Probabilistic Safety Assessment Upgrade 10 - 62440

Partial Release Business Case Summary N-BCS-03500-10000-R000

1/ RECOMMENDATION:

Approval is requested for a partial release of $11.3 Million (including contingency) OM&A project funding to initiate the upgrading the Darlington, Pickering A and Pickering B Probabilistic Safety Assessments (PSA - also known as Probabilistic Risk Assessment or PRA).

The business objectives of this project are to:

- Upgrade the Darlington and Pickering B Probabilistic Safety Assessments to bring them into compliance with their current Power Reactor Operating Licenses. The respective operating Licenses for both stations (revised and reissued by the CNSC in 2008) mandate that by December 31, 2010, each station must have a PSA that is compliant with the requirements of CNSC Regulatory Standard S-294 "Probabilistic Safety Assessment (PSA) for Nuclear Power Plants". The development, maintenance and use of PSA is also mandated by the requirements of the Corporate Nuclear Safety Policy and by the requirements of the corporate Risk and Reliability Program N-PROG-RA-0016.
- Upgrade the Pickering A Probabilistic Safety Assessment to be compliant with Regulatory Standard S-294, which is anticipated to be required in the Pickering A Power Reactor Operating License renewal in 2010.
- Develop sustainable in-house PSA expertise which will support:
  - The regulatory trend towards risk-based decision making in relation to assessment of emergent plant issues
  - The industry trend towards use of PSA for business risk assessments and for business optimization decisions related to on-line and outage maintenance strategies and scheduling.

The cost estimate is based on a project execution plan provided by the primary contractor and input from potential secondary contractors. Costing is based on experience to date with recent risk model upgrades and projected costs for inclusion of evaluation of internal events such as fire and external events such as seismic incidents.

The funding estimate also includes the requirements for OPG staff for project management and station support staff (7 full time equivalents) up to the end of 2010 to provide expert detailed review of contractor product and to develop a sustaining in-house expertise in the PSA field.

$000's (incl contingency)	Funding	LTD 2008	2008	2009	2010	2011	2012	Later	Total
Currently Released	None	-	-	-	-	-	-	-	-
Requested Now	Partial	-	1,800	10,200	-	-	-	-	12,000
Future Funding Req'd	Full	-			10,400	4,400	-	-	14,800
Total Project Costs		-	1,800	10,200	10,400	4,400	-	-	26,800
Other Costs									-
Ongoing Costs									-
Grand Total		-	1,800	10,200	10,400	4,400	-	-	26,800
Investment Type: Regulatory		Class: OM&A		(NEV) Impact on Ec Value: (15,800)		IRR: N/A		Discounted Payback: N/A	

Submitted By:

R.C. Morrison — Date: 8 Sep 08
Vice President & Chief Nuclear Engineer

Finance Approval:

D. Hanbidge — Date:
Senior Vice President & Chief Financial Officer

Line Approval (Per OAR Element 1.2 Project not in Budget):

J. Hankinson — Date: Jan 9/09
President & Chief Executive Officer

2/ BACKGROUND & ISSUES

In April 2005 following industry consultation (including OPG through the CANDU Owners Group), the Canadian Nuclear Safety Commission published Regulatory Standard S-294 which mandates that each nuclear power plant licensee carry out plant specific Level 2 Probabilistic Safety Assessments. A probabilistic safety assessment (also known as a probabilistic risk assessment) is a comprehensive and integrated assessment of the safety of the plant or reactor. The safety assessment considers the probability, progression and consequences of equipment failures or transient conditions to derive numerical estimates that provide a consistent measure of the safety of the plant or reactor. The regulatory standard requires that Canadian utilities have probabilistic safety assessments consistent with international standards. During the review process, the industry questioned need for a probabilistic safety assessment when there was no regulatory context for their usage. The regulator decided on a step-wise process whereby the probabilistic safety assessments will be put in place first to be followed by risk limits and processes.

