mockup, in service declaration scheduled for Apr. 2010
	Mar	2008	Inspection of Unit 4 – **Completed** non-arm inspection Jan. 2009 in P941, Unit 4 arm inspection not scheduled
	Sep	2008	Inspection of Unit 1 – Arm inspection scheduled for Jun. 2010 in P1011
29	Jan	2010	1 CV manipulator arm takeover
6	Mar	2010	1 CV manipulator arm takeover
15	Apr	2010	AFS for equipment
6	Apr	2011	Project Closeout

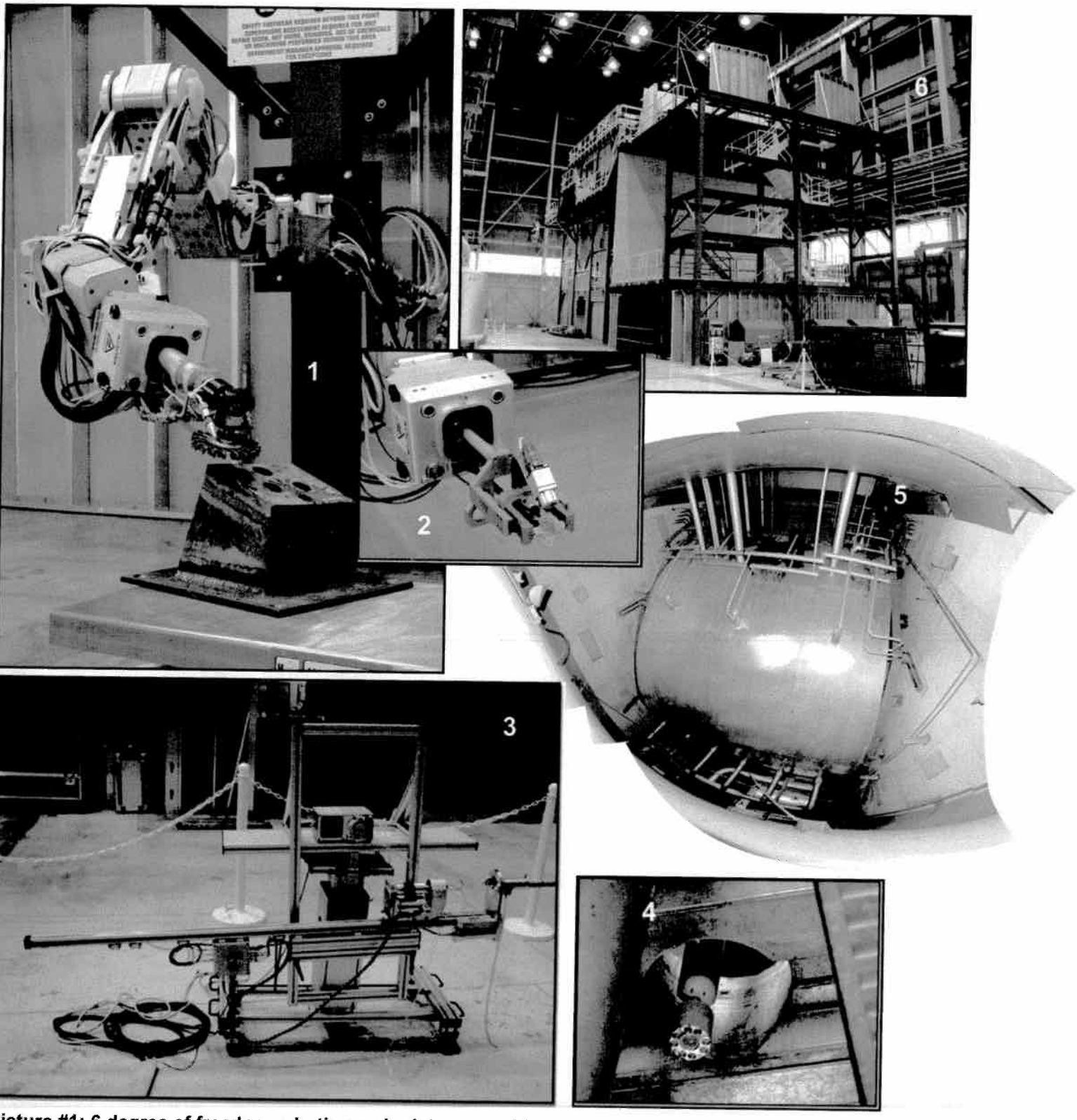
A revised Project Execution Plan (PEP) **will be approved by Oct 2009**