A Level 1 probabilistic safety assessment identifies and quantifies the sequence of events that may lead to the loss of core structural integrity and massive fuel failures. A Level 2 probabilistic safety assessment starts from the Level 1 results and provides an analysis of containment behaviour, the radionuclides released from the failed fuel and a quantification of releases to the environment.

The Darlington and Pickering B Power Reactor Operating Licenses, as revised and re-issued by the Canadian Nuclear Safety Commission in 2008, mandate that both stations must have a probabilistic safety assessment compliant with the requirements of Regulatory Standard S-294 by December 2010. (Discussions between OPG and regulatory staff prior to the Darlington license re-issue had suggested that the license condition would be to provide a plan to bring it into compliance with S-294 with 2012 as the planned completion.) It is anticipated that an S-294 compliant probabilistic safety assessment will be required for Pickering A in the next issuance of its Power Reactor Operating License in 2010.

The Corporate Nuclear Safety Policy and Corporate Risk and Reliability Program also mandate the development, maintenance and use of probabilistic safety assessments. Probabilistic safety assessments will support the regulatory trend towards risk-informed decision making. Industry experience in jurisdictions requiring Level 2 probabilistic safety assessments indicates that risk-informed decision making has resulted in relaxation of deterministic limits to continuing operation, thereby avoiding shutdowns that otherwise would have occurred. Probabilistic safety assessments will also be required to support regulatory approvals of plant life extensions.

The Darlington Probabilistic Safety Evaluation was issued in 1987 and a "draft" Darlington Risk Assessment was developed. This draft document, although in current use, requires a major revision in order to accurately reflect current plant operation and to comply with the specifications of Regulatory Standard S-294. Preliminary work on the Darlington upgrade is currently in progress.

The Pickering B Risk Assessment was updated and issued in 2007. This probabilistic safety assessment is essentially compliant with Level 1 and Level 2, but requires revision to address regulatory comments.

The current Pickering A Power Reactor Operating License does not require an S-294 compliant assessment. The Pickering A Probabilistic Risk Assessment requires updating of the Level 1 and Level 2 analyses to bring it into compliance with Regulatory Standard S-294.

The existing probabilistic risk assessments have already been used to improve public safety, as discussed in examples below, and the upgrades are expected to identify additional areas for improvement.

- The Pickering A probabilistic risk assessment was used to identify improvements and support restart following Unit 1 and Unit 4 refurbishment.
- The work completed on the Darlington upgrade has already identified gaps in operating documentation and surveillance programs as well as deficiencies that were addressed through operability evaluations.

Due to the increased complexity and cost imposed by the new license conditions and the compressed time frame for completion, it is proposed to manage the upgrade to license compliance as a project, with appropriate project management, augmentation of resources, vendor oversight and station support staffing.

3/ ALTERNATIVES AND ECONOMIC ANALYSIS

$ 000's	Status Quo	Alt 1 (Recommended) Full Cost	Alt 1 (Recommended) Incremental Cost	Alt 2 Delay	Alt 3	Alt 4	Alt 5
Revenue							
OM&A		(26,800)	(26,800)	(18,800)			
Capital							
NPV (after tax)		(15,896)	(15,896)	(14,951)			
Impact on Economic Value (IEV)	N/A	(15,896)	(15,896)	(14,951)			
IRR%	N/A	N/A	N/A	N/A			
Discounted Payback (Yrs)	N/A	N/A	N/A	N/A			

Status Quo - Not Recommended

Status quo is not recommended. The current Darlington and Pickering B PSAs currently do not comply with S-294 requirements. Darlington and Pickering B will be in non-compliance with their respective PROL license conditions as of Dec 31, 2010 and risk regulatory action. The CNSC will most probably impose the S-294 compliance on Pickering A in its next PROL. There is very low probability that the CNSC will rescind the regulatory document or license condition requiring a level 2 PSA.

Alternative 1 - Complete PSA to Meet License Conditions - Recommended

Upgrade the Darlington and Pickering B Probabilistic Safety Assessments to bring them into compliance with Regulatory Standard S-294 by their respective compliance dates. Upgrade the Pickering A Probabilistic Safety Assessment to bring into compliance with anticipated regulatory requirement. Provide corporate project management and oversight, create separate station organization to execute the project, interface with the regulator and to provide vendor support through to completion.

Alternative 2 - Delay Project - Not Recommended

Delay of project is not recommended as the schedule completion by the license date is already at risk. The probability of acquiring a license amendment extending the deadline for full compliance is very low unless significant progress can be shown.

Alternative 3 – - Not Recommended
NA

Alternative 4 – - Not Recommended
NA

Alternative 5 – - Not Recommended
NA

4/ THE PROPOSAL

This release of the project will initiate the work to update the probabilistic safety assessments of Darlington and Pickering B to bring them into compliance with Regulatory Standard S-294 by Dec 31, 2010 as mandated by the respective current Power Reactor Operating Licenses, and begin work on the Pickering A probabilistic safety assessment as described below:

Develop S-294 Compliant Probabilistic Safety Assessment for Darlington

The probabilistic safety assessment of Darlington will be upgraded in four interdependent phases, as listed below.

- Phase 1: Update Level 1 probabilistic safety assessments (excluding fire and seismic events).
- Phase 2: Develop Level 2 probabilistic safety assessment models (excluding fire and seismic events).
- Phase 3: Address remaining S-294 gap issues including disposition of other external events such as airplane crash, intense precipitation, tornadoes, rail line explosion, rail line toxic gas release, transportation accident, low lake level, meteorite strike, and geomagnetic storms.
- Phase 4: Develop Level 1 and Level 2 assessment models for fire and seismic events.

Develop S-294 Compliant Probabilistic Safety Assessment for Pickering B

This phase of the project will revise the existing probabilistic safety assessment to address regulatory comments and initiate work on Level 1 and Level 2 fire and seismic probabilistic safety assessment, along with disposition of other external events described above. The extent of the probabilistic safety assessment will depend on the end-of-life decision for Pickering B.

Develop S-294 Compliant Probabilistic Safety Assessment for Pickering A

This phase of the project will be to begin the update the Level 1 probabilistic safety assessment to incorporate identified issues, design changes such as permanent Inter-Station Transfer Bus design, incorporation of Unit 2 and Unit 3 Safe Storage end states and other design changes as well as development of the data file necessary for the Level 2 analysis.

Develop Sustainable Internal Expertise for Probabilistic Safety Assessment

Develop sustainable internal probabilistic safety assessment expertise which will support:

- Risk-informed decision making on regulatory issues and response to emergent plant conditions.
- Business risk assessments and optimization decisions.

The project will meet the following overall requirements:

1. A formal quality assurance process for completing a probabilistic safety assessment will be established and applied.
2. Models will reflect the plant as built and operated as closely as reasonably achievable within limitations of probabilistic safety assessment technology and consistent with risk impact.
   - Both internal and external events will be included.
   - At-power and shutdown modes will be included.
   - Sensitivity analysis, uncertainty analysis and importance measures will be included.
3. Models will be developed using assumptions and data that are realistic and practical.
4. The level of detail of the probabilistic safety assessment will be consistent with plant testing and configuration management programs.
5. Canadian Nuclear Safety Commission acceptance of the methodology and computer codes to be used for the probabilistic safety assessment will be obtained.

The project cost is based on vendor budgetary estimates, and experience with preliminary vendor work on PSA revision and considers the increased complexity imposed by the requirement for S-294 compliance and increased scope required to complete the fire and seismic portions of the PSA.

The estimate includes the cost to establish corporate oversight and to create dedicated PSA project teams at the stations to manage and execute the project, provide oversight of vendor activities and costs, provide expert review of vendor product, to provide regular interface with the regulator and for the development of a sustaining in house PSA capability.

Seven Full Time Equivalent employees (FTEs) are required on the station project teams for the duration of the project.

5/ QUALITATIVE FACTORS

The existing probabilistic risk assessments have already been used to improve public safety, as discussed in examples below, and the upgrades are expected to identify additional areas for improvement.