In Service Declarations: (Capital Only)

Month	Year	Description	$ 000's	%
April	2008	ISD #1 Calandria Vault Full Scale Mockup - **Completed**	2,059	8.1
April	2009	ISD #2 Non-Arm, Non-ICCL Support and Inspection Equipment - **Completed**	2,607	10.3
Aug.	2009	ISD #3 ICCL Inspection Equipment	584	2.3
Oct.	2009	ISD #4 Manipulator Arm Ultrasonic End Effectors	910	3.6
April	2010	ISD #5 Manipulator Arm	17,335	68.5
April	2011	ISD #6 Project Closeout	1,811	7.2

Attachment "D"

Project Pictures



Picture #1: 6 degree of freedom robotic manipulator arm with surface preparation end effector attached; #2: Close-up of ultrasonic end effector integrated with robotic arm; #3: Ion Chamber Cooling Line inspection system during testing & commissioning; #4: Vertical Overview Camera during testing & commissioning; #5: Panoramic view of inside of calandria vault mockup; #6: Calandria vault mockup and platforms.
Internal OPG Website: http://cmsprod.corp.opg.com/OPG/Content/Nuclear/IMS/About/Projects+-+46537.htm

Attachment "E"

Risk Probabilities Chart

Likelihood	Improbable	Unlikely	Possible	Likely	Probable
Probability	<= 1 in 1000	About 1 in 100	About 1 in 10	About 1 in 5	>= 3 in 4
Rank	1	2	3	4	5

Risk Impact Chart

Impact Rating	Financial	Project Schedule (12 months)	Quality	Corporate Reputation	Regulatory / Legal	Health & Safety	Environment	Nuclear Safety
5	>80% of Total Project $	> 90 day delay	Significant, unacceptable non-conformance requiring extensive rework	National and international adverse coverage or impacts	Non-compliance with potential for significant implications for personnel, potentially large damages or Criminal Charges **OR** Potential loss of operating licenses	Potential for fatality(s)	Spill or release causing immediate and extended impact with off-site impacts, e.g.: Clean-up costs > $15M Cat. A spill (>55 pts)	Loss or serious degradation of a safety system
4	30% - 80% of Total Project $	30 - 90 day delay	Unacceptable non-conformance requiring some rework, but not major	Long-term local or national impact	Legislative non-compliance with potential for fines, charges, and damages **OR** Major degradation of reputation with regulatory bodies	Potential for life-threatening critical injury or permanent total disability, including occupational disease	Exceedances resulting in charges or Director's Order Cat. A spill (45 - 55 pts) Public complaints with OPG implications Explosion and/or major fire	Reduced effectiveness of a safety system
3	15% - 30% of Total Project $	10 - 30 day delay	Non-conformance bordering design tolerances, potential to require rework	Major local impact or minor national impact. Minor local damage	Systematic non-compliance with potential for fines OR Potential to cause strained relationship with regulator, increased surveillance and/or regulations	Potential for less serious critical injuries (e.g. fractures), permanent partial disabilities and temporary total disabilities of a significant nature	Cat. B spills Emission in exceedance of regulatory or legal limits Field orders or AMP's Public complaints with OPG implications Danger to health, life, or property	Reduced effectiveness of redundant safety system components
2	5% - 15% of Total Project $	3 - 10 day delay	Acceptable non-conformance, within design tolerances, no rework required	Complaints from local officials / politicians	Systematic non-compliance with impacts to Project schedule OR Possibility of regulatory / legal implications	Potential for less serious temporary disabilities and injuries requiring off-site medical attention other than first-aid. Complete recovery by worker.	Cat. C spills - reportable Administrative infractions Public Complaints with plant level implications	Impact on a safety support or safety relat s
1	<5% of Total Project $	< 3 day delay	Minimal impact on quality Routine non-conformance, can be easily dispositioned	Complaints from local public	Isolated non-compliance OR Routine approval / notification	No medical attention beyond first aid, no impairment to worker or complete recovery of worker.	Administrative, non-reportable events Cat. C spills non-reportable and spills resulting from Acts of G	

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