- The Pickering A probabilistic risk assessment was used to identify improvements and support restart following Unit 1 and Unit 4 refurbishment.
- The work completed on the Darlington upgrade has already identified gaps in operating documentation and surveillance programs as well as deficiencies that were addressed through operability evaluations.

6/ RISKS

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigating Activity	Risk After Mitigation
Cost				
Complexity of analysis is greater than expected	Budgeted cost exceeded	**High**	Project team to determine acceptable level of complexity. Contingency funding identified in this BCS	**Low**
Scope				
Fire and Seismic PSA not required in previous regulation	Amount of work is more than anticipated resulting higher than budgeted costs	**High**	Initiate as soon as possible and use vendor with previous experience in seismic / fire assessments. Contingency funding identified in this BCS.	**Low**
Analysis reveals situations that require shutdown of one or more units.	Loss of revenue and increased costs while solution to analysed condition is implemented.	**High**	Discovery Issue Resolution Process and Technical Operability Evaluation processes will be used to address issues identified during analysis. Analysis will also support risk-informed decisions by the regulator on increasing the duration of shutdown clocks.	**Low**
Analysis reveals safety deficiencies that require plant modifications to address.	Increased costs as modifications are implemented	**Medium**	Analysis will be used to support risk-informed decisions on proceeding with plant modifications. Proposed modifications will be assessed and prioritized by the AISC process to ensure spending ceilings are maintained.	**Low**
Schedule				
Rework of submitted analyses	Delay in completing analysis work with potential to miss license condition.	**High**	Use staged reviews to minimize rework time.	**Low**

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigating Activity	Risk After Mitigation
Resources				
There is a limited pool of experienced probabilistic risk analysts in Canada.	Completing the required analysis by the Darlington and Pickering B license condition date may be missed due to the volume of work.	High	Update of the Level 1 and 2 internal event analyses to be completed by the current vendor of probabilistic risk assessment services. Development of the fire, seismic and other external event analyses to be sourced from vendors in Canada and the United States with experience in fire and seismic analysis. Third party review of the analyses will be sourced from vendors in the United States.	Low
Technical				
Quality / Methodology	Schedule delay	High	Vendor to use industry standard methodology. Station Team to review vendor product. Independent Third Party review.	Low
Regulatory				
Regulator rejects analysis due to methodology, data and assumptions	Delay in completing analysis work with potential to miss license condition.	High	Staged review by regulator. Establish update process similar to Safety Report update. Vendor to use industry standard methodology. Third party review. Experienced vendors.	Low

7/ POST IMPLEMENTATION REVIEW PLAN

Type of PIR:	Targeted Final AFS Date:	Targeted PIR Approval Date:	PIR Responsibility (Sponsor Title)
TBD in Next Release	TBD in Next Release	TBD in Next Release	

Comments:

	Measurable Parameter	Current Baseline	Targeted Result	How will it be measured?	Who will measure it? (person / group)
1.					
2.					
3.					
4.					
5.					

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

CNSC: Canadian Nuclear Safety Commission

DARA: Darlington A Risk Assessment

Level 1 PSA: Probabilistic Safety Assessment of Core Damage Frequency

Level 2 PSA: Probabilistic Safety Assessment of Large Release Frequency

NSS: Nuclear Safety Solutions

PRA: Probabilistic Risk Assessment

PSA: Probabilistic Safety Assessment

PROL: Power Reactor Operating License

S-294: CNSC Regulatory Standard – Probabilistic Safety Assessment for Nuclear Power Plants

Appendix "B"

Project Funding History

$ 000's		All Existing and Planned Releases (incl contingency) Cumulative Values									
Release Type	Month	Year	2008	2009	2010	2011	2012	2013	2014	Later	Total
Partial	Jul	2008	1,800	10,200	10,400	4,400					26,800
											0
											0
											0
											0
											0
											0
											0
LTD Spent	Jul	2008	0								0

Comments:

Appendix "C" Financial Model – Assumptions

Project Cost Assumptions:

- Schedule is mandated by licensing requirements
- 1 Project Manager (Corporate) and 6 FTE's (Station Based) to support project over duration of the project
- Contract value based on budgetary estimates provided by vendors

Financial Assumptions:

- Annual cashflows dependant on resource availability, timeliness of contract award, vendor capability and mobilization.

Project / Station End of Life Assumptions:

Energy Price / Production Assumptions:

Operating Cost Assumptions:

Other Assumptions:

ONTARIO POWER GENERATION

OPG Confidential | Page: 13 of 15

BUSINESS CASE SUMMARY

Probabilistic Safety Assessment 10 - 62440

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Attachment "A" **Project Cost Summary**

$000's OM&A	LTD Prior Yr 2007	This Release 2008	This Release 2009	Future Release 2010	Future Release 2011			Later	Total
Project Management (OPG)	-	100	200	200	100				600
Engineering & Drafting (OPG)	-	300	1,000	1,200	300				2,800
Material									-
Installation – PWU, BTU									-
Contract - Design									-
Contract - Installation									-
Contract - Analysis Services	[redacted]								-
									-
									-
Interest (Capital Project Only)									-
Project Costs (excl contingency)	-	[redacted]							
General Contingency		[redacted]							
Specific Contingency									-
Project Costs (incl contingency)	-	1,800	10,200	10,400	4,400	-	-	-	26,800
2008-2012 Business Plan		-	-	-					-
Variance to Business Plan	-	1,500	9,200	9,400	3,900	-	-	-	24,000
Committed Cost									-
Inventory Write Off Required									-
Spare Parts / Inventory									-
Total Release (excl contingency)	-	[redacted]							
Total Release (incl contingency)	-	1,800	10,200	10,400	4,400	-	-	-	26,800
Ongoing OM&A (non-project)									-
Removal Costs (incl in above)									-

Basis of Estimate					
Design Complete	Zero to Minimal		Quality of Estimate	Conceptual + 60% to - 25%	
3rd Party Estimate	Yes	OPEX used	Yes	Lessons Learned	Yes
Reviewed by Sponsor		Budgetary Quote(s)	Yes	Phase 1 Actual Used	No
Similar Projects		Contracts in place		Competitive Bid	

Variance to Business Plan

The estimated variance(s) to the 2008-2012 Business Plan will be addressed through the portfolio management process. A PCRAF is not required

Reviewed By:

P. Lawrence
Project Manager Date:

Approved By:

Y. Sirota
Manager, Reactor Safety Date:

Probabilistic Safety Assessment Upgrade 10 - 62440

Partial Release Business Case Summary N-BCS-03500-10000-R000

Attachment "B" **Project Variance Analysis**

OM&A	LTD N/A N/A	Partial Release Last BCS N/A N/A	Partial Release This BCS Jul 2008	Variance	Comments
Project Management (OPG)				0	
Engineering & Drafting (OPG)				0	
Material				0	
Installation – PWU, BTU				0	
Contract - Design				0	
Contract - Installation				0	
Contract - Other				0	
				0	
				0	
Interest (Capital Project Only)				0	
Project Costs (excl contingency)	0	0	0	0	
General Contingency				0	
Specific Contingency				0	
Project Costs (incl contingency)	0	0	0	0	
Committed Cost				0	
Inventory Write Off Required				0	
Spare Parts / Inventory				0	
Total Release (incl contingency)	0	0	0	0	
Total Release (excl contingency)	0	0	0	0	
Ongoing OM&A (non-project)				0	
Removal Costs (incl in above)				0	

Comments:

As this is the first release for this project, the variance analysis is not applicable.

Attachment "C"

Key Milestones

Completion Date			Description
Day	Mth	Yr	
01	09	08	Initiating Events identified and frequency calculated.
30	09	08	Detailed PEP issued.
28	02	09	Event Tree analysis completed.
30	03	09	Screening analysis for low frequency external events completed.
31	06	09	Fault Tree analysis completed.
31	12	09	Level 1 Integration completed.
31	03	10	Level 1 fire PRA completed.
31	06	10	Seismic margin assessment completed.
31	06	10	Containment fault trees completed.
31	10	10	Level 2 PRA completed.

A Project Execution Plan (PEP) will be approved by September 2008.

Comments: