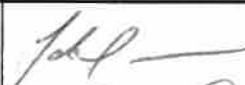
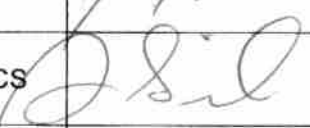
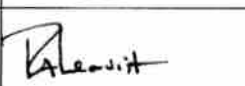
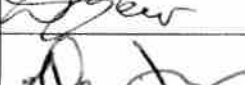
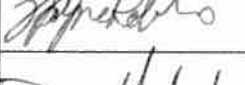
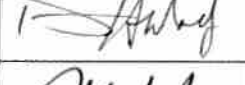


Business Case Summary

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<u>Name / Title / Phone</u>	<u>Location</u>	<u>Action</u>	<u>Signature</u>	<u>Date</u>
Nahil Rahman Director - Pickering Projects 701-4053	P72-1	Review BCS		13 Feb 2012
Sean Granville Director Operations & Maintenance - Pickering 701-2099	PO5-A2	Review BCS		2012/2/24
Dwight Zerkee Manager, Investment Management 702-5058	P82-3	Review BCS		2 Mar 12
Randy Leavitt Vice President - Nuclear Finance 702-5177	P82-3	Review BCS		March 5, 2012
Stephen Rogers Director - Asset Planning & Integration 400-3993	H07-E5	Review BCS		March 19/2012
Don Power Vice President - Corporate Investment 400-7172	H07-G05	Review BCS		March 26/12
Glenn Jager Senior Vice President - Pickering 701-3260	P42-E3	Submit BCS		30 MAR 2012
Wayne Robbins Chief Nuclear Officer 702-5294	P82-6	Review BCS		24/2/04-02
Donn Hanbidge SVP & Chief Financial Officer 400-2395	H19-F27	Approve BCS		2012-04-27
Tom Mitchell President & CEO 400-2121	H19-A24	Approve BCS		2012-6-16
Carolyn Sicard Nuclear Investment Management 702-4082	P82-3B6.2	Return for Distribution		

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PRESIDENT & CEO

APR 30 2012

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1/ RECOMMENDATION:

We recommend a **Full Release** of an **additional \$23.088 Million** (\$16.136 Million **Capital** and \$ 6.952 Million **OM&A**) to fund **completion of all modification, commissioning and closeout** for this project. Approval of this request will bring the total to date funding to **\$34.262 Million** including a contingency of [REDACTED]. The total project is estimated to cost **\$ 34.262 Million** with an estimated completion date of 12/30/2014.

The Business Objective of this **Sustaining** project is to improve the performance and reliability of the Pickering A Fuel Handling (FH) System to address the following issues:

- Pickering A FH System is a significant contributor to production loss from forced outages and Unit deratings
- Component obsolescence is becoming a major issue with the Fuel Handling System reaching its end of life
- Fuelling unavailability often disrupts outage critical path and station Integrated Operating Plan (IOP) schedules

In addition, during fuel handling equipment or systems failure, there is an employee and public safety risk when irradiated fuel cannot be transferred to the appropriate location where adequate cooling is maintained.

This project will replace, refurbish or overhaul the key system components that have aged past their design end of life. Specifically, the focus will be on components classified as Single Points of Vulnerability (SPV) equipment that have a zero tolerance of unplanned failures. Replacing these components will improve the FH system performance and reliability until the Station end of life.

Installation activities in Unit 4 during the 2011 planned outage were completed, for the most part, under the current funding release. Some work (Electrical Catenaries, Rolling Shield Gear Box and Y-Drive Mitre Box) could not be completed due to unavailability of materials at that time. Funds requested in this Full Release BCS are to complete design and installation activities for Unit 1, the remaining work for Unit 4 and project close out. Execution is planned during P1211 outage in Sep 2012 and during P1341 outage in Sep 2013 (for the remaining Unit 4 work).

\$000's (incl contingency)	Funding	Type	LTD Dec 2011	2012	2013	2014	2015	2016	Later	Total
Currently Released	Partial	OM&A	200							200
		Capital	10,700	3,900						14,600
Adjustments to Current Release	Adjustments	OM&A	(146)							(146)
		Capital	(3,480)							(3,480)
Requested Now	Full	OM&A		6,952						6,952
		Capital		8,036	7,890	210				16,136
Future Funding Req'd	None	OM&A								.
		Capital								.
Total Project Costs		OM&A	54	6,952	.	.	.	.	.	7,006
Total Project Costs		Capital	7,220	11,936	7,890	210	.	.	.	27,256
Total Project Costs		Total	7,274	18,888	7,890	210	.	.	.	34,262
Other Costs										.
Investment Type Sustaining			Class Multi Class	NPV 24,852		IRR 20.3		Discounted Payback 5.2		

Submitted By:  (Date) 30 MAR 2012
Glenn Jager
Senior Vice President – Pickering Nuclear

Financial Approval By:  (Date) April 27/12
Donn Hanbidge
SVP & Chief Financial Officer

(OAR Element 1.1 Project in Budget)
Line Approval By:  (Date) 2012-05-06
Tom Mitchell
President & CEO

2/ BACKGROUND & ISSUES:

During the Pickering A Return to Service project, new safety requirements required conversion of adjuster rods to shutoff rods to increase total shut off rod reactivity worth. Following the changeover, adjuster rods cannot be retracted to compensate when fuel handling is unavailable. As a result, the system is required to be available to fuel at least every 33 hours or the reactor Units will de-rate. The original design requirement for the FH system availability was 70%, whereas the availability target is now 92%. Since the Pickering A FH systems are 35 to 40 years into their 40 year design life, component obsolescence and end of life issues present significant challenges in meeting the availability targets.

This project is an immediate priority due to continued FH system deterioration, known end of life components, and limited outage window availability to accommodate work without extending outage durations in the future. Since the Return to Service Project, Pickering A FH has seen its highest contributions to Forced Loss Rate (FLR):

- 36.2 days in 2008
- 0.5 days in 2009
- 17 days in 2010
- 6.7 days in 2011

With aging components and major obsolescence issues, this trend is estimated to increase and thereby pose a significant threat to the current Business Plan FLR targets of 42.4 days for 2012, 43.5 days for 2013 and 43.7 days for 2014.

As well as being a major contributor to units FLR, poor fuel handling system reliability also impacts station performance objectives. Unplanned fuelling unavailability disrupts scheduled maintenance. When fuel handling capability is restored, priority is given to fuel the unit for full power operation. As a result, scheduled maintenance is deferred, particularly channelized maintenance and testing.

Outage critical path schedule adherence is also affected by poor fuel handling reliability. Fuel handling supports outage execution by providing a platform for reactor inspection and maintenance activities as well as delivery of inspection tools. Fuel handling system unavailability has a direct and negative impact on critical path during these outages.

Furthermore, when irradiated fuel is stranded in the fuel handling systems as a result of breakdowns, the required repairs pose a significant radiological safety risk to our employees and an increase in public safety risk.

A review of the fuel handling systems based on INPO AP-913 (Equipment Reliability Process) was conducted to determine the scope of work required to achieve acceptable levels of reliability for the Pickering A Fuel Handling systems. The review identified equipment that are Single Points of Vulnerability (SPV) or equipment with a zero tolerance of unplanned failures. Any FH SPV equipment failures (within the scope of this project) would result in Unit shutdown(s) and/or de-rating(s).

The project scope focuses on the replacement, refurbishment and overhaul of SPV equipment of the Pickering A Fuel Handling System. Improvements to maintenance capabilities and routine maintenance (i.e. component replacements) will also be performed to ensure maximum gains in system availability and reliability until the end of station life.

The following activities have been completed using the Partial Release funding:

- Purchase order issued for major equipment/component procurement for Units 1 and 4 (except U1 Ball Nuts as no OEM vendor was available to supply these nuts at that time)
- Unit 4 and Unit 1 work plan preparation and assessment completed

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- Unit 4 Installation activities completed, except for the following:
 - Electrical Catenaries – due to material unavailability
 - Rolling Shield Gear Box – Obsolete part (spare gear box has now been obtained from Unit 3)
 - Y-drive Mitre box - due to material unavailability
- Return For Service (RFS) after Unit 4 SPVs replacement

The Partial Release was not fully spent due to the following:

- Some material was not available and could not be installed in P1141
- Labour cost less than estimated (reduced scope in P1141)
- Contingency not used

The P1141 OPEX has been incorporated into the remaining work scope. Some major OPEX includes:

- Thrust bearing – Use of manlifts to reduce time and dose.
- Configuration Issues on Y Drive alignment and elevator chain
- New Gear box rotation checks during installation
- FM Catenary Hoses – Alignment/Twists

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3/ ALTERNATIVES & ECONOMIC ANALYSIS:

\$ 000's	Base Case	Alt 1 (Recommended)		Alt 2	Alt 3	Alt 4	Alt 5
		Full Cost	Incremental Cost				
Revenue	(93,744)	(8,573)	(8,179)	(18,335)			
Base OM&A	0	0	0	0			
Outage OM&A				0			
Project OM&A	0	(7,006)	(6,952)	(7,006)			
Total OM&A	0	(7,006)	(6,952)	(7,006)	0	0	0
Provision							
Capital		(25,689)	(18,533)	(27,328)			
Present Value (PV)	(50,559)	(32,425)	(25,907)	(37,471)			
Net Present Value (NPV)	N/A	18,134	24,652	13,088			
Internal Rate of Return (IRR) %	N/A	11.0	20.3	10.3			
Discounted Payback (Yrs)	N/A	6.2	5.2	7.0			

Base Case: *× Not Recommended - Stop the Project*

Maintaining the status quo is not an acceptable option for the following reasons:

- FH Systems will continue to be a main contributor to Unit de-ratings and forced outages and result in large financial losses. The consequences include:
 - De-rating 10% of both Units 1 and 4 for two weeks per year due to unavailability of SPV parts in the FH systems.
 - 10% probability of one unit shut down for one month per year because of FH SPV equipment failures and spare parts unavailable.
 - 50% probability of one unit shut down for three weeks per year because of FH SPV equipment failures.
- Considering component obsolescence and unavailability of spare parts, the probability of equipment failure will continue to increase within the intended station life
- Failures will continue to disrupt Outage critical path and IOP scheduled activities
- With fuel handling equipment or system failures, there is an employee and public safety risk if irradiated fuel cannot be transferred to the appropriate location where adequate cooling is maintained

Alternative 1: *✓ Recommended - Replace/Refurbish/Overhaul SPV equipment*

The recommended alternative focuses on replacing the Single Point of Vulnerability (SPV) items identified by the Equipment Reliability Analysis Program as per AP-913 guidelines. This includes the development of Engineering Changes, procurement of long lead material and replacement and overhauling of life-expired FH equipment.

This option is recommended because:

- All business objectives are achieved
- It is in alignment with the Equipment Reliability Restoration Program (ERRP)
- It will help ensure current station FLR objectives and priorities are met
- It will contribute towards achieving FH equipment availability rate of 92%
- The P1211 and P1341 planned outages have sufficient windows for carrying out all installation work for Unit 1 and outstanding installation work for Unit 4

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The following assumptions were made with regard to Unit deratings/outages until the modifications are completed:

- De-rating 10% of Unit 1 for two weeks and Unit 4 for 1 week due to unavailability of SPV parts in the FH systems.
- 10% probability of Unit 1 shut down for one month and Unit 4 for 15 days per year because of FH SPV equipment failures and spare parts unavailable.
- 50% probability of one Unit 1 shut down for three weeks and Unit 4 for 10 days per year because of FH SPV equipment failures

The breakeven point for this alternative is 5.5 days FLR days per unit per year.

Alternative 2: × *Not Recommended* - Delay for 2 Years

Although this alternative satisfies all objectives of the project, it is not recommended because:

- Delaying the project will impact key business production objectives due to the high probability of existing Fuel Handling system equipment failure
- Any cost savings would be offset by the increased risk and consequence of forced outages due to equipment failure
- The delay period has a negative impact on the probability of aging equipment failure
- P1441 and P1511 outage windows may not be adequate for completing all installation activities which may result in an outage extension

4/ THE PROPOSAL

The following are the objectives and expected results (deliverables) for this Full Release BCS:

- Project Management Support
- Engineering Support
- Modification - SPV equipment replacement for Unit 1 and remaining work for Unit 4
- Stress Assessments
- Project Close Out

The following activities will be completed using the Full Release Funding:

- Capital Activities
 - Purchase order issued for U1 Ball Nuts (deferred from partial release)
 - Design and procurement activities for TM Rotor Bearing Tooling and Replacement of U1 & U4
 - Unit 1 Installation activities during P1211
 - Unit 4 remaining work (Electrical Catenaries, Rolling Shield Gear Box, and Y-drive Mitre Box) during P1341 (deferred from 2011 outage)
 - Operations acceptance/RFS for Unit 1 and remaining work for Unit 4
 - Unit 1& 4 Design Close Out
 - Project Close Out
- OM&A Activities:
 - Ball Screw Stress Assessment
 - FM Pressure Boundary Stress Assessment
 - FM Carriage/Trolley Structure Stress Assessment

Please refer to Attachment "E" for detailed scope of the project.

Note:

The scope of the project is limited to SPVs (as listed in Attachment 'E') that have been determined to pose the greatest risk or have uncertainty that requires further assessment. Any additional equipment/component will be addressed under the FH/Station maintenance program. Ball screw and pressure boundary component analyses are included in the project scope; however if replacements are required a separate project will be initiated to complete the required work.

TM Overhaul (SPV 895) – The TM Rotor bearing replacement in U1 and U4 will be executed if it is determined that the condition of the bearings in U2 or U3 indicates the need for replacement. In situ inspection of the bearing in running units will result in high doses and high hazard work. Tooling will be developed to carry out in situ inspection in U2/U3. Based on the observed condition of the TM rotor bearing with similar service life in U2/U3, the decision will be made for the path forward for U1/U4. Specific contingency money is allocated if the TM Rotor bearings cannot be replaced in situ resulting the need to remove the TM from the unit. The plan is to develop tooling to replace bearings "in situ", practice on U2/U3 and execute in U1 and U4.

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5/ QUALITATIVE FACTORS

1. Improve FH System health and reliability by replacing SPV components.
2. Reduce risk of radiological dose to public and employees until end of station life.
3. Avoid disruption to Outage critical path and IOP schedule activities.

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6/ RISKS ANALYSIS (See Attachment D for details)

Low 1 to 3		Medium 4 to 9		High 10 to 25		Probability X Impact									
		Impact					Finance	Schedule	Quality	Corporate Reputation	Regulatory	Health & Safety	Environmental	Nuclear Safety	Risk Rating (1 to 25)
		1	2	3	4	5									
Probability	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		Mitigation	Specific Cont'ncy \$000's										
Cost a) The Project Charter identifies Fuel Transfer Mechanism Overhaul (SPV 875) as part of the scope. It is not conclusive if a complete overhaul is necessary to replace the TM Rotor Bearings. Additional funds will be required, if work to remove and/or overhaul the TM is to be completed.		1. Allocate specific contingency for Fuel Transfer Mechanism Overhaul (SPV 875) should it be required to remove it from the unit. 2. Develop tooling early so assessments can be performed ASAP to determine extent of work required for FTM.		Before	5,000	9	9								9
				After		4	4								4
b) Estimate is based on similar projects, first unit installation and consultations with other work groups involved. There is no OPEX available for some major works such as trolley bearings, electrical catenaries. Assessment cost estimates are of conceptual quality and may be conservative.		1. Use OPEX from first unit construction. 2. Allocate contingency to address over expenditures. 3. Monitor project costs on a weekly basis to avoid cost over runs.		Before		9	6								9
				After		4	4							4	
Scope: Scope of work is fairly well defined but there may be discovery issues during installation, such as unforeseen radiological hazards e.g. Hot particles and high dose situations. Discovery work may also require additional Design and Installation contract efforts.		1. Ensure Fuel Handling personnel reviews scope and assesses work to be completed. 2. Allocate contingency to address issues that may arise. 3. Obtain Radiation Protection input when preparing and assessing work plans to minimize/reduce radiation hazards. 4. Have all stakeholders perform walkdowns and conduct comprehensive Pre-job briefings. 5. OPEX		Before		3	9				6				9
				After		2	4					2			4

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Schedule Ability to complete the required prerequisite work at risk within the outage window. Above risks may result in outage extension or deferring of some work. Conflicting projects (i.e. ECI vs. FH SPV) will impact outage schedule and may result in outage extension or deferring of some work. Ability to complete the work is at risk due to critical material availability like Ball Nuts. OPEX from U4 modification, - changes in outage schedule, insufficient time allowed for FH to conduct testing, configuration issues, discovery work, legacy issues. All these can impact schedule (and cost).	1. Work closely with the Outage group and Fuel Handling to coordinate activities. 2. Engage Supply Chain to ensure all materials (including ball nuts) required for installation are available and ready for use. 3. Close coordination and field walkdowns. 4. General contingency added to address these risks. 5. OPEX from U4	Before		6	9							9
Resources Possibility of a change in personnel working on this project such that knowledge and experience from previous installation will not be fully applied. Station resources may be pulled to complete higher priority work during outages. OPEX from U4 modification – Maintenance Techs required to support troubleshooting, are not always available readily, causing delay.	1. Obtain early commitment from OPG resources i.e. Design, Field Eng and Station. 2. Fuel Handling Technical and Assessing units will assist and be consulted by projects group to help build expertise. 3. Use augmented staff or have additional budget to complete work. 4. Contractor Engaged	After		4	4							4
		Before		3	9	9						9
		After		2	4	2						4

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Quality Quality of design and manufacturing of ball nuts being installed may lead to “new” failure modes which may not show up during testing or commissioning. There is a possibility that new components may not be compatible with existing system. There will be a major schedule impact if issues with the components arise. OPEX from U4 modification – some quality issues with the new material	1. Use qualified and experienced vendors (on ASL) with access to quality manufacturing facilities. Engage OEM supplier for critical components. Request Supply Chain inspections at various stages in the production process. 2. Use OPEX from previous U4 FH maintenance/work. 3. Use lessons learned from previous Unit installation. Work plans updated with OPEX from U4 4. Employ strict quality control and testing of new components. 5. Save the old components, in case it is to be reused.	Before		3	9	9						9
	After		2	6	4						6	
Technical a) Hot spot in Unit 1 tensioning tower may affect conveyor cart overhaul work. Work will require additional Radiation Protection consideration and extra rigor.	1. Engage Radiation Protection and ALARA in advance to come up with strategy to complete work. 2. Consult Radiation Protection for preparation of work plans.	Before		6	9				6		9	
		After		3	6			3		6		
b) Configuration Issues	1. OPEX from U4 2. FH Technical Support to address ‘as found’ 3. General Contingency	Before		6	6						6	
		After		3	3						3	
c) Ball screw and pressure boundary component analysis and assessments will be done in this project There is a very low probability that replacements will be necessary.	Ball screw & Pressure boundary component replacement will be carried out as separate project, if required.	Before		8	10						10	
		After		2	4						4	

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7/ POST IMPLEMENTATION REVIEW

Type of PIR:	Targeted Final AFS Date:	Targeted PIR Approval Date	PIR Responsibility (Sponsor Title)
Comprehensive	31-Dec-13	30-Jun-14	Fuel Handling Manager

	Measurable Parameter	<u>Current Baseline</u>	<u>Targeted Result</u>	How will it be measured?	Who will measure Person / Group?
1.	Forced Loss Rate due to Fuel Handling	FLR 3% (2010) and trending upward	FLR <2%	FLR attributed to SPV failure	Fuel Handling Manager
2.	Replace/Refurbish/Overhaul SPV equipment identified in Project Charter	Equipment is at the end of design life	No SPV component failures leading to unit outage/ de-rating	Outages/De-rating contributed by SPV failures.	Fuel Handling Manager
3.	Availability of Fuel Transfer mechanism	Equipment is at the end of design life. Condition of bearings unknown.	Assessment completed and suitable actions taken to mitigate the risk.	FLR attributed to SPV failure	Fuel Handling Manager
4.	Life expectancy of Ball screws	Near end of design life. Remaining life expectancy unknown.	Assessment completed and remaining life expectancy known.	Assessment completion	Fuel Handling Manager
5.	Health of PB components and load bearing structures.	Near end of design life. Remaining life expectancy unknown.	Assessment completed and remaining life expectancy known.	Assessment completion	Fuel Handling Manager

APPENDIX "A"

GLOSSARY (acronyms, codes, technical terms)

AFS	Available for Service
ALARA	As Low As Reasonably Achievable
BCS	Business Case Summary
CMO	Contract Management Office
CNSC	Canadian Nuclear Safety Commission
COMS	Constructability, Operability, Maintenance, Safety
ECC	Engineering Change Control
EOL	End of Life
ERRP	Equipment Reliability Restoration Program
FH	Fuel Handling
FLR	Forced Loss Rate
FM	Fuelling Machine
FTM	Fuel Transfer Mechanism
INPO	Institute of Nuclear Power Operations
IOP	Integrated Operating Plan
IRR	Internal rate of return
NICR	Non-Identical Component Replacement
NPV	Net Present Value
OAR	Organizational Authority Register
OEM	Original equipment manufacturer
OM&A	Operation, Maintenance and Administration
OPEX	Operational Experience
OPG	Ontario Power Generation
PB	Pressure Boundary
PEP	Project Execution Plan
PIR	Project Implementation Review
REIS	Report of Equipment In Service
RFS	Return For Service
SCR	Station Condition Record
SPV	Single Point of Vulnerability

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APPENDIX "B"

Comparison of Total Project Estimates

\$ 000's		This Appendix compares the Total Project Estimate for each BCS										
BCS Type	Class	Mth	<i>Total Project Estimate (by Year incl Contingency)</i>							2017	Later	Total Project Est
			Yr	2011	2012	2013	2014	2015	2016			
Developmental	Capital	Jan	2011	8,000	14,500	500						23,000
Partial	Capital	Feb	2011	10,700	15,500	750						26,950
Partial	OM&A	Feb	2011	200	7,990							8,190
Full	Capital	Jan	2012	7,220	11,936	7,890	210					27,256
Full	OM&A	Jan	2012	54	6,952							7,006
												0

LTD Spent	Capital	Dec	2011	7,220								7,220
LTD Spent	OM&A	Dec	2011	54								54
LTD Spent												0

Comments:

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APPENDIX "C"

FINANCIAL MODEL – ASSUMPTIONS

Financial Assumptions:

Discount Rate:	7%	Cost Escalation (Yr)	3%	SR&D Opportunity	No
Progress Payments	No	Foreign Currency	No	Retainer Fee	No
Depreciation Rate (Capital)	Generating Equip 8%	PST	No	Interest Rate (Capital)	6%
Revenue Rate	Corp SEV	Leasing	No	Indexed Priced Contract	No

Comments:

Major assumptions about contribution of the FH system to unit de-rates/shutdowns used in the financial evaluation for the base case and Alternative 1 are listed in Section 3 "Alternative and Economic Analysis". These assumptions are based on available FLR data and OPEX from FH department.

Project Cost Estimate:

Design Complete:	100%	Fixed Price Contract	No	3rd Party Estimate	No
Quality of Estimate	Budget +30% to -15%	OPEX used	Yes	Lessons Learned	Yes
Similar Projects	Yes	Budgetary Quote	Yes	First Unit Actual Used	Yes
Firm Vendor Proposal	No	Cost Sharing	No	Competitive Bid	Yes
Reviewed by Sponsor	Yes	Fee for Service	No	Contracts in place	Yes

Comments:

Project cost estimate is based on man-hour commitment provided by various contributing groups such as Projects, Design, Field Engineering, Station resources, Contract Management Office and Project Management Office. The project estimate for remaining installation work is based on the first unit construction costs. There is no OPEX for some major work such as FT magazine bearing, electrical catenaries and assessments. No contracts are in place for stress assessment/analysis and quality of estimates is conceptual.

Rationale for Capital Cost Classification:

As per FIN-PROC-PA-003, this project qualifies for Capital funding since it involves the upgrade/replacement of a system that will contribute to extending the life of the asset.

Generation Plan Assumptions:

Station	Unit	EOL or Refurb	MW	Planned Outages for Project Work						
Pickering A	1	Jun-20	515	P1211						
	4	Jun-20	515	P1141	P1341					
Pickering B	5	Nov-18	516							
	6	Nov-18	516							
	7	Jun-20	516							
	8	Jun-20	516							
Darlington	1	Sep-16	878							
	2	Feb-18	878							
	3	Sep-19	878							
	4	Jan-21	878							

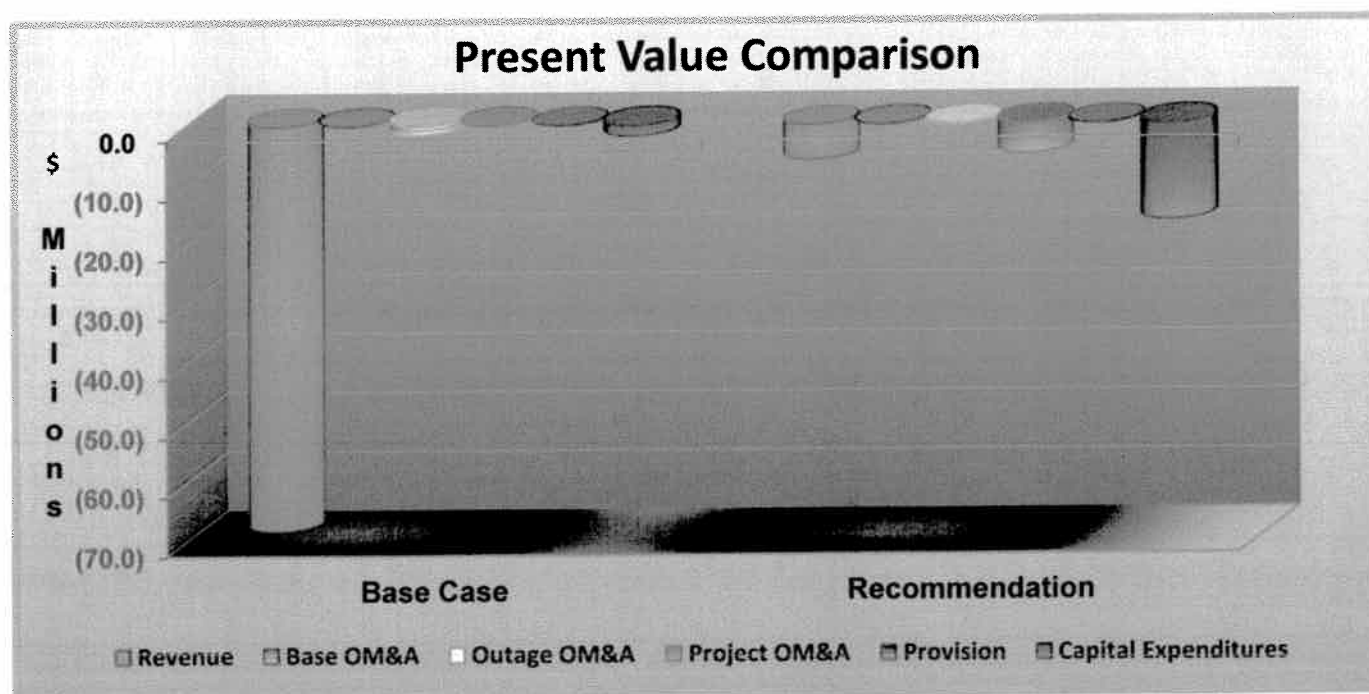
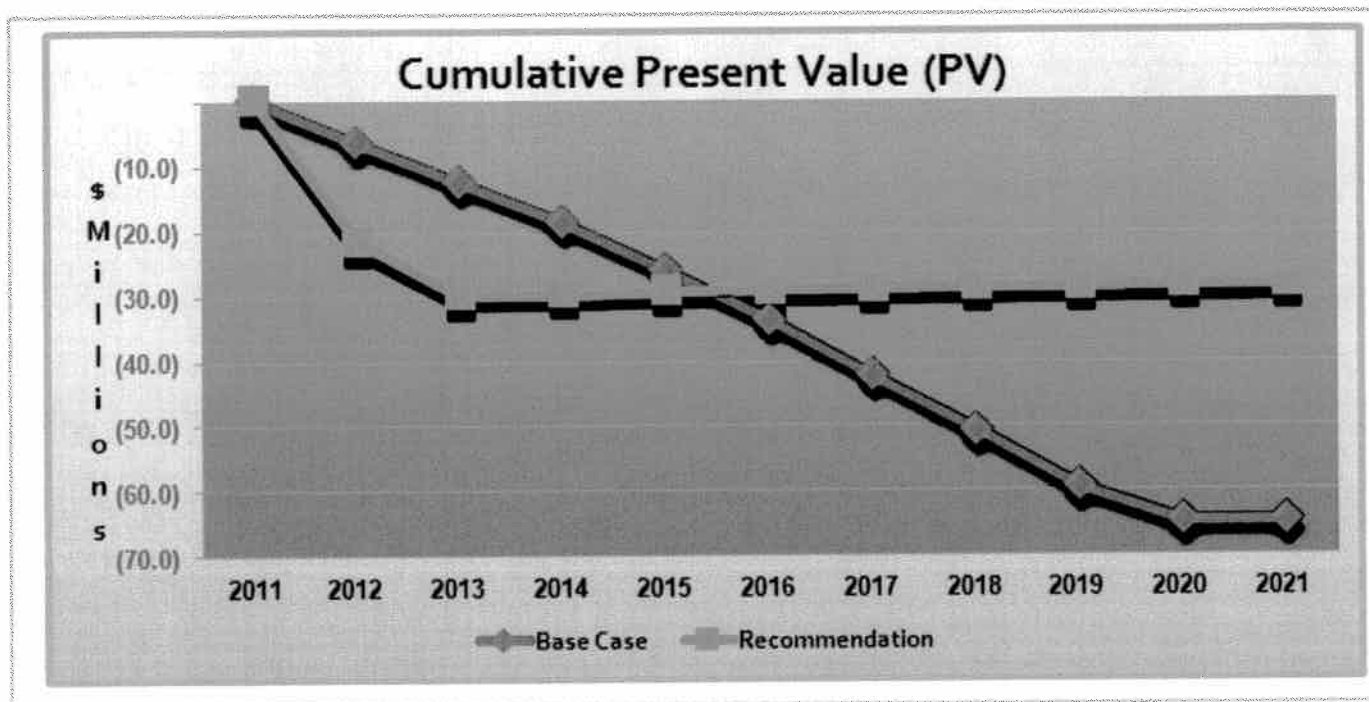
Comments:

If TM Rotor Bearing cannot be replaced in situ, then FT Mechanism replacement will need to be scheduled in a future outage.

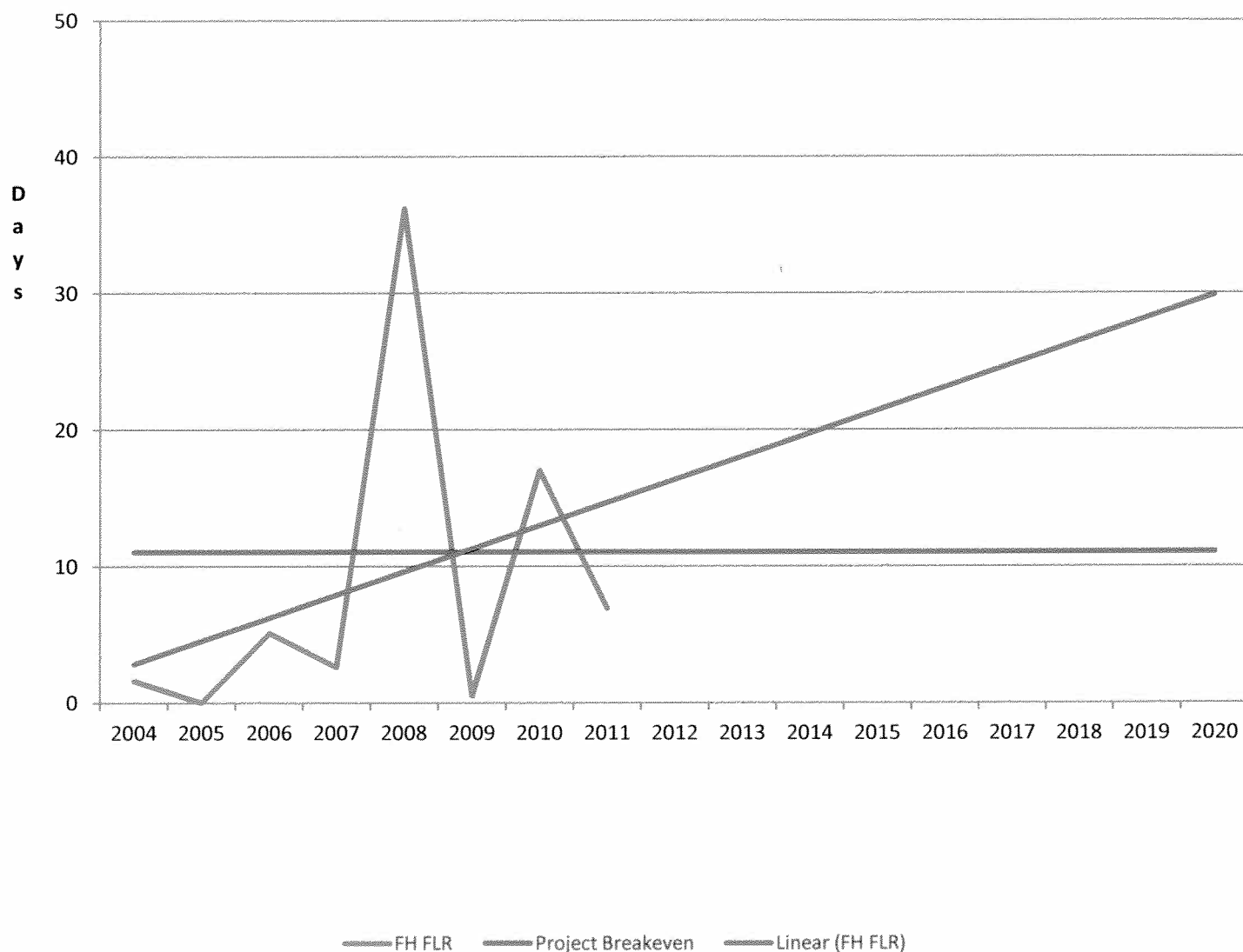
Pickering A Fuel Handling SPV Reliability Improvement 13 - 46634 (Capital) 13 - 46635 (OM&A)
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APPENDIX "D"

FINANCIAL MODEL – ASSUMPTIONS
Impact on Operations



PNGSA FH Equivalent Days Lost Generation



The number of days lost due to PNGSA fuel handling failures has been trending upwards since re-start in 2004. While some of the lost generation is due to failures other than SPV equipment, it is assumed that SPV equipment failures will be the predominant failure mode going forward. The breakeven point for this \$35M project is 11 days equivalent of lost generation due to fuel handling failures (or 5.5 days per unit).

**Pickering A Fuel Handling SPV Reliability Improvement 13 - 46634 (Capital) 13 - 46635 (OM&A)
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APPENDIX "E"

PROJECT DELIVERABLES

For this Release

Description	Item	Cost (\$000's)
Provide Project Mangement Support	Design Projects and Project Controls	1,185
	Project Close Out	67
Provide Engineering Support	Design and Drafting Support	564
	Design Agency Support	200
	Field Eng. Support	877
	EC Close Outs (U1 and U4)	87
Procurement	Unit 4 Materials	500
Construction	Installation of SPVs for Unit 1	
	TM Rotor Bearing Tooling Development	
	Installation of remaining SPVs for Unit 4	
	CMO, Rad Protection, ALARA	
Stress Assessments (OM&A)	Ball Screw	
	FM Pressure Boundary	
	FM Carriage Trolley Structure	
Interest	Capital Project	
Contingencies	General Contingency	
	Specific Contingency	
		23,088

PROJECT DELIVERABLES

From Partial Release (Jan 2012 – Mar 2012)

Description	Item	Cost (\$000's)
Provide Project Mangement Support	Design Projects and Project Controls, CMO, Rad Protection, Field Engineering	441
Provide Engineering Support	Design and Drafting Support	114
Procurement	Unit 1 Materials	2,263
Interest	Capital Project	
Contingencies	General Contingency	
		3,918

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Pickering A Fuel Handling SPV Reliability Improvement 13 - 46634 (Capital) 13 - 46635 (OM&A)
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ATTACHMENT "A"

PROJECT COST SUMMARY - 13-46634 (Capital)

\$ 000's Capital		LTD Dec 2011	2012	2013	2014	2015	2016	2017	Later	Total
Accounting Basis	Project Mgmt & Support	2,127	1,087	272	131					3,617
	Engineering	441	1,269	394	44					2,148
	Procurement	1,909	2,263	500						4,672
	Construction									
	Other									
										-
										-
	Interest (Capital Project)									-
	Project Costs									
	General Contingency									
	Specific Contingency									
	Project Costs	7,220	11,936	7,890	210	-	-	-	-	27,256

\$ 000's Capital		LTD Dec 2011	2012	2013	2014	2015	2016	2017	Later	Total
Funding Basis	Current Release	Project Costs								
		Contingency								
		Total								
	Adj to Current Release	Project Costs								
		Contingency								
		Total								
	This Release	Project Costs								
		Contingency								
		Total								
	TTD Released	Project Costs								
		Contingency								
		Total	7,220	11,936	7,890	210	-	-	-	27,256
	Future Releases	Project Costs								
		Contingency								
		Total	-	-	-	-	-	-	(0)	(0)
	Project Funding									
	Contingency Funding									
	Total Funding		7,220	11,936	7,890	210	-	-	-	27,256

Budget	2011 - 2015 Business Plan	7,220	8,100	600						15,920
	Variance to Budget	0	1,847	1,808	175	0	0	0	0	3,830

Other	Removal Costs (above)									-
	Inventory W / O									-
	Spare Parts in Invent									-

Reviewed by:

(Date)

Craig Verwey
Project Manager

FEB 10/12

Approved by:

(Date)

Nahil Rahman
Director - Pickering Projects

13 Feb 2012

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Pickering A Fuel Handling SPV Reliability Improvement 13 - 46634 (Capital) 13 - 46635 (OM&A) Full Release Business Case Summary NA44 - BCS - 35300 - 00004 - R000		

ATTACHMENT "A"

PROJECT COST SUMMARY - 13-46635 (OM&A)

\$ 000's Capital		LTD Dec 2011	2012	2013	2014	2015	2016	2017	Later	Total
Accounting Basis	Project Mgmt & Support	34	184							218
	Engineering	20	136							156
	Procurement									-
	Construction									-
	Other									-
	Assessments									-
	Interest (Capital Project)									
	Project Costs									
	General Contingency									
	Specific Contingency									-
Project Costs		54	6,952	-	-	-	-	-	-	7,006

\$ 000's Capital		LTD Dec 2011	2012	2013	2014	2015	2016	2017	Later	Total
Funding Basis	Current Release	Project Costs								
		Contingency								
		Total								
	Adj to Current Release	Project Costs								
		Contingency								
		Total								
	This Release	Project Costs								
		Contingency								
		Total								
	TTD Released	Project Costs								
		Contingency								
		Total	54	6,952	-	-	-	-	-	7,006
	Future Releases	Project Costs								
		Contingency								
		Total	-	-	-	-	-	-	-	-
	Project Funding									
	Contingency Funding									
	Total Funding		54	6,952	-	-	-	-	-	7,006

Budget	2011 - 2015 Business Plan	54	6,150							6,204
	Variance to Budget	0	170	0	0	0	0	0	0	170
Other	Removal Costs (above)									-
	Inventory W / O									-
	Spare Parts in Invent									-

Reviewed by:

(Date)

Craig Verwey
Project Manager

FEB 10/12

Approved by:

(Date)

Nahil Rahman
Director - Pickering Projects

13 Feb 2012

ATTACHMENT "B"

PROJECT VARIANCE ANALYSIS

	\$ 000's Capital	LTD Dec 2011	Total Project		Variance	Comments
			Last BCS Jan 2011	This BCS Jan 2012		
Scores Basis	Project Mgmt & Support	2,161	2,500	3,835	1,335	See comments below.
	Engineering	461	1,100	2,304	1,204	See comments below.
	Procurement	1,909	6,000	4,672	(1,328)	New estimate based on actual cost per OPEX from Unit 4.
	Construction					
	Other					
	Analysis/Assessments					
					-	
					-	
	Interest (Capital Project Only)				-	
	Project Costs (Scores Basis)					
Other	General Contingency					Less is required due to OPEX from unit 4.
	Specific Contingency					
	Project Costs (Scores Basis)	7,274	35,140	34,262	(878)	
	Removal Costs included above				-	
	Inventory to be written off				-	
	Spare Parts in Inventory				-	

Comments:

PM increase due to:

- Field Eng./Rad. Protection/PM costs under estimated in previous release
- Increase in original Project duration

Engineering increase due to:

- Field Eng./FH Technical Support costs now included here vs. PM support.
- Configuration/Engineering cost greater than original estimate
- Additional engineering work for revision to Non-Identical Component Replacement (NICR) to be completed for Electrical Catenaries due to configuration issues.

Construction increase due to:

- Increase in project duration and TM Rotor Bearing Tooling development
- CMO and Rad. Protection costs now included here vs. PM

**Pickering A Fuel Handling SPV Reliability Improvement 13 - 46634 (Capital) 13 - 46635 (OM&A)
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ATTACHMENT "C"

SCHEDULE

Key Milestones

Completion Date	Description
26-Sep-12	<u>Start of Installation, Unit 1, P1211 - SOI</u>
2-Jan-13	<u>Operations Acceptance/Readiness for Service for Unit 1 - AFS</u>
9-Oct-13	<u>Start of Installation, Unit 4 (remaining SPVs) , P1341 - SOI</u>
30-Dec-13	<u>Operations Acceptance/Readiness for Service for Unit 4 - AFS</u>
30-Dec-14	<u>Project Complete Milestone - PSM</u>

A Project Execution Plan (PEP) will be approved by 29-Feb-12

In Service Declarations: (Capital only)

Date	Description	\$000's (Total = Project Cost excl contg)	% In Service (= 100%)
31-Dec-11	SPV's in service in Unit 4 (P1141)	7,298	37
2-Jan-13	SPV's in service in Unit 1 (P1211)	10,426	53
20-Dec-13	Remaining SPV's in service in Unit 4 (P1341)	2,026	10
		19,750	100

Comments:

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Attachment "D"

Risk Probabilities Chart

Likelihood	Improbable	Unlikely	Possible	Likely	Probable
Probability	<= 1 in 100	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 month	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 related system
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 God	

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Attachment "E"

Project Scope

The project scope is divided between two funding classes, Capital and O&MA. Scope of work for each funding class is listed below:

Capital – SPV's Replacement:

I. U1/U4 Fuelling Machine SPV parts Replacement/Refurbish/Overhaul

- Y drive Pillow Block Bearings replacement (SPV#10)
- Y drive Mitre box replacement (SPV20)
- Guide Column Reducing gear box (SPV30)
- Guide Column Ball nuts overhauling and tooling development (SPV35)
- Modification and replacement of wiring harness (SPV 195-515)
- Replacement of Catenaries (SPV 565)

II. U1/U4 FM Vault SPV parts Replacement/Refurbish/Overhaul

- Rolling shield Reducing gear box (SPV40)
- Rolling shield Mitre box (SPV45)
- Rolling shield chains (SPV55)
- Rolling shield Pillow block bearings (SPV56)
- Rolling shield Couplings (SPV50)
- Rolling shield sprockets (SPV57)
- Thrust bearing (SPV610)

III. Fuel Transfer mechanism SPV parts Replacement/Refurbish/Overhaul

- Ferguson drive clutch & brake (SPV145)
- Cable harness (SPV 170-190, 471,472.1,473.1,474.1,476.1,477.1,478.1,479,481,482.1,483.1,484)
- Elevator carriage overhaul (SPV 585)
- Fuel transfer bearing cam follower (SPV590)
- Transfer mechanism Carriage bearing /bushing (SPV 595)
- TM Ferguson drive (SPV 600)
- Fuel Transfer mechanism Overhaul (SPV 875)

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- Elevator gear box (SPV 995)
- Elevator carriage (SPV 1000)
- Elevator top housing snout assembly (SPV 1005)
- Elevator top housing intermediate assembly (SPV 1006)
- Elevator top housing Take up assembly (SPV 1007)
- Elevator top housing sprocket (SPV 1010)
- Elevator top housing spherical roller bearing (SPV 1015)
- Roller bearing (SPV 1020)
- Elevator top housing sprocket assembly (SPV 1025)
- Elevator chain (SPV 1030)
- Elevator bottom housing sprocket (SPV 1035) (inspection only)
- 1&4-35230-DM2 (SPV 150)

IV. Irradiated fuel bay SPV parts Replacement/Refurbish/Overhaul

- Conveyor Cart Overhaul and develop tooling (SPV 580)

V. Stress analysis of FM pressure boundary and load bearing components for life extension.

- Carriage/Trolley load bearing structure/welds SPV 130
- FM Pressure Vessel SPV 135

VI. Non SPV oil Catenaries

- Oil Catenaries SPV 956

VII. Non SPV D2O Catenaries

- D2O Catenaries SP V957

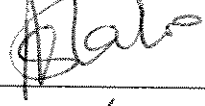
OM&A – Assessments:

- I. Ball Screw Stress Assessment
- II. FM Pressure Boundary Stress Assessment
- III. FM Carriage Trolley Stress Assessment

BUSINESS CASE SUMMARY

Standby Generator Governor Upgrades Pickering B 13 - 49109 Capital 13 - 40528 OM&A

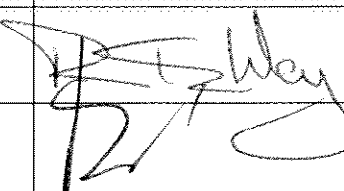
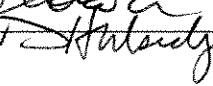
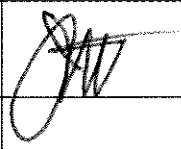
Full Release (Phase 2) Business Case Summary NK30-BCS-54600-00011-R000

<u>Routing</u>	<u>Location</u>	<u>Action</u>	<u>Signature</u>	<u>Date</u>
David Calkin, Project Leader, Design Projects 701-3831	P72-3	Prepare BCS		Jan 30 2007
George Makdessi Project Manager, Design Projects 701-6617	P72-3	Review BCS		30 Jan 2007
Joseph Leung Section Manager, Project Design 701-2635	P72-3	Review BCS		Jan 30 2007
Sepehr Ghorashi Section Manager, Process Scheduling 701-4491	P72-3	Review BCS		2007/01/30
Randy Ludlow Manager, Design Projects - Strat IV 701-8055	P72-3	Review BCS		2007/01/31
Alnoor Bhaloo Manager, Perf Engineering - Strat IV 701-3562	P41E3	Review BCS		2007/02/02
Mark Arnone Director, Projects & Mods 701-6063	P72-1	Review BCS		02 FEB 2007
M. Elliott <i>Bob Goodman</i> Director Station Engineering 701-7078	P41-E3	Review BCS		Feb 2 2007
Ron Ball Senior Financial Analyst 702-4084	P82-3	Review BCS		2 Feb 07
R. Ball Senior Financial Analyst 702-4084	P82-3B6	Return For Distribution		

BUSINESS CASE SUMMARY

Standby Generator Governor Upgrades Pickering B 13 – 49109 Capital 13 – 40528 OM&A

Full Release (Phase 2) Business Case Summary NK30-BCS-54600-00011-R000

<u>Routing</u>	<u>Location</u>	<u>Action</u>	<u>Signature</u>	<u>Date</u>
R. Leavitt Director Investment Planning	P82-3	Review BCS		Feb 6, 2007
P. Tremblay Senior V. P. Pickering B	P41-E3	Submit BCS		Feb 7/07
J. Beech V.P. Nuclear Finance	H7-E19	Review BCS		Feb 7/07
T. Mitchell Chief Nuclear Officer	P82-6	Review BCS		Feb 8/07
D. Power V. P. Corporate Investment Planning	H7-D06	Approve BCS		Feb 18/07
P. Charlebois Chief Operating Officer	H19-E21	Review BCS		Feb 20/07
J. Hankinson President & C.E.O.	H19-A24	Approve BCS		Mar 5/07
R. Ball Senior Financial Analyst 702-4084	P82-3B6	Return For Distribution		

Standby Generator Governor Upgrades Pickering B 13 - 49109 Capital 13 - 40528 OM&A

Full Release (Phase 2) Business Case Summary NK30-BCS-54600-00011-R000

1/ RECOMMENDATION:

We recommend a Phase 2 release of \$8.8M (total project \$23.3M) to complete the design, comprehensive installation work packages and installation/commissioning of governors on the remaining four (of six) Pickering B Standby Generators (SG's).

This project is one of five SG Upgrade projects designed to reduce the likelihood of a forced outage due to SG obsolescence and spare parts unavailability that has been negatively impacting reliability. The scope of these projects was based on a Pratt & Whitney (P&W) report IMR # 510 issued in May 1999 which focused on equipment obsolescence issues and the OEM's inability to support critical products. Phase 2 of this project (\$8.8M) and the Protective Relay project (\$1.8M) are the two outstanding initiatives of the overall program that is estimated to cost \$50M. We have a REGM target to complete this work by Dec 31, 2007.

Prior to the start of this initiative, Pickering B SG performance indicated a deteriorating trend. We were not able to consistently meet the design basis SG start reliability. Approximately 70% of the total SG trips identified in the P&W report could have been prevented by the SG Governor upgrade by ensuring consistent SG starting time bench marks within the start permissive logic. Continued degradation has the potential of severe, protracted adverse impact on SG performance and forced unit outages due to unavailability of Standby Class III Power redundancy. Forced shutdowns of operational Nuclear units can occur when SG unavailability is combined with other safety support system degradation, functional failures or operational restrictions (such as Class II UPS and SES).

At this time, two (2) Governors have been installed, placed in service, and a Post Implementation Reviews (PIR) has been completed. We have seen improvements in SG performance, as work has progressed and the SG health system has recently changed from RED to WHITE. Project completion is a requirement to maintain system health WHITE assessment. The total project estimate has increased \$1.2M to \$23.3M, due primarily to Vendor QA issues, material costs, and underestimated design costs. Lessons learned from Phase 1 have been incorporated into the Phase 2 estimate.

The current Integrated Operating Plan (IOP) schedule calls for the completion of four (4) SGs in 2007. However, due to the degree of difficulty in executing four installations in one year, we are recommending the installation of three (3) governors in 2007 and one early in 2008. This will involve an adjustment to the IOP schedule and an extension to the REGM commitment. However, if conditions prove favourable, we will install four (4) units in 2007.

\$000's (incl contingency)	Funding	LTD 2005	2006	2007	2008	2009	2010	Later	Total
Currently Released	Full - Phase 1	2,672	8,850	2,969	-				14,491
Requested Now	Full - Phase 2	-	(1,186)	6,984	3,042				8,840
Future Funding Req'd	None								-
Total Project Costs		2,672	7,664	9,953	3,042	-	-	-	23,331
Other Costs									-
Ongoing Costs									-
Grand Total		2,672	7,664	9,953	3,042	-	-	-	23,331
Investment Type Sustaining		Class Cap & OM&A		Breakeven Level of Risk 5.2% forced outage		IRR N/A		Discounted Payback N/A	

Submitted By:

Pierre Tremblay
Pierre Tremblay
Senior Site Vice President, Pickering B

Date:

Approved by:

T.N. Mitchell
T.N. Mitchell
Chief Nuclear Officer

Finance Approval:

D. Power
D. Power
V. P. Corporate Investment Planning

Date:

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

Jim Hankinson
Jim Hankinson
President and CEO

Date:

2/ BACKGROUND & ISSUES

The Standby Generator Health system was rated as RED as recently as Q1 2006 due to functional failures on aging parts that are obsolete and no longer supported by the OEM. Over the last few years the SGs have experienced a number of functional failures that contributed to forced outages. The functional failures reduce redundancy and potentially could lead to a Pickering B units shutdown. Recent upgrades and maintenance have improved the system health rating from RED (Q1) to YELLOW (Q2/3) to WHITE (Q4). Project completion is required to ensure system reliability and resolve obsolescence of the governor system which is not supported by the OEM.

The SG system is an essential safety related support system which supplies Class III power to the electrical equipment required to ensure a safe shutdown of the reactor; continuous core cooling, and supply to essential loads in the turbine, water and air systems, in the event of loss of Class IV power. There are three SGs that support each pair of Pickering units (i.e. 056-54600-SG1/SG2/SG3 supports Units 5 & 6, and 078-54600-SG1/SG2/SG3 supports Units 7 & 8).

As per Abnormal Incidence Manual (NK30-AIM-058-09013-04.01), following are the impairments for the Standby Generator system:

- Coincidental unavailability of three SGs per pair of units will result in SG system impairment (system does not meet design intent). In this impairment, both Pickering B affected Units need to be shutdown within 24 hours unless approval has been given by the Duty Manager for continued operation beyond 24 hours. The minimum system requirement is to have at least one SG available per pair of units.
- If two of the three SGs are unavailable per pair of units, the system will be considered to have reduced redundancy or margin of safety and required action will be to suspend testing of remaining SGs and repair to be carried out on high priority basis for the affected SG.
- If one of the three SGs is unavailable per pair of units, the system will be considered to have reduced redundancy or margin of safety and required action will be to suspend non-emergency operation of remaining SGs above 3.5MWe in peaking mode and repair to be carried out on high priority basis for the affected SG.

The following projects represent the Pickering B SG Upgrade program:

Pickering B Standby Generator Upgrade Projects				
49033	SES/HPECI Power Supply Upgrade	Capital	12.7	Complete
49088	Standby Generator Upgrade	OM&A	1.0	Near Completion
40412	Standby Generator Upgrade	Capital	11.0	Near Completion
40628	New Protective Relays	Capital	1.8	Developmental Stage
49109 /40528	Standby Generator Governor Upgrade	Capital / OM&A	23.3	2 of 6 complete
Total			49.8	

See Attachment 'D' for summary of Pickering B SG functional failures extracted from the System Health Report.

3/ ALTERNATIVES AND ECONOMIC ANALYSIS

\$ '000's	Stop the Project	Alt 1 (Recommended)		Alt 2	Alt 3	Alt 4	Alt 5
		Full Cost	Incremental Cost	Delay 1 yr			
Revenue	(16,265)	(1,857)	(1,857)	(3,778)			
OM&A	(9,847)	(2,466)	(2,007)	(2,316)			
Capital	1,477	(22,872)	(12,995)	(13,385)			
NPV (after tax)	(12,401)	(20,782)	(12,401)	(13,353)			
Impact on Economic Value (IEV)	N/A	(8,381)	-	(952)			
IRR%	N/A	N/A	N/A	N/A			
Discounted Payback (Yrs)	N/A	N/A	N/A	N/A			

Stop the Project - Not Recommended

This is not recommended as we are at risk of an unplanned SG outage or possible forced unit outage due to SG obsolescence and a lack of spare parts. Moreover, the REGM commitment would not be addressed and we would have to write approximately \$ 5.4 M of capital charges off to OM&A

Alternative 1 - Proceed with Project - Recommended

Proceed with upgrades to the SG Governor system and related controls as outlined in section 4 below to reduce the increasing likelihood of an unplanned SG outage or forced unit outage. Because we cannot effectively install more than 3 governors this year, we will need to seek an extension to our REGM commitment and complete the final installation early in 2008. Completion of this work and the Protective Relay project will finalize the upgrades to the Pickering B Standby Generators and thereby remove the threat of a forced outage, maintain the Health System at white and satisfy a REGM commitment.

Due to the complexity of such an event (see Background Section), the likelihood of a forced outage due SG failure is not easily estimated. Lacking an accurate way to determine this level of risk, financial justification must be made on an assessment of whether there is a reasonable chance that the breakeven point for the incremental investment will be surpassed. Calculations indicate that the breakeven point is reached when the likelihood of a forced 30 day outage (involving 2 units) is 5.2% and the cost to repair is \$300K. Based on past SG performance (see Attachment D), we feel it is reasonable to assume that we would likely surpass this level of risk, should the investment not be made. Moreover, it makes sense to complete the last major initiative of the \$50M SG Upgrade program, so that we can realize the overall objective of SG reliability.

Alternative 2 - Delay Project - Not Recommended

This is not recommended as there is an increasing likelihood of an unplanned SG outage / forced unit outage and we would not be addressing the REGM commitment.

Alternative 3 - Install 2 of the remaining 4 - Not Recommended

Modifying only 2 of the remaining 4 Pickering B SG's is not recommended for the following reasons:

- OPG is locked into an Engineered Material Vendor contract totaling all six SG's (as per previous release),
- Increased likelihood of error when performing SG maintenance, as there would be two designs.
- Increased documentation effort as all the operating and maintenance documentation would need to reflect two designs.
- 68 percent of the project cost is with the first two SG's.

4/ THE PROPOSAL

We recommend continuing with the replacement of the existing SG Governor, sequencing/control relay logic, fuel delivery package and associated I&C monitoring for the remaining four Pickering B SGs.

Scope Breakdown:

Governor fuel delivery system replacement
New PLC based integrated governor and sequencer controls
Replace majority of the relay start/control logic with PLC
Independent over speed protection system (due to adoption of PLC)
Relay logic changes covered by Pratt & Whitney Study Report IMR 510
PLC based speed switches and timers
New Data event logger with expansion capabilities
New Machine monitor (temperature and vibration)

Phase II major project deliverables are as follows:

- (a) Update Project Execution Plan
- (b) Revise Vendor design packages as required
- (c) Complete Design Packages for remaining two SG's (first four SG's completed under Phase I)
- (d) Work Plans and Field Engineering Packages for remaining four SG's
- (e) Systems and equipment installation and commissioning remaining four SG's
- (f) New and/or revised Operating and Maintenance Procedures for remaining SG's.
- (g) Project close out – station document updates, PASSPORT updates
- (h) Post implementation review, lessons learned

The SG Governor Upgrade Project Execution Plan (PEP) NK30-PEP-54600-00001 defines the project scope to complete the deliverables. Finish dates in future based on current SG outage schedule. Should outages move, dates will vary accordingly.

5/ QUALITATIVE FACTORS

1. Lower system maintenance costs (Governor and logic failures being minimized) with the new Governor and start/control logic.
2. Improved diagnostic capabilities using new data logger and machine monitor, thus reducing forced SG outage troubleshooting times.
3. Elective and Corrective Maintenance backlogs expected to decrease due to replacement of instrumentation and components

6/ RISKS

Description of Risk	Description of Consequence	Risk Before Mitigation	Mitigating Activity	Risk After Mitigation
Cost				
Additional material may be required depending on as found condition of machine when disassembled for the retrofit modification.	Added material costs to replace broken or unusable existing equipment.	Medium	Added \$211K specific contingency for materials	Low
Increased OPG installation package preparation and design review costs due to Vendor documentation QA issues.	May not be able to complete installation packages within budget and schedule.	Medium	\$209K Specific Contingency included for increased installation package preparation effort. OPG Supply Chain working with the Vendor to improve documentation QA through OPG corrective action process. Incorporating Lessons Learned.	Low
Scope				
May need to account for field discovery during installation phase.	Delay completion of tasks. May not be able to complete scope within allocated budget.	Medium	\$499K Specific Contingency included for Installation to minimize impact. Design phase comprehensive walkdowns complete. Increase scope only with management approval and funding allocation. Incorporating Lessons Learned.	Low
Integration complexities with SG Upgrade project and other Maintenance.	Delay completion of tasks. May not be able to complete scope within allocated budget.	Medium	Specific Contingency included for Installation (see above) to minimize impact. Integrated work programs of SG Governor & SG Upgrade projects and station maintenance. Multiple station challenge reviews conducted. Incorporating Lessons Learned.	Low
Schedule				
REGM commitment for Dec07 at risk (aggressive station SG outage schedule).	Project may not meet current REGM deadline	High	REGM commitment date to be reviewed and extended as required.	Low
Station driven SG Outage	IOP process not being followed for	High	General contingency includes amounts for	Medium

BUSINESS CASE SUMMARY

schedule and SG outage maintenance window is very aggressive with little contingency. SG outage opportunities may change.	design issuance milestones and installation package preparation. Delay installation and SG return to service. May not be able to complete scope within allocated schedule windows and budget.		minor delays for the remaining 4 SG's. Many challenge reviews conducted to minimize hand-off / turn-over delays. Increased pre-outage preparation planning. Incorporating Lessons Learned. Recommend adding \$2.8M to 2008 B.P. budget against final SG installation delays to 2008. To be reviewed during 2008 Business Planning. Risk remains medium.	
Delays caused by maintenance activities (unforeseen work) during SG outages could affect SG outage schedule	Delay installation. May not be able to complete scope within allocated budget.	Medium	Project integrated into station SG maintenance program. Added minor contingency to project schedule. Covered by Specific Installation Contingency discussed on previous page.	Low
Resources				
Limited engineering resources. Other project priorities.	Delay completion of scope. Impact on design schedule for subsequent SG's.	Medium	Use contract resources, if necessary.	Low
Limited installation resources (BTU and PWU). Competing with SG Upgrade project and other maintenance programs. Limited Ops resources during commissioning.	Delay installation	Medium	Use contract resources, if necessary. General contingency includes overheads to administer contracts. Pre-arranged Ops support including a SPOC prior to outage. Permit walkdown prior to outage.	Low
Engineered Material Vendor resources diverted to other contracts. Vendor has access to limited resources and has limited project management skills.	Delays in subsequent design packages for remaining SG's. Delays in testing and material delivery	High	OPG added resources to assist Vendor in project co-ordination. Vendor added technical and project management resources. Vendor advancing production schedule for remaining SG's. Supply Chain exploring other contractual remedies.	Low
Technical				
Commissioning / testing of complete modification on subsequent SGs. Possible software modifications during commissioning.	Delay return to service due to cumbersome SQA field change process. SG unavailability combined with other safety support system degradations (i.e., UPS, SES) may cause forced unit shutdowns.	Medium	Minor schedule and cost contingency added (see specific contingency on previous page). Design verifications, simulations and comprehensive FAT prior to installation. Independent verification of software and hardware design. Software Field Change process developed with Computer Design Group to enable parallel Software	Low

BUSINESS CASE SUMMARY

			verification with field implimentation. Incorporating Lessons Learned.	
Regulatory				
None.				
Environmental				
Scrapping of old material	Environmental regulatory non-compliance	Medium	Material to be sampled and scrapped in accordance with approved procedures.	Low
Health & Safety				
None.				
Investment				
Project does not satisfy the Business Objectives	Rework, extra cost	Low	The first two governors have been installed and are operating as designed	Low

7/ POST IMPLEMENTATION REVIEW PLAN

Type of PIR:	Targeted Final AFS Date:	Targeted PIR Approval Date:	PIR Responsibility (Sponsor Title)
Simplified	Jun 2008	Dec 2008	Director - Station Engineering

Comments:

	Measurable Parameter	Current Baseline	Targeted Result	How will it be measured?	Who will measure it? (person / group)
1.	Available For Service (first 2 SG's)	N/A	AFS and open items acceptance by stakeholders	Attach copy of AFS and open items with A/R's to PIR	System Engineer
2.	SG Machine performance Criteria Met	N/A	Commissioning results acceptance by Design	Signed Commissioning Report scanned in Passport	Project Manager
3.	Standby Generator (SG) System Health	Red	Removal of SG Governor and associated control systems as contributor to Red system status	Updated SG system health report indicating improved status for affected equipment	System Engineer
4.	REGM 28007285 complete	Dec 2007	SG Governor Project contribution to REGM completion	SMB REGM schedule review Milestone added to SG Outage Plan	Project Manager
5.					

Appendix "A"

Glossary (acronyms, codes, technical terms)

AFS	Available for Service
BCS	Business Case Summary
B.P.	Business Plan
BTU	Builders Trade Union
COMS	Constructability, Operability, Maintainability, Safety
CUSW	Direct Hire Building Trade Union (Electrical)
CWP's	Comprehensive Work Packages
DCN	Design Change Notice
ECC	Engineering Change Control
EPG	Emergency Power Generator
FAT	Factory Acceptable Test
FE	Field Engineering
FIPR	Field Installation Package Release
FME	Foreign Material Exclusion
HFE	Human Factors Engineering
IOP	Integrated Operating Plan
ITP	Inspection Test Plan
I&C	Instrumentation and Controls
IRR	Internal Rate of Return
NUCORDS	Nuclear Components Reliability Data System
NPV	Net Present Value
OAR	Organizational Authority Register
OLW	Online Wiring
OM&A	Operations, Maintenance and Administrative expense
ONL	Online Wiring
OPEX	Operating Experience
Ops	Operations
O.T.	Overtime
PC1	Worker Protection Permit application Form
PEP	Project Execution Plan
PIR	Post Implementation Review
PFU	Predicted Unavailability Factor
PINO	Performance Improvement Nuclear Oversight
PLC	Programmable Logic Control
PSL	Power Supply List
PWU	Power Workers Union
QA	Quality Assurance
QCIV	Quality Control Inspection Verification
QSITP	Quality Surveillance Inspection Test Plan
REGM	NSC Management Commitment
SCR	Site Condition Report
SE's	System Engineer
SES	Site Electrical System
SG	Standby Generator
SMB	Site Management Board
SPOC	Single Point of Contact
SQA	Software Qualification Assurance
TSSA	Technical Safety Standards Authority
UPS	Uninterruptible Power Supply

BUSINESS CASE SUMMARY

Appendix "B"

Project Funding History

\$ 000's		All Existing and Planned Releases (incl contingency)								
Release Type	Month	Year	Cumulative Values							
			2002	2003	2004	2005	2006	2007	2008	Later
Developmental	Jul	2,002	300							
										300
Full (Phase 1)	Apr	2,004	87	0	1,010	7,712				
										8,809
Superseding	Feb	2,006	87	0	372	2,213	8,850	2,969	0	
										14,490
Full (Phase 2)	Jan	2,007	87	0	372	2,213	7,664	9,953	3,042	
										23,331
										0
										0
										0
										0

LTD Spent	Dec	2,006	87		372	2,213	7,664			
										10,336

Comments:

Appendix "C"

Financial Model – Assumptions

Project Cost Assumptions:

Cost estimates have been verified by 3rd party reviewer, Atlas Helyar. Task Identification Sheets (N-Form-11025) have been validated by all contributing resource groups. Actuals and lessons learned have been incorporated into estimates.

Financial Assumptions:

The breakeven point for this investment is reached when the probability of a 2 unit forced outage of 30 days reaches 5.2% and the cost of repair accumulates to \$300K. This is based on the following:

Loss of Revenue during forced unit outages:

$(516\text{MW for PB}) \times (85\% \text{ Capacity Factor}) \times (24 \text{ Hours}) \times (30 \text{ Days}) \times (\text{Rate MWH}) \times (2 \text{ Units}).$

Repair Costs during forced SG outages:

\$300K per year + 3% inflation

Project / Station End of Life Assumptions:

Pickering B End of Life: 2014 Units 5, 6, and 7 2016 Unit 8

Energy Price / Production Assumptions:

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
56.2	58.2	57.0	55.6	54.4	54.2	56.3	60.2	64.4	67.1

Operating Cost Assumptions:

N/A

Other Assumptions:

N/A

BUSINESS CASE SUMMARY

Standby Generator Governor Upgrades Pickering B 13 - 49109 Capital 13 - 40528 OM&A

Full Release (Phase 2) Business Case Summary NK30-BCS-54600-00011-R000

Attachment "A"

Project Cost Summary

\$000's	LTD Prior Yr 2006	This Release 2007	This Release 2008						Later	Total
Capital & OM&A										
Project Management (OPG)	623	253	260	-						1,136
Engineering & Drafting (OPG)	1,874	1,018	374	-						3,266
Material	2,370	3,159	1,053							6,582
Installation - PWU, BTU	3,534	4,068	920							8,522
Contract - Design	495	57	4	-						556
Contract - Installation	386	264	86							736
Contract - Other	340	75	25	-						440
OMA Project 40528	459	-	-	-						459
										-
Interest (Capital Project Only)	255	249	74	-						578
Project Costs (excl contingency)	10,336	9,143	2,796	-	-	-	-	-	-	22,275
General Contingency		67	227							294
Specific Contingency		743	20							763
Project Costs (incl contingency)	10,336	9,953	3,042	-	-	-	-	-	-	23,331
2007-2011 Business Plan	10,336	7,083	2,230	-						19,649
Variance to Business Plan	-	2,060	566	-	-	-	-	-	-	2,626
Committed Cost										-
Inventory Write Off Required										-
Spare Parts / Inventory										-
Total Release (excl contingency)	10,336	9,143	2,796	-	-	-	-	-	-	22,275
Total Release (incl contingency)	10,336	9,953	3,042	-	-	-	-	-	-	23,331
Ongoing OM&A (non-project)										-
Removal Costs (incl in above)										-

Basis of Estimate

Design Complete	100%		Quality of Estimate		Release + 15% to - 10%
3 rd Party Estimate	Yes	OPEX used	Yes	Lessons Learned	Yes
Reviewed by Sponsor	Yes	Budgetary Quote(s)	Yes	Phase 1 Actual Used	Yes
Similar Projects	Yes	Contracts in place	Yes	Competitive Bid	Yes

Variance to Business Plan

The estimated variance(s) to the 2007-2011 Business Plan will be addressed through the portfolio management process. A PCRAF will be approved by Apr 2007.

Reviewed By:



George Makdessi
Project Manager

30 Jan 2007

Date:

Approved By:



Randy Ludlow
Eng & Mods Manager (Strat IV)

31 Jan 2007

Date:

Standby Generator Governor Upgrades Pickering B 13 - 49109 Capital 13 - 40528 OM&A
Full Release (Phase 2) Business Case Summary NK30-BCS-54600-00011-R000

Attachment "B"

Project Variance Analysis

Capital & OM&A	LTD Dec 2006	Total Project		Variance	Comments
		Last BCS Feb 2005	This BCS Jan 2007		
Phase 1					
Project Management (OPG)	623	668	623	(45)	As per actuals
Engineering & Drafting (OPG)	1,874	1,518	2,039	521	Vendor software changes QA, Rework, Field Changes
Material	2,370	5,667	6,142	475	Commissioning Supp from Vendor, Increases to Misc Matl
Installation -- PWU, BTU	3,534	3,654	3,735	81	As per actuals
Contract - Design	495	322	502	180	As above
Contract - Installation	386	260	392	132	056-SG3 Outage start delays, ES Fox/Crosby Dewar Increased Costs due to design changes.
Contract - Other	340	302	340	38	Training materials and hardware costs
OMA Project 40528	459	459	459	-	Sunk costs of previous OM&A project
Interest (Capital Project Only)	255	258	255	(3)	As per Actuals
Phase 1 (excluding contingency)	10,336	13,108	14,486	1,378	
General Contingency		242	-	(242)	Materialized risk as outlined in last BCS brought into budget.
Specific Contingency	-	1,140	-	(1,140)	Materialized risk as outlined in last BCS brought into budget
Phase 1 (incl contingency)	10,336	14,490	14,486	(4)	

Phase 2

Project Management (OPG)	-	238	513	275	Outage Delays and increased support of Vendor
Engineering & Drafting (OPG)	-	450	1,227	777	Adjustments as per lessons learned and increased review effort of vendor design and field changes
Material	-	186	440	254	Commissioning Support from Vendor, Increased Misc Matl costs (lessons learned)
Installation -- PWU, BTU	-	4,650	4,787	137	Adjustments as per lessons learned
Contract - Design	-	49	55	6	Adjustments as per lessons learned
Contract - Installation	-	393	344	(49)	Adjustments as per lessons learned
Contract - Other	-	100	100	-	
OMA Project 40528	-	-	-	-	
Interest (Capital Project Only)	-	174	323	149	Cash Flow adjustments
Phase 2 (excluding contingency)	-	6,240	7,789	1,549	
General Contingency		1,409	86	(1,323)	Incorporation of lessons learned.
Specific Contingency		-	970	970	Identified risks going forward
Phase 2 (incl contingency)	-	7,649	8,845	1,196	

Total Project (incl contingency)	10,336	22,139	23,331	1,192	
General Contingency		1,651	86		
Specific Contingency		1,140	970		
Total Project (excl contingency)	10,336	19,348	22,275	2,927	

Comments:

Attachment "C"

Key Milestones

Completion Date			Description
Day	Mth	Yr	
15	Apr	2007	Revise PEP
09	Feb	2007	5th SG Detailed Design Package 056SG2
07	May	2007	6th SG Detailed Design Package 078SG2
19	Feb	2007	056-SG1 (3rd SG) Installation Start (T-0)
07	May	2007	078-SG1 (4th SG) Installation Start (T-0)
22	Oct	2007	056-SG2 (5th SG) Installation Start (T-0)
15	Feb	2008	078-SG2 (6th SG) Installation Start (T-0)
10	Apr	2007	056-SG1 (3rd SG) AFS
06	Jul	2007	078-SG1 (4th SG) AFS
21	Dec	2007	056-SG2 (5th SG) AFS
7	Apr	2008	078-SG2 (6th SG) AFS
30	Dec	2008	Project Complete

A Project Execution Plan (PEP) will be approved by 2007

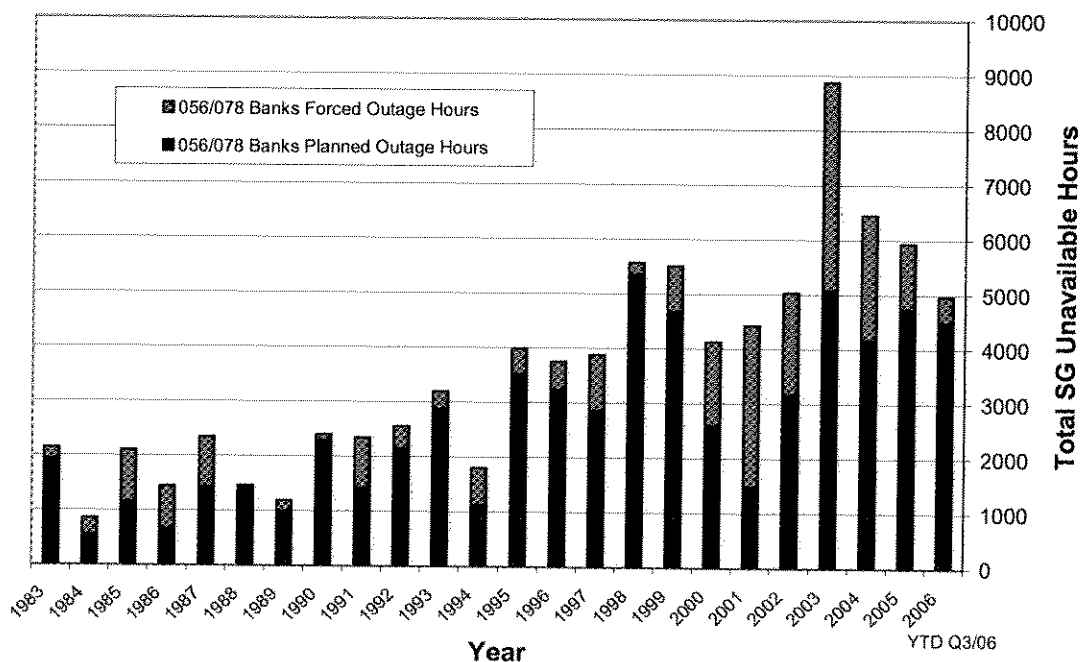
Comments:

Attachment 'D'

Pickering B Standby Generator 2005 & 2006 Failures / SCR Summary

Functional Failures (QTR/2YR)	Common		056 SGs		078 SGs		Overall System Health
	Qtr	2 Yr	Qtr	2 Yr	Qtr	2 Yr	
Q1 2005	0 →	0	0 ↓	9 ↓	2 ↑	17 →	RED
Q3 2005	0 →	0	1 ↓	6 ↓	1 ↓	16 ↓	RED
Q2 2005	0 →	0	2 ↓	6 ↓	2 ↓	16 ↓	RED
Q4 2005	0 →	0	0 ↓	6 →	1 →	16 →	RED
Q1 2006	0 →	0 →	0 ↓	4 ↓	0 →	14 ↓	RED
Q2 and Q3 2006	0 →	0 →	0 ↓	4 ↓	0 →	14 ↓	YELLOW
Q4 2006	0 →	0 →	0 →	1 ↓	0 →	7 ↓	WHITE

**Pickering B SG Unavailable Hours per Year
(Planned vs Forced/Outage Extension)**



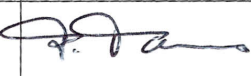
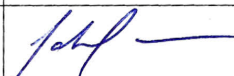
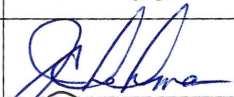
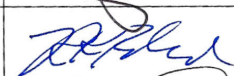
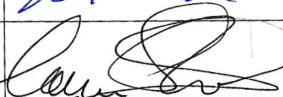
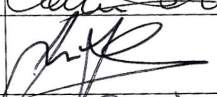
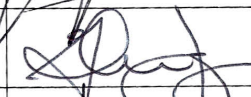
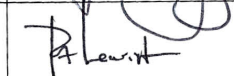
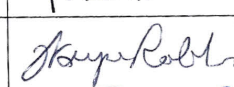
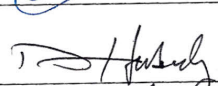
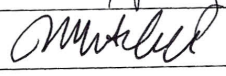
ENGINEERING & MODIFICATIONS BUSINESS CASE SUMMARY

Event Date	SCR	Equipment / Event Summary
Jan 04, 2005	P-2005-00131	056-54600-SG3 tripped during start-up of pre-outage test run on "PT Exhaust Temp.
Jan 18, 2005	P-2005-01151	078-54600-SG2 tripped during start-up of routine P-07 test run.
Feb 13, 2005	P-2005-02699	078-54600-SG2 tripped on "DC Lube Oil Pump Failure" during U7 P-05 routine test - defective pressure switch PS12.
Feb 18, 2005	P-2005-03115	056-54600-SG1 incurred a "Fuel Boost Pressure Low" (Test Mode only) start trip during U5 loss of class III bus test. It is a Peaking Mode only trip.
Feb 19, 2005	P-2005-03249	078-54600-SG3 failed to start and was rejected during U7 P-5 test. Fault was traced back to a faulty T8 timer.
Mar 18, 2005	P-2005-05152	056-54600-SG3 tripped on "PT Exhaust Temp. High" during start-up of U6 UPSB backup test.
May 01, 2005	P-2005-07961	056-54600-SG1 tripped during start-up of P7 routine test run on "PT Lube Oil Sequence Failed". - It is a Peaking Mode only trip. Intermittent equipment failure.
May 22, 2005	P-2005-09305	078-54600-SG3 tripped during start-up of routine P-07 test run on "Main Lube Pressure Low" - defective T8 timer.
Jun 18, 2005	P-2005-10865	056-54600-SG2 tripped on "PT Lube Oil Sequence Failed" during P7 routine test. It is a Peaking Mode only trip. Defective T11 timer.
Jun 28, 2005	P-2005-11400	078-54600-SG3 tripped during start-up of routine P-07 test run on "Main Lube Pressure Low". - Defective T8 timer.
Jul 05, 2005	P-2005-11683	078-54600-SG2 failed to start.
Jul 06, 2005	P-2005-11734	Temperature Switch Non-Conformance.
Jul 07, 2005	P-2005-11779	Actual Past Unavailability due to SGs Failures
Aug 28, 2005	P-2005-14142	056-54600-SG3 Unavailable.
Sep 19, 2005	P-2005-15563	Fuel leak at 056-SG3 fuel oil integrator FZ3399
Nov 22, 2005	P-2005-19625	078-54600-SG3 tripped during start up for routine test.
April 20, 2006	P-2006-06624	078 SG2 trip on startup. 078-SG2 started for supporting Unit 8 BUS transfer operation @ 10:52 on April 20/06. The machine tripped approximately 15 seconds into the start sequence. DC Lube Oil pump did not start as expected. Trip appears to be spurious.
Sept. 30, 2006	P-2006-16975	On 09/30/06 @ 4:00, CI 525 "056-SG1 Process Trouble" annunciated in MCR. Local inspection discovered "FIRE" window lit on. SG was declared unavailable (ref. SCR P-2006-16975 & WR# 520871). Fault was traced back to a defective R1 relay which caused this spurious alarm.
Dec 18, 2006	P-2006-24708	Standby Generation Impairment 078-SG1 tripped on routine test run./ During routine P-007 test run of 078-SG1 on Dec 18/06, the machine started up with an initial frequency @ 63 Hz which was above the normal 61.2 Hz.

BUSINESS CASE SUMMARY

PNGS A - Mod/Replacement of FRP Components During 2010 VBO 13 - 49285

Superseding Business Case NA44 - BCS - 34320 - 00004 - R000

<u>Routing</u>	<u>Location</u>	<u>Action</u>	<u>Signature</u>	<u>Date</u>
John Melmer Section Manager Design Projects - Pickering A	P72-2	Review BCS		06 APR 2010
John Taras Section Manager Process Scheduling	P72-2	Review BCS		06 Apr 2010
Nahil Rahman 4053 Manager Design Projects - Pickering A	P72-1	Review BCS		06 Apr 2010
Mark Arnone Director Projects and Modifications	P72-1	Review BCS		06 APRIL 2010
Dwight Zerkee Manager Nuclear Investment	P82-3	Review BCS		7 Apr 10
Jeff Lehman Manager Performance Engineering, Pickering A	P42-3	Review BCS		APR 06/10
Rob Powell Director Vacuum Building Outage	P42-1	Review BCS		APR 06/10
Rob Black Director Station Engineering, Pickering A	P42-3	Review BCS		6 APR '10
Louie Shoukas Director Business Support	P42-3	Review BCS		06 April 2010
Jamie Lawrie Director Nuclear Investment	P82-3	Review BCS		8 APRIL 2010
Glenn Jager Senior VP Pickering A	P42-3	Submit BCS		9 APR 2010
Randy Leavitt VP - Nuclear Finance	P82-3	Review BCS		April 15, 2010
Wayne Robbins CNO	P82-6A1	Review BCS		2010-04-15
Don Power VP Corporate Investment Planning	TCH07G05	Review BCS		April 23/10
Donn Hanbidge CFO	TCH19F27	Approve BCS		Apr. 26/10
Tom Mitchell President & CEO	TCH19A24	Approve BCS		Apr 28/10
Sue MacKinnon Nuclear Investment Management 702-4082	P82-3B6.2	Return For Distribution		

PNGS A - Mod/Replacement of FRP Components During 2010 VBO 13 - 49285

Superseding Business Case NA44 - BCS - 34320 - 00004 - R000

1/ RECOMMENDATION:

We recommend a Superseding Release of \$11.7M (including \$1.8M contingency), for the PNGS A Modification/Replacement of Fiberglass Reinforced Plastic (FRP) Components During the 2010 Vacuum Building Outage (VBO) Project. The total released will be \$24.5M (including \$1.8M contingency).

The release history for this work had it moving from OM&A to Capital with change in strategy from inspect and selective replacement to full replacement. As such, the cost of the incremental costs that are now being included in this BCS were previously captured among the various contracts within the Outage. The main business objective of this project remains unchanged from the Full Release Business Case; however the BCS has been updated to include the following incremental costs required for the execution of the project that were not identified in the full release. The final project estimate includes the following costs:

1. Incremental scaffolding required to install the FRP piping. This was segregated from the remainder of the scaffolding requirements for the outage work program and is specific to the installation of the FRP,
2. Incremental Power Supplies associated with the installation of the piping.
3. Incremental Craning and Rigging requirements to transport/install the FRP material in the Vacuum Building.
4. Incremental Safety equipment required for installation of the piping due to hazardous fumes. This item was determined to be an incremental requirement late in the project due to one time use of the equipment associated with the resin environment.
5. Incremental resources to perform confined space monitoring duties due to the hazards created in the vacuum building due to hazardous fumes.

Items 1 -3 were discovered during a detailed review of outage scope, reviewed by Finance, and deemed to be an incremental cost of the project that satisfies the Capital eligibility requirements. The balance of the Superseding Release remains unchanged except for the updated financial figures throughout the balance of the document. The proposed scope remains unchanged as detailed in Section 4 – The Proposal. The superseding release has been developed in consultation with the Outage, Finance, Maintenance and Project organizations.

\$000's (Incl contingency)	Type	LTD 2008	2009	2010	2011	2012	2013	Later	Total
Currently Released	Full		1,181	11,582	46				12,809
Requested Now	Superseding			11,701	-				11,701
Future Funding Req'd	N/A								-
Total Project Costs		-	1,181	23,283	46	-	-	-	24,510
Non Project Costs									-
Grand Total		-	1,181	23,283	46	-	-	-	24,510
Investment Type Sustaining		Class Capital		NPV 19,724		IRR N/A		Discounted Payback N/A	

Submitted By:

Glenn Jager
SVP, Pickering A

Date:

9 APR 2010

Finance Approval:

Donn Hanbidge
CFO

Date:

Apr. 12/10

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

Tom Mitchell
President and CEO

Date:

28 April 2010

2/ BACKGROUND & ISSUES

This project is being implemented to complete modifications/repairs/replacement of FRP components located within the Vacuum Building.

The Water Spray System located in the Vacuum Building (VB) at the Pickering Nuclear Generating Station performs the pressure suppression function of the Negative Pressure Containment System (NPC) following a Loss of Coolant Accident (LOCA) or a Main Steam Line Break (MSLB) inside containment. The Vacuum Building supports both Pickering A and B stations.

The Water Spray System and the Vacuum System utilize FRP piping extensively. Degradation or aging of FRP components is being assessed and repairs have been required during past VBOs. Prior testing and analysis has concluded that the FRP components are fit for service until 2012.

There is currently an aging management program (project 49273) being executed by third party subject matter experts aimed at assessing the degradation of the material over time and gives recommendations for replacements or repairs to FRP components. Project 49273 includes testing of FRP samples removed during the 2000 VBO to determine the material properties and quantify the degradation. A series of recommendations have been developed which identify high risk FRP components as well as recommended samples to be removed to support the aging management program (reference NA44-CORR-34320-024520). The recommendations for the FRP components of the Vacuum System (SCI 34220) are being addressed by a separate project, the VB Basement Improvements Project 49278.

The higher risk components identified include the spray headers, spray plates and risers (below the EWST water line). Components considered to be low risk include the spray header T-sections, U-tubes, the Upper and Lower Down-Corners (UDCs & LDCs) and their flanges in the Upper Vacuum Chambers. Originally (at the time of Partial Release) one Riser and 1 Upper Down-corn sample were required. However, further assessment by the Aging Management program has been unable to conclusively support fitness for service of the existing Risers, therefore they are planned to be replaced. Also, in order to provide sufficient confidence in Upper Down-corn fitness for service, an additional sample must be taken (2 total). One Spray Header sample is to be extracted along with two Spray Header Saddle Supports. In addition, FRP parts are required to be on hand in case more components are found to be damaged/degraded beyond repair.

There is a known issue of possible gaps forming between the Spray Plates and Spray Headers during a douse due to the differential expansion under pressure and a deteriorated glue bond. The water spray function is not compromised by this condition (reference NA44-CORR-25000-0274905), however, load testing for spray plates will be completed (by IM&CS) to verify integrity of the glue bonds, and any failed plates will require repair or replacement during the outage.

The Down-Corners have Stiffening Rings installed for reinforcement to meet the required safety factor. Two types exist, "old" Stiffening Rings (installed in 1980) and "new" Stiffening Rings (installed in 2000). The new rings were redesigned to properly bond to the pipe but the old rings will need reinforcement FRP strips or "Reinforcement Bands" installed to ensure that they do not shift out of position. Some of the old rings were reinforced during the 2000 VBO.

The Spray Header Fill Lines are used to circulate the water that forms the loop seal in the U-tubes to separate the Main and Upper Vacuum Chambers. The connections to the Spray Headers are considered to be a sub standard design and at least one connection was found to leak in the last VBO.

The vertical leg of each Spray Header Saddle Support is constructed of an FRP pipe and press-molded flange. The flange is bolted to a steel plate which is connected to a concrete beam. One of the press-molded flanges removed during the 2000 VBO was badly damaged and some of the flanges are not properly glued to the support pipe. Although the Water Spray System is not required to be seismically qualified, seismic loading is considered in the stress analysis to avoid a VB outage for inspection following small earthquakes. It therefore must be demonstrated that the support pipe will not dislodge from the flange under seismic loading.

The Lower Down-Corn Split Flanges, located on the EWST Floor, are potential leakage sites. Pickering B requires the water in the tank for make-up to the moderator system following a DBE coincident with failure of the Emergency Water /Power Systems. The Water Spray System is not seismically qualified and therefore these flanges cannot be relied upon to maintain the seal following a DBE. It has been proposed that seismically qualified weirs be installed around the flanges to maintain adequate water inventory in the tank, refer to NK30-CORR-71330-0279688, "Requirement for Seismic Qualifications of the



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BUSINESS CASE SUMMARY

Emergency Storage Water Tank".

In addition to the modifications to be completed and samples to be extracted, repairs to FRP components may be required based on inspections completed during the outage or, as a result of "grinding" required to support various inspections.

3/ ALTERNATIVES AND ECONOMIC ANALYSIS

\$000's	Base Case	Alt 1 (Recommended)		Alt 2	Alt 3	Alt 4	Alt 5
		Full Cost	Incremental Cost				
PNGSA	(24,197)	(4,570)	(4,570)	(4,570)	0	0	0
PNGSB	(48,677)	(9,192)	(9,192)	(9,192)	0	0	0
Total Revenue	(72,874)	(13,762)	(13,762)	(13,762)	0	0	0
Total OM&A	0	0	0	0	0	0	0
Capital Expenditures	0	(24,382)	(23,140)	(25,269)	0	0	0
Present Value (PV)	(48,032)	(29,369)	(28,308)	(30,072)	0	0	0
Net Present Value (NPV)	N/A	18,664	19,724	17,960	0	0	0
IRR%	N/A	291.4%	N/A	449.7%	N/A	N/A	N/A
Discounted Payback (Yrs)	N/A	0.35	N/A	0.25	N/A	N/A	N/A

Base Case: Not Recommended - Status Quo

If replacement materials are not procured and design packages not completed, significant extensions to the 2010 VB Outage are likely. Current fitness for service is to 2012 only, therefore a subsequent outage may also be required if the necessary repairs and modifications cannot be completed during the 2010 VBO.

Alt. 1: Recommended - Modifications & Repairs - Riser Replacement with Contingency for Major Discovery Repairs

This alternative is recommended in support of the fitness for service evaluation of the FRP components to 2024. The following is a brief summary of the scope. A detailed description can be found in Section 4, The Proposal.

1. Extraction and replacement of FRP samples to support the aging management program
2. 100% replacement of the Riser sections below a cut made just above the EWST waterline
3. Procurement of limited number of spare components for Spray Headers, Spray Header Saddle Supports, Upper Down-Corners, Spray Plates and 4" Vacuum System piping as well as replacement as necessary during the VBO
4. Replace Spray Header Fill Line Connections (modification)
5. Add reinforcing bands to the Upper Down-Corner Stiffening rings installed in 1980
6. Install Weirs around the Upper Down-Corners to ensure EWST inventory is maintained following a DBE (modification)
7. Complete minor repairs to FRP components as identified by in-situ inspections.

This option provides the most economical solution by completing necessary replacements/modifications and preparing for the replacement/repair of additional high risk components. The highest risk components, the risers, will be replaced as part of scope. Other components will be procured but replacement cost is to be covered by specific contingency. The positive NPV calculated assumes that a 4 day outage extension is required for riser replacement but the risk of further extension (material lead time) and the risk of a subsequent outage for further repairs is mitigated.

The Partial Release included an option with a reduced amount of contingency preparation. This option has been eliminated based on the relatively low cost compared to significant consequences of an outage extension which could be as long as the material lead time of approximately 5 months.

Alt. 2: Not Recommended - Modification and Repairs with Stainless Steel

This alternative is not recommended. Replacement of the high risk Water Spray System components with new stainless steel to reduce requirements for aging of samples, associated with determination of long term integrity of FRP components. The main reasons for rejection of this alternative are discussed below:

Some components are not possible or practical to replace with stainless steel such as the fill line connection points, the spray plates and the lower components of the saddle supports. Also, transitions between materials (FRP flanges required) would be necessary for the riser replacement in order to maintain the current VBO schedule similar to Alternative 1. Therefore FRP expertise and design would still be required, and engineering effort would be substantially increased since these



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BUSINESS CASE SUMMARY

replacements would no longer be equivalent. There is also a technical/operability risk introduced at the required mechanical joints due to the possibility of main to upper chamber leakage. To eliminate this risk, complete riser replacement would be required (up to flange in the upper chamber). The schedule would be substantially increased due to multiple field welds required for installation.

4/ THE PROPOSAL

There is significant risk of outage extensions due to as-found condition of FRP components. This project will ensure readiness to repair or replace high risk FRP components as well as support the aging management program to ensure fitness for service to at least 2024.

The following is the proposed scope for the recommended alternative (Alt. 1):

Risers

- (a) Procure, Remove and Replace all 14 (section below a cut made above the EWST water line)
- (b) Procure 1 additional section (similar to the replacement components) for aging management
- (c) Procure 1 extra 10' length of riser pipe for additional parallel plate tests as requested by the aging management program

Upper Down-Comers

- (a) Procure, Remove and Replace 2 sections (section below a cut made above the EWST water line) for aging management
- (b) Procure and Replace 1 additional section (dependent on inspection results, installation costs included in contingency)
- (c) Procure 1 extra Upper Down-Comer to be used for aging management (no installation involved)

Spray Headers

- (a) Procure, Remove and Replace 1 section for aging management
- (b) Procure and Replace 1 additional section (dependent on inspection results, installation costs included in contingency)
- (c) Procure 1 extra header section to be used for aging management (no installation involved)

Spray Plates

- (a) Procure and replace 100 new Spray Plates (dependent on inspection results, installation costs included in contingency)

Spray Header Saddle Supports

- (a) Procure, Remove and Replace 2 supports (from under the Spray Header section removed) for aging management
- (b) Procure and Replace 2 additional supports (dependent on inspection results, installation included in contingency)
- (c) Procure 2 extra Saddle Supports for aging management (no installation involved)
- (d) Procure 51 additional replacement parts for the lower flange. Installation costs are covered under contingency.

4" Vacuum System Piping in the Main Volume

- (a) Procure and Replace up to 20 feet of pipe and 8 elbows (dependent on inspection results)

Spray Header Fill Line Connections

- (a) Modify/Replace all 28 fill line connections via the modification process

Stiffening Rings

- (a) Install Reinforcing bands on old Stiffening Rings not previously reinforced.

Lower Down-Comer Split Flanges

- (a) Install Weirs around 14 Lower Down-Comer Split Flanges (around Upper Down-Comers), via the modification process

This release also includes the execution support work directly required to complete the above scope of work.

This Full Release will include:

Project Management Services
Completion of Detailed Design
Installation Contracts Awarded
QA/QC Support Contracts Awarded
Installation, Commissioning, AFS and Closeout

BUSINESS CASE SUMMARY

5/ QUALITATIVE FACTORS

The following project benefits have not been quantified in the Economic Analysis but are significant and therefore worth noting.

This project will procure samples of new material and extract/replace samples from the VB. These are required to support future aging management.

Pickering B requires a supply of water from the EWST for moderator makeup following a seismic event. Installation of seismically qualified weirs around the Lower Down-Corner Split flanges will ensure this supply is available. Currently Pickering B risk assessment does not include external events (seismic) but must do so by 2010 as per the new operating license.

The risk of disengagement or excessive leakage from the Spray Header Fill Line connections will be eliminated through a modification.

Spare Spray Header sections, Spray Header Saddle Supports, Spray Plates, and 4" FRP pipe, will be available and replaced if necessary, contributing to fitness for service.

All of the repairs/replacements/modifications identified in this BCS, support fitness for service evaluation for the Vacuum Building Water Spray System until 2024.

6/ RISKS (see Attachment D for details)

Low = 1 to 3			Medium = 4 to 9		High = 10 to 25		Probability x Impact								Probability x Impact																											
			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)																	
			1	2	3	4	5																																			
Probability	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								After Mitigation																												
Preferred FRP Contractor Resource availability (includes design, manufacturing and installation).			1. Issue contracts as early as possible to secure resources. 2. Communicate with contractor on a regular basis to avoid unexpected situations.			6	6	9							9	4	4	6							6																	
QA/QC Resources availability from both Contractor and OPG groups.			1. Coordinate with support groups as early as possible. 2. Ensure resources are input in appropriate databases, workgroups informed of required resources and commitment obtained from work groups (i.e. FE). 3. Issue contracts with 3rd party contractors for FRP QA inspections as early as possible.			6	6	9							9	4	4	6							6																	
Increased installation costs			1. Obtain quotes from multiple contractors 2. Obtain input from CMO and FE regarding estimated hours for execution. 3. Obtain fixed price contracts where possible.			12									12	8									8																	
Increased costs for FRP material/manufacturing			1. Obtain material contracts as early as possible. 2. Maintain close communication with material vendor/fabricator. 3. Track FRP thru supply chain process.			9									9	6									6																	
Conventional Safety and			1. Maintain close communication with			12	12					8	8		12	8	8				6	6			8																	

BUSINESS CASE SUMMARY

Low = 1 to 3		Medium = 4 to 9		High = 10 to 25		Probability x Impact								Probability x Impact															
		Impact																											
		1	2	3	4	5																							
Probability	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								After Mitigation									
Environmental Protection (impact on material, labor, etc). Examples include styrene and dust hazards, and confined space requirements.						Conventional Safety and Environmental Department to identify requirements as early as possible. 2. Pre-determination of hazards, compensatory actions and equipment to be used.																							
Training cost and schedule (Additional due to unforeseen training requirements, extended training schedule due to classes being full, etc).						1. Clearly document training requirements in contracts. 2. Reserve training spots for contractors as early as possible						6	6						6	4	4							4	
Regulatory involvement Could cause delays and / or additional costs. Planned Modifications are to be addressed with CNSC.						1. Maintain communication with CNSC regarding planned modifications. 2. Submit design documentation to CNSC for approval/ disposition where required as early as possible.						9	9		9				9	6	6		6					6	
VBO Schedule/Priority Changes						1. Maintain continued communication with VBO group to ensure adequate coordination. 2. Ensure VBO representation in Project Status Meetings.						9	9						9	6	6							6	
Construction quality issues may cause delays and rework						1. Ensure stakeholder participation in COMS meetings and technical review meetings. 2. Ensure direct feedback from Design Agency to contractor where appropriate to avoid miscommunications. 3. Ensure ITPs and related documentation are reviewed by FRP expert. 4. Construction and support staff O/T if necessary.						8	8	8					8	4	4	4							4
Contingency/Discovery Work						1. Identify major spares to be procured (Additional material costs for major spares						9	9						9	6	6							6	

BUSINESS CASE SUMMARY

Low = 1 to 3			Medium = 4 to 9		High = 10 to 25		Probability x Impact								Probability x Impact												
			Impact																								
			1	2	3	4	5																				
Probability	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								After Mitigation							
Legacy issues may result in necessary field changes.							included in project estimate). 2. Review design and construction issues at regular meetings to uncover possible issues. 3. Complete thorough drawing reviews. 4. Utilize experience gained during previous VBOs and OPEX .																				
Minor scope changes / additions might be required by VBO group							1. Engage field engineering in design review. 2. Follow COMS procedure. 3. Engage station support to complete Field Initiated Changes as quickly as possible					6								4							
Minor changes in post-accident design temperatures							1. Maintain close communication with stakeholders. 2. Challenge all potential scope additions and ensure appropriate processes are followed. 3. VBO Scope Change approval process to be followed.					9								9							
							1. Reactor Safety/Analyst expected to provide post-accident temperature and make final decision on impact to design temperatures. Project Team to follow up. 2. Correspondence from Reactor Safety (P-CORR-34200-0291154) and Memo of Understanding (P-CORR-34200-0280240) indicate that temperature changes should not greatly affect the design of FRP components.					8								8							

BUSINESS CASE SUMMARY

7/ POST IMPLEMENTATION REVIEW PLAN

Type of PIR:	Targeted Final AFS Date:	Targeted PIR Approval Date:	PIR Responsibility (Sponsor Title)
Simplified	May 2010	Dec 2010	Vacuum Building Outage Manager

	Measurable Parameter	Current Baseline	Targeted Result	How will it be measured?	Who will measure it? (person / group)
1.	Return to service of the VB following the 2010 VBO	Repairs and replacements required as identified by Aging Management Program	Necessary repairs / replacements completed.	Sign off of ITP's / workplans, WO tasks set to finished	Design Projects Pickering A and/or Vacuum Building Outage Organization
2.	Fitness for Service of Water Spray System FRP	Fitness for service declared to 2012	Fitness for service declared to 2024	Fitness for service report	C&E Engineering through the Aging Management Program
3.	Seismically qualified water supply to Pick B Moderator System.	Not available	Available	AFS of Lower Down-comer Split Flange Weir modification	Design Projects Pickering A and/or Performance Engineering Pickering B
4.	Risk of Spray Header Fill line leakage/ disengagement	High	Low	AFS of Spray Header Fill line connection modification	Design Projects Pickering A and/or Performance Engineering Pickering B

Appendix “A”

Glossary (acronyms, codes, technical terms)

AFS	Available for Service
CGD	Commercial Grade Dedication
CNSC	Canadian Nuclear Safety Commission
DBE	Design Basis Earthquake
EC	Engineering Change
EQ	Environmental Qualifications
ECR	Engineering Change Request
EWST	Emergency Water Storage Tank
FIPR	Fabrication & Installation Package Release
FRP	Fiberglass Reinforced Plastic
IRR	Internal Rate of Return
ITP	Installation and Test Plan
LOCA	Loss of Coolant Accident
MSLB	Main Steam Line Break
NC	Nuclear Class
NPC	Negative Pressure Containment
NPV	Net Present Value
NSS	Nuclear Safety Solutions
OM&A	Operations, Maintenance, and Administration
PV	Present Value
RAB	Reactor Auxiliary Bay
SCR	Station Condition Record
SME	Subject Matter Expert
VB	Vacuum Building
VBO	Vacuum Building Outage

Comments:

BUSINESS CASE SUMMARY

Appendix "C"

Financial Model – Assumptions

Financial Assumptions:

Discount Rate	7%	Cost Escalation (yr)	None	SR & D Opportunity	No
Progress Payments	N/A	Foreign Currency	No	Retainer Fee	No
Income Tax Rate	Generation	PST		Interest Rate (Capital)	6%
Depreciation Rate (Capital)	N/A	Leasing	N/A	Indexed Priced Contract	N/A

Comments:

Project Cost Estimate:

Design Complete	100%	Quality of Estimate	Release + 15% to - 10%	3 rd Party Estimate	No
Reviewed by Sponsor	Yes	OPEX used	Yes	Lessons Learned	Yes
Similar Projects	Yes	Budgetary Quote(s)	Yes	First Unit Actual Used	Not unitized
Cost Sharing	Yes	Contracts in place	Yes	Competitive Bid	Yes
Fixed Price Contract	Yes	Fee for Service		Firm Vendor Proposal	Yes

Comments:

Rationale for Cost Classification:

Switch from OM&A to Capital – Replacement of Water Spray system FRP components which have significant risk of not being fit for service until the next VBO.

Generation Plan Assumptions:

Station	Unit	EOL	MW	Capacity	Planned Outages for Project Work (eg P1071)					
Pickering A	1	N/A	N/A	513	85%					
	4	N/A	N/A							
Pickering B	5	N/A	N/A	516	85%					
	6	N/A	N/A							
	7	N/A	N/A							
	8	N/A	N/A							
Darlington	1	N/A	N/A	N/A	N/A					
	2	N/A	N/A							
	3	N/A	N/A							
	4	N/A	N/A							

Comments:

The NPV calculations are all based on the risk of lost generation due to an outage extension in 2010 VBO or a subsequent outage in 2012 (when FRP fitness for service expires). The end of life of all 6 remaining Pickering units therefore does not factor into the calculation.

BUSINESS CASE SUMMARY

Appendix "C"

Financial Model – Assumptions
Impact on Operations

Impact on Revenue

	Present	2,010	2,011	2,012	2,013	2,014	2,015	2,016	Later	Total
Rate MWH	52.98	54.58	54.58	56.23	56.23	57.93	57.93	59.68		
Probability	0	0.10	0	0.20	0	0	0	0	0	0
Consequence	0	(516,076)	0	(106,332)	0	0	0	0	136,581	(485,827)
Risk	0	(51,608)	0	(21,266)	0	0	0	0	0	(72,874)
Other	0	0	0	0	0	0	0	0	0	0
Base Case	0	(51,608)	0	(21,266)	0	0	0	0	0	(72,874)
Probability	0	1.00	0	0	0	0	0	0	0	1
Consequence	0	(13,762)	0	0	0	0	0	0	0	(13,762)
Risk	0	(13,762)	0	0	0	0	0	0	0	(13,762)
Other	0	0	0	0	0	0	0	0	0	0
Recommendation	0	(13,762)	0	0	0	0	0	0	0	(13,762)
Net Impact	0	37,846	0	21,266	0	0	0	0	0	59,112

Comments:

See NPV Calculations for Details and Summary

Impact on OM&A

	Present	2,010	2,011	2,012	2,013	2,014	2,015	2,016	Later	Total
Base OM&A	0	0	0	0	0	0	0	0	0	0
Outage OM&A	0	0	0	0	0	0	0	0	0	0
Project OM&A	0	0	0	0	0	0	0	0	0	0
Base Case	0	0	0	0	0	0	0	0	0	0
Base OM&A	0	0	0	0	0	0	0	0	0	0
Outage OM&A	0	0	0	0	0	0	0	0	0	0
Project OM&A	0	0	0	0	0	0	0	0	0	0
Recommendation	0	0	0	0	0	0	0	0	0	0
Net Impact	0	0	0	0	0	0	0	0	0	0

Comments:

No impact on OM&A since the project is being transferred to the Capital Portfolio.

See NPV Calculations for Details and Summary

BUSINESS CASE SUMMARY

PNGS A - Mod/Replacement of FRP Components During 2010 VBO 13 - 49285
Superseding Business Case NA44 - BCS - 34320 - 00004 - R000

Attachment "A"

Project Cost Summary

	\$000's Capital	LTD 2009	2010	2011	2012	2013	2014	2015	Later	Total
Scores Basis	Project Mgmt & Support	375	1,402	21						1,798
	Engineering	867	700	17						1,584
	Procurement		4,000		-					4,000
	Construction		15,200		-					15,200
	Other		-	-	-					-
										-
										-
										-
	Interest (Capital Project Only)		120	8						128
	Project Costs	1,242	21,422	46	-	-	-	-	-	22,710
Cash	General Contingency		1,800							1,800
	Specific Contingency									-
	Project Costs	1,242	23,222	46	-	-	-	-	-	24,510
	Adjust to Cash Basis + / -	1,561	(1,561)							-
	Project Costs	2,803	21,661	46	-	-	-	-	-	24,510

Funding	Currently Released	1,181	11,582	46						12,809
	This Release		11,701	-	-					11,701
	Future Release		-	-						-
	Project Funding	1,181	23,283	46	-	-	-	-	-	24,510

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

Budget	2010-2014 Business Plan	1,242	8,695	46	-					9,983
	Variance to Business Plan	-	12,727	-	-	-	-	-	-	12,727

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 is not required

Reviewed By:

John Melmer
 Project Manager

Date:

Approved By:

Nahil Rahman
 Strat IV Manager

Date:

06 Apr 2010

BUSINESS CASE SUMMARY

PNGS A - Mod/Replacement of FRP Components During 2010 VBO 13 - 49285
Superseding Business Case NA44 - BCS - 34320 - 00004 – R000

Attachment “B”

Project Variance Analysis

	Capital	LTD Feb 2010	Total Project		Variance	Comments
			Last BCS Oct 2009	This BCS Mar 2010		
Scores Basis	Project Mgmt & Support		1798	1798	0	
	Engineering		1329	1584	255	Additional analysis support required to qualify new FRP components.
	Procurement		1571	4000	2429	Original values based on budgetary quote received from vendors to supply similar material to that supplied for the 2000 VBO. Current estimate based on actuals.
	Construction		5151	15200	10049	Includes actual awarded contract costs for FRP work as well as directly related additional execution support costs eg. Scaffolding, confined space monitoring, power, rigging, lighting, PPE, craning and VB access.
	Other				0	
					0	
					0	
					0	
					0	
	Interest (Capital Project Only)	0	73	128	55	Increase due to increased scope.
	Project Costs (Scores Basis)	0	9922	22710	12788	
	General Contingency		1562	1800	238	Increased due to increased scope.
Other	Specific Contingency		1325	0	-1325	Awarded labour contract includes contingency hours based on required manpower to complete known scope within the outage window.
	Project Costs (Scores Basis)	0	12809	24510	11701	
Other	Removal Costs included above				0	
	Inventory to be written off				0	
	Spare Parts in Inventory				0	

Comments:

Project variances are compared to the previous release which was approved under OM&A project 46604.

BUSINESS CASE SUMMARY

Attachment "D"

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 related system
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 God	

BUSINESS CASE SUMMARY

Weld Overlay Project 10 - 62568 Capital 10 - 62435 OM&A

Full Release Business Case Summary N - BCS - 30751 - 10002 - R000

1/ RECOMMENDATION:

Approval is requested for the Full Release of \$53.2M Capital (including contingency) and [REDACTED] OM&A (specific contingency) to proceed with the next stage of the Weld Overlay Project which will design and manufacture weld overlay tooling for those Darlington outlet feeders that are life-limited by pipe wall thinning caused by Flow Accelerated Corrosion (FAC). This brings the total costs to \$71M.

The business objective of this project is to reduce the cost of managing life-limiting feeder thinning by developing a repair alternative to the current exclusive use of Cut and Weld tooling for replacing thinned feeders. It is estimated that using weld overlay repair technology in conjunction with Cut & Weld tooling (as necessary), will provide a financial benefit in the range of approximately \$38M - \$143M (NPV) with a 19% - 45% IRR. (See Alternative Section for details). This estimate is based primarily on the assumptions:

- Less overall time required to repair a feeder during a Darlington outage
- Lower execution costs per feeder repair

To date, there has been four partial releases for Weld Overlay under project # 62435 (OM&A): \$1.5M in 2005-2006 for the Definition stage (Proof-of-Concept); \$700K in 2006-2007 for the Pre-Tool Development phase, \$3.7M in 2007 for Stage I (Preliminary Design of Tool and process) and; \$10.6M in 2008 to complete Stage I which is in progress. The project is currently managing Stage I Preliminary Design contracts with two separate vendors in an effort to maximize the probability of project success.

A 2011 Darlington Spring Outage In-service date for this process and tool significantly increases its economic benefits, which necessitates seamless transition into Stage II of the Weld Overlay Project. For this reason, this request for Capital funding approval is being made prior to the completion of Stage I, and prior to estimates being provided by the vendors. The budgetary estimates included in this request are based on costing experience with the similar Cut and Weld tooling, and are considered conservative. Also, a large amount of contingency has been assigned in this BCS to account for the uncertainty.

At the end of Stage I, a revised BCS will be prepared with updated project costs within the value of this release request, and updated risks to reflect the work completed in Stage I. The project team will present the technical and business case as a formal recommendation in a decision meeting, chaired by the CNE (see Attachment D). This revised BCS will be presented for signature during this decision meeting with the CNE, and follow up meetings with the CNO, COO, and CEO. If approved, only the value in the revised BCS will be released.

At this time, outage savings will be quantified for 2010 - 2014 business planning - Plan 1.

1000's (incl contingency)	Funding	Type	LTD 2008	2009	2010	2011	2012	Later	Total
Currently Released	Partial	OM&A	3,647	12,887					16,534
		Capital							
Requested Now	Full	OM&A			1,000				1,000
		Capital		5,050	45,060	3,084			53,194
Future Funding Req'd	N/A	OM&A							
		Capital							
Total Project Costs			3,647	17,937	46,060	3,084			70,728
Other Costs									
Ongoing Costs									
Grand Total			3,647	17,937	46,060	3,084			70,728
Investment Type			Class		NPV		IRR		Discounted Payback
Value Enhancing			Capital & OM&A		38M - 143.4M		19% - 45.5%		5 - 3 Years

Submitted By:

T. Mitchell
 Chief Nuclear Officer

Date:

Finance Approval:

D. Hanbidge
 S.V.P. & Chief Financial Officer

Date:

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

J. Hanjinson
 President & Chief Executive Officer

Date:

May 15/09

BUSINESS CASE SUMMARY

2/ BACKGROUND & ISSUES

Degradation of primary heat transport system feeders by flow-accelerated corrosion (FAC) is a significant life-limiting threat to OPG Nuclear plants. Cut and weld methods currently used for replacement of thinned feeder sections requires a number of preparatory activities (including channel defuelling, isolation and draining) that cannot be completed in parallel. As the number of feeders to be replaced increases, the time required to complete the repairs has a more significant impact on the duration of planned outages.

Another approach to feeder repair is to build up the feeder wall thickness by weld overlay, which deposits a layer of weld metal on the exterior of the pipe work. Advantages of this method include elimination of the need to defuel and drain the channel, a potential reduction in the time required for repairing each feeder, as well as an anticipated reduction in worker radiation dose and the amount of loose contamination and radioactive waste produced.

Weld overlay is a demonstrated technology that has been used successfully in both nuclear and non-nuclear repair applications. This current proposed application of the technology is considered a first of a kind due to the specific conditions of the repair. These include, that it is to be performed on thin wall, carbon-steel nuclear class 1 piping with specific material property requirements; it is to be applied with very tight clearances making tooling design difficult, and the pipe will be full of water during the application. In the original proof of concept study, weld overlay was demonstrated as being feasible for these specific conditions, however residual technical risks were identified. These risks include material properties (hydrogen, hardness, and residual stress), and miniaturization of the tooling.

During Stage I Preliminary Engineering (currently in-progress), the residual risks identified during the proof of concept work are being addressed. Weld processes are being developed to enhance favourable material properties, inspection techniques are being developed for pre and post overlay requirements, and a conceptual tool design will be provided based on tooling requirements and available clearances at the feeder hub to pipe weld area. Two vendors are currently contracted in competitive, parallel efforts to successfully complete Stage I in order to maximize the probability of project success.

A 2011 Darlington Spring Outage in-service date for this process and tool significantly increases its economic benefits, which necessitates a seamless transition into Stage II of the Weld Overlay Project. For this reason, this request for Capital funding approval is being made prior to the completion of Stage I, and prior to estimates being provided by the vendors. The budgetary estimates provided in this request are based on costing experience with the similar Cut and Weld tooling, and are considered conservative. Also, a [REDACTED] contingency has been assigned in this BCS to account for the uncertainty.

At the conclusion of Stage I, an updated economic analysis and revised BCS will be prepared using vendor provided budgetary estimates for Stage II, and a formal decision meeting will be held to determine whether to recommend proceeding with weld overlay tool detailed design and manufacture. The basis for the decision meeting may be found in Attachment D. If a recommendation to proceed is decided, a second decision meeting will be held with the CNO to present the case and obtain his acceptance. The CNO will then take the recommendation to the COO and then to the President for approval and final release.

The Weld Overlay Project is being executed in two stages as detailed in the table below. This staged funding release and execution is being used to minimize the financial risk, and provide adequate assurance that the repair technique and tooling is technically acceptable.

Stage 1 (OM&A) consists of: Proof of Concept (complete); Pre-Tool Development (complete); and Preliminary Engineering (in progress). To date, the concept of weld overlay has been demonstrated as a feasible repair technology and residual technical risks have been identified. The Preliminary Engineering phase will resolve the technical risks which involve primarily material property issues, and will provide a conceptual tool design.

Stage 2 (Capital) consists of three distinct phases: Detailed Design & Prototype Fabrication; Fabrication & Mock Up Testing; and Commissioning. At the end of this stage of the project, the tool sets will be declared as Available For Service, Regulatory approval will have been granted, and multiple tool sets ([REDACTED] currently projected) will be available for use at Darlington.

ONTARIOPOWER GENERATION

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BUSINESS CASE SUMMARY

Stage	Phase	Cost Area	Cost Item	Estimated Cost (K\$ CND) Includes Contingency							
Cost Type				2005	2006	2007	2008	2009	2010	2011	Total
1 OM&A	1	Proof-Of-Concept	Develop Concept and identify major risks	1,275	145						1,420
		Pre-Tool Development	Development of tool requirements		260	370				630	
		Preliminary Engineering (Currently in Progress)	Material Property Issue Resolution, Preliminary Design - Tool / Process			127	1,470	12,887		14,484	
2 Capital	2	Detailed Design & Prototype Fabrication	Tool Development & Commissioning								
	3	Fabrication & Mock Up Testing									
	4	Commissioning									
2 OM&A	(OM&A Specific Contingency)										
				1,275	405	497	1,470	17,937	46,060	3,084	70,728

A total of \$53.2M Capital (including contingency) and [REDACTED] OM&A (specific contingency) is requested to perform Stage II of the Weld Overlay project. This release request includes a [REDACTED] specific contingency to cover uncertainties regarding applicability of PST which is dependent on Tool ownership (title) by OPG or entry of a non-OPG owned tool into Ontario which may be built in the USA. Applicability of PST will not be known until the successful completion of Stage I; therefore, [REDACTED] of tool development costs have been reserved in a specific contingency. This funding will only be released if PST is required.

This release request also includes a specific contingency of [REDACTED] OM&A to deal with uncertainties regarding on-reactor commissioning in 2010. If the feeder is repaired and left in-service, it is Project OM&A; if it is repaired and cut out it is Project Capital. At this point in the project, it has not been decided whether the feeder will be left in service or cut out.

This full release business case summary and the associated economic analysis ("Economic Analysis to Support Weld Overlay BCS N-BCS-30751-10002", N-REP-30751-10007) considers only the weld overlay candidates at Darlington based on the latest feeder replacement schedule. The analysis assumes that weld overlay repair will be performed on the feeder repair candidates from 2011 onward.

Since the original Economic Analysis assessment in 2007, the 6 probe inspection results at Darlington have shown an increased number of feeders that have life limiting thinning in the Grayloc area (as projected in N-BCS-30751-100000-R000) which considerably strengthens the economic viability of this project with the additional funding requested. As well, 6 probe inspections for all Darlington units are not yet complete and may reveal additional life limited thinned feeders.

This project includes only the costs associated with developing, delivering and commissioning the Weld Overlay tooling. Weld Overlay field application costs will be addressed outside this project; however, these projected (listing estimates) costs have been included in the NPV calculations.

3/ ALTERNATIVES AND ECONOMIC ANALYSIS

The economic benefit of introducing weld overlay tooling is presented in this BCS as a potential NPV range. This approach was taken for the following reason:

The actual number of feeders scheduled for repair in any given outage (until Unit end-of-life) can vary because of new inspection results and emergent repair requirements. There are currently two methods used for determining feeder repair candidates (Reference NK38-CALC-33160-10044):

1. **Current Assessment:** The current case provides the remaining life of feeders with the current assessed wall thinning rates as determined by the *rate from initial* methodology for feeders limited adjacent to the Grayloc weld. It is commonly assumed that the feeder pipe adjacent to the Grayloc weld began life at a wall thickness lower than that of nominal pipe thickness. Thus, the methodology is assumed to provide conservative estimates of the wall thinning rate.
2. **Risk Informed:** The risk informed method incorporates all the information that is available for each feeder. As described, the formal feeder thinning assessment utilizes a single thinning rate to ensure conservatism in estimating remaining life. However, for replacement planning purposes it is recognized that over conservatism puts a strain on long term planning practices.

The Risk Informed method allows for a more realistic approach to determining which feeders require replacement, however, by reducing some of the conservatism, there is an inherent risk of under estimating thinning rates, which could result in emergent replacements. Because of this risk, and the risk of emergent replacement requirements coming from future inspections, two (2) separate economic analyses were conducted, using a set of feeder repair candidates derived from each estimating method. The result of each analysis (NPVs) represents the potential range of economic benefits/losses of introducing weld overlay tooling.

Risk Informed Scenario

\$ 000's	Base Case	Alt 1 (Recommended)		Alt 2 Delay Project (1 Year)	Alt 3	Alt 4	Alt 5
		Full Cost	Incremental Cost				
Revenue	(265,956)	(145,853)	(145,853)	(157,929)			
OM&A	(170,802)	(125,618)	(121,971)	(126,299)			
Capital	0	(51,205)	(51,205)	(51,205)			
Present Value (PV)	(201,308)	(165,731)	(163,233)	(170,893)			
Net Present Value (NPV)	N/A	35,576	38,074	30,414			
Internal Rate of Return (IRR) %	N/A	17.7%	19.1%	17.7%			
Discounted Payback (Yrs)	N/A	8.2	8.1	8.3			

Current Assessment Scenario

\$ 000's	Base Case	Alt 1 (Recommended)		Alt 2 Delay Project (1 Year)	Alt 3	Alt 4	Alt 5
		Full Cost	Incremental Cost				
Revenue	(573,891)	(311,812)	(311,812)	(335,964)			
OM&A	(370,833)	(252,997)	(249,350)	(258,266)			
Capital	0	(51,205)	(51,205)	(51,205)			
Present Value (PV)	(451,016)	(310,114)	(307,616)	(325,336)			
Net Present Value (NPV)	N/A	140,903	143,401	125,680			
Internal Rate of Return (IRR) %	N/A	42.5%	45.5%	44.4%			
Discounted Payback (Yrs)	N/A	5.1	5.0	5.3			

Monte Carlo Simulation

The purpose of the analysis is to demonstrate the viability of Weld Overlay within the parameters of uncertainty that currently exist, before Stage 1 is complete. This was accomplished by completing a Monte Carlo simulation of the impact of Weld Overlay (versus Cut and Weld) using 28 variables that were identified as having the greatest impact on economic viability of the project.

Two Hundred Thousand (200,000) iterations were completed using @Risk software. The 28 variables were chosen randomly (for each iteration), within our best estimate of the parameters for each variable. The Monte Carlo analysis produced the following results:

Mean NPV = \$72 Million

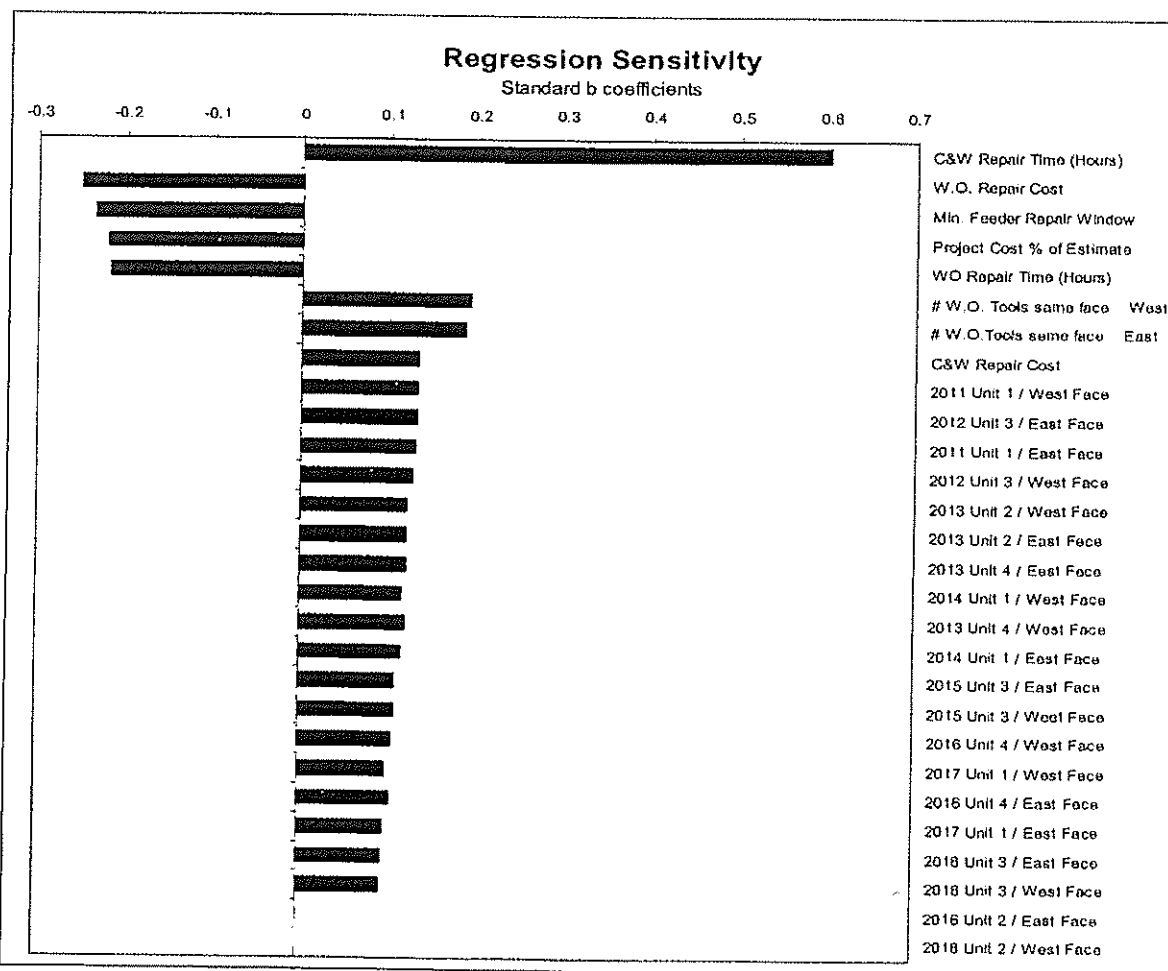
Maximum NPV = \$233 Million

Minimum NPV = - \$39 Million

There is a 90% confidence that the NPV will fall between \$20 Million and \$ 130 Million

The analysis produced 1,564 negative results

The analysis produced a tornado diagram ranking variable sensitivity. See below.



Refer to N-REP-30751-10007, "Economic Analysis to Support Weld Overlay BCS N-BCS-30751-10002" for detailed financial model assumptions used in the development of this business case.

Base Case: Not Recommended - Stop the project

This is not recommended, as the exclusive use of Cut and Weld tools will result in lengthy outages during the peak replacement years that could jeopardize the Darlington Business Plan and the Darlington target of 38-day outages.

Alt. 1: Recommended - Proceed with Stage II of the Weld Overlay project

It is recommended to proceed with the release of \$53.2M Capital (including contingency) and [REDACTED] OM&A (specific contingency) to award and execute a contract for Stage II of the Weld Overlay project. This technology will provide an alternative feeder repair option for repairing thinned areas, with an expected reduction in:

- Overall time required to repair a feeder
- Execution cost of feeder repair
- Production and safety risks associated with breaking the pressure boundary (See Qualitative factors)

It is estimated that using Weld Overlay tools in conjunction with Cut and Weld tools (as required) starting in 2011 will provide a financial benefit of approximately \$38M - \$143M (NPV). At the conclusion of Stage I, an updated economic analysis will be prepared using vendor provided budgetary estimates for Stage II and a formal decision meeting will be held to determine whether to proceed with weld overlay tool development, therefore, limiting sunk costs should this project not prove beneficial.

This alternative includes a specific contingency of [REDACTED] capital to cover uncertainties regarding applicability of PST, as well as a specific contingency of [REDACTED] OM&A to deal with uncertainties regarding on-reactor commissioning in 2010.

Details of the proposal are presented in Section 4.

Alt. 2: Not Recommended - Delay project for 1 year

This alternative is not recommended because delaying the project will:

- Reduce the overall financial benefit by ~ \$8M - \$18M (NPV) if tooling is available for 2012 vs. 2011
- Increases the risk that, due to unforeseen issues in this R&D project, the tooling will not be ready when feeder repairs are most needed.
- Risk losing experienced team members and vendors to support tool development.

Alt. 3: Not Recommended - Include Pickering A and Pickering B

This is not recommended because:

- Pickering B has very few feeders that are candidates for weld overlay before end of life. Pickering A feeders may not benefit from grayloc-area overlay, as they have concerns with life-limiting thinning further downstream. The extent of downstream thinning and the potential benefit of grayloc-area overlay will become more apparent after further inspection programs are completed at Pick A. It would be advantageous to first develop the tooling for Darlington, and adapt the tooling for Pickering A later, as required.
- Both Pickering A and Pickering B have tighter clearances around the feeders, making tool design more challenging.

The NPV has not been shown for this alternative because of the uncertainty indicated above.

4/ THE PROPOSAL

Upon successful completion of Stage I (currently in-progress), a formal decision meeting will be conducted to determine whether to proceed with weld overlay tool development based on Stage I results and up to date Stage II budgetary estimates.

If tool development does not present a positive economic case or if Stage I was not able to resolve outstanding areas of technical risk, the project will likely be cancelled; otherwise, a revised BCS, within the value of this BCS, will be submitted for approval and used to award a contract for Stage II of the weld overlay tooling and processes development project for Darlington. Stage II will be executed in three (3) phases:

1. Detailed Design and Prototype Fabrication

In this Phase, detailed documentation and drawings for the weld overlay tool and process will be prepared based on the parameters identified in Stage I.

A prototype tool will be built and tested on a mock-up which will simulate real feeder configurations, feeder clearances and shutdown conditions.

CNSC acceptance will be obtained for the weld overlay processes, analyses and inspections; as well as support for joint registration of the weld procedure with TSSA.

2. Fabrication and Mock-up Testing

In this Phase, the Production Tools (up to 1 sets) will be manufactured and the application of the weld overlay and weld defect repair will be further tested and demonstrated.

3. Commissioning

In this Phase, commissioning tests and available for service declaration will occur, with likely one commissioning trial at a Darlington unit in 2010.

5/ QUALITATIVE FACTORS

Using Weld overlay technology in combination with the Cut & Weld method (as required) potentially offers the following qualitative benefits:

- Eliminates the need for isolating, draining, removal and replacement of feeders experiencing thinning in the area adjacent to the Grayloc hub, thereby reducing production and safety areas of risk inherent in breaking the pressure boundary.
- Reduces exposure time, thereby achieving an overall reduction in radiation dose uptake.
- Reduces both the potential for loose contamination release and the production of high level active waste associated with Cut & Weld activities.

As well, this repair technology may be considered for providing a potential repair technique for pipe thinning problems in other systems or at other OPG stations.

BUSINESS CASE SUMMARY

		Low = 1 to 3		Medium = 4 to 9		High = 10 to 25		Probability x Impact								Probability x Impact												
		Impact																										
		1	2	3	4	5																						
Probability	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								After Mitigation												
The vendor's proposed cost of Stage 2 scope (Tool Design and Commissioning) is significantly higher than current estimates. Impact: Higher than estimated capital costs; lower NPV; delay to project resulting from the requirement for a superseding BCS approval.		- Conservative estimates based on Cut and Weld tooling development experiences have been used. - A [REDACTED] general contingency has been established for this project phase. - A competitive atmosphere for award of Stage II has been set up with two vendors performing Stage I activities. - A firm price contract will be negotiated.						12		15								15		6		8						8
The scope of work may increase based on unresolved technical issues, or discovery of new issues, or Regulatory requirements. Impact: Increased costs, schedule extension and increased complexity		- A [REDACTED] general contingency has been established for this project phase. - The proof of concept phase disclosed significant technical risks. - Experienced vendors have been contracted.						16		20		8						20		6		15		6				15
The schedule necessary to meet the DNGD 2011 outage may not be achievable resulting in repair of feeders solely with cut and weld tooling during this outage. Impact: An estimated decreased		- Experienced vendors are being used. - A competitive atmosphere between vendors has been established to increase their motivation. - Capital funding release is being						20		25								25		16		20					20	

BUSINESS CASE SUMMARY

Low = 1 to 3		Medium = 4 to 9			High = 10 to 25		Probability x Impact								Probability x Impact																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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Risk Description							Mitigating Activities							Before Mitigation								After Mitigation																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
savings of approximately \$10M-\$20M (NPV). Availability of long lead parts/tools (e.g. feeder mock-up) may delay tool development (Stage 2) and subsequent tool AFS resulting in repair of feeders solely with cut and weld tooling during the 2011 Darlington outage. <u>Impact:</u> An estimated decreased savings of approximately \$10M - \$20M (NPV).							sought in order that Stage II award is not delayed. - Plan to include Mock-up in vendor's deliverables for early Stage II. - Use of existing mock-ups if available.							20	25																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			

BUSINESS CASE SUMMARY

Low = 1 to 3		Medium = 4 to 9		High = 10 to 25		Probability x Impact								Probability x Impact								
		Impact																				
		1	2	3	4	5																
Probability	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								After Mitigation							
		by half since the proof of concept, thus reducing the overlay area required. Vendors will have to disclose known limitations at the end of Stage I so that this may be accounted for in the final economic evaluation before proceeding with Stage II.																				
The "As-Built" clearances at the grayloc area of some feeders may be more restrictive than the designed feeder clearances, resulting in the tooling not being able to fit those Weld Overlay feeder candidates. <u>Impact:</u> The cost of unplanned Cut and Weld repairs; Weld Overlay tool having less value than originally projected.		- A sample of actual field measurements will be performed during the spring 2009 DNGS outage to assess the magnitude of the difference. - Actual field measurements of all candidate feeders will be recommended as they are available in lead-up outages to avoid unplanned replacement activities. - Methods will be explored to increase feeder clearances, such as end-fitting jacking techniques.					20		16					20	12		9					12
Post Weld Overlay material properties (Residual Stress, Hydrogen Ingress and Hardness) may not be fully resolved after Stage I. <u>Impact:</u> Schedule delays and cost overrun for additional work		- Post Stage I decision meeting to cancel project if risk is too high going into Stage II. - Removed DNGS feeders (artifacts) have been set aside for weld overlay testing purposes (if required).					15	15						15	6	6						6

BUSINESS CASE SUMMARY

Low = 1 to 3		Medium = 4 to 9		High = 10 to 25		Probability x Impact								Probability x Impact															
		Impact																											
		1	2	3	4	5																							
Probability	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								After Mitigation							
required. At worst, cancellation of the weld overlay project would result in sunk costs of approximately \$16.5M OM&A (includes contingency) and any Stage II expenditures (Capital Release).							▪ Experienced vendors are being used.																						
Weld Overlay repair may not be feasible with fuel in the channel. Impact: Channel will be refueled for the weld overlay repair, increasing time and cost of the repair.							▪ Currently Cut and Weld requires the channel to be defueled therefore the cost of fuel would be the same under both Cut & Weld and Weld Overlay scenarios should this risk materialize. The cost of fuel has not been included in the economic analysis. (If included, the case for Weld Overlay is made stronger).							4								2							
Regulatory approval sought in Stage II may be delayed or rejected. Impact: Schedule delays and cost overrun for additional work required. At worst, cancellation of the weld overlay project would result in sunk costs of approximately \$16.5M OM&A (includes contingency) and any Stage II expenditures (Capital Release).							▪ A Regulatory plan has been prepared and an initial meeting held early in the project. ▪ During Stage I, at least one update meeting will be held with the CNSC ▪ Technical experts with knowledge in Code/Regulatory issues will be contracted for this work and will support Regulatory discussions and submissions. ▪ Nuclear Weld Overlay experience from utilities will be							12 15								9 15 6 8 4 8							

BUSINESS CASE SUMMARY

Low = 1 to 3		Medium = 4 to 9		High = 10 to 25		Probability x Impact								Probability x Impact													
		Impact																									
		1	2	3	4	5																					
Probability	5	5	10	15	20	25	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)			
	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							After Mitigation						
may be significant.																											
<u>Impact:</u> Less return on investment.																											
The efficiency (time required) or the application cost per feeder of weld overlay is greater than that for cut and weld.							At the conclusion of Stage I, the economic benefits will be re-assessed prior to proceeding with Stage II							8							8						
<u>Impact:</u> Less return on investments. At worst, sunk costs could reach \$16.5M OM&A (Including contingency) and any Stage II expenditures (Capital Release)																											
The value of the Canadian dollar drops to a value for a sustained period of time that may significantly increase costs should a vendor from the U.S. be contracted for this job (<\$0.8 USD).							- Request proposals in Canadian funds. - contingency has been added to conservative estimates.							12							12						
<u>Impact:</u> Higher cost of development and/or application																					6						
The vendor's QA program is not approved for stage II work and/or implementation							- OPG Supply chain is engaged in reviewing and auditing the vendor's QA program. - Two vendors are contracted for stage I work.							8 15							15						
Impact: That vendor's bid is not acceptable.																					8 10						
Opportunity - Another utility with							Senior Management to														4						

BUSINESS CASE SUMMARY

[illegible]

BUSINESS CASE SUMMARY

7/ POST IMPLEMENTATION REVIEW PLAN

Type of PIR:	Targeted Final AFS Date:	Targeted PIR Approval Date:	PIR Responsibility (Sponsor Title)
Comprehensive	Jun 2011	Dec 2012	VP Science & Technology Development

	Measurable Parameter	Current Baseline	Targeted Result	How will it be measured?	Who will measure it? (person / group)
1.	Time to perform a single repair	Cut & Weld	<25 hours	Use outage reporting data	Performance Engineering
2.	Dose per repair	Cut & Weld	< cut and weld	mRem/Feeder Dose reporting system.	Reactor Maintenance
3.	Number of feeders that require cut and weld replacement per 100 feeders requiring repair.	Cut & Weld	< 10	Use outage reporting data	Major Components/ Feeders
4.	Weld overlay in-service repair failures.	N/A	0	SCRs	Major Components/ Feeders
5.	Number of pipe 'blow-thru' events	N/A	0	SCRs	Reactor Maintenance
6.	Cost per repair average.	Cut & Weld	< 500k in first 3 years	Negotiated cost per repair	Supply Chain

- A Comprehensive Post Implementation Review (CPIR) will be carried out at the conclusion of Stage 1 of the project to capture the lessons and make recommendations for the next stage. If a CPIR is found not appropriate at the end of Stage 1, it will be conducted within one year of the project in service (by December 2012), consistent with the corporate PIR Procedure.
- The Comprehensive PIR will be an independent and systematic performance evaluation of the project for these objectives:
 - Assess the realization of the project benefits consisting of:
 - i. The effectiveness of the weld overlay repair technology in conjunction with Cut & Weld tooling over the previous cut and weld method alone
 - ii. The measurement of project targets specified in the table above

BUSINESS CASE SUMMARY

- Review project intent, plan, implementation and operational performance
- Review BCS - major assumptions, economic and financial evaluation looking back from results, for future decisions
- Review project risk management
- Identify over all lessons learned, in addition to those documented by the project team, for future improvement
- The Comprehensive PIR will be conducted by Independent Team with the Team Leader appointed by the Project Approval Authority
- Key Lessons-Learned on the technology development, contracting and planning will be captured in addition to the project execution lessons.

BUSINESS CASE SUMMARY

Appendix "A"

Glossary (acronyms, codes, technical terms)

- Acronyms etc are spelled out in the text.

Appendix "B"

Project Funding History

\$ 000's Capital Release Type	Month	All Existing and Planned Releases (Incl contingency) Cumulative Values									Total
		Year	2009	2010	2011	2012	2013	2014	2015	Later	
Full	May	2009	5,050	45,060	3,084						53,194
											0
											0
											0
											0
											0
											0

LTD Spent	Feb	2009	0								0
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\$ 000's OM&A Release Type	Month	All Existing and Planned Releases (Incl contingency) Cumulative Values									Total
		Year	2005	2006	2007	2008	2009	2010	2011	Later	
Developmental	Feb	2005	200								200
Partial	Jun	2005	1,500								1,500
Partial	Jul	2006	1,273	686							1,959
Partial	Aug	2007	1,273	407	670	3,560					5,910
Partial	Oct	2008	1,273	407	497	3,867	10,490				16,534
Full	May	2009	1,273	407	497	3,867	10,490	1,000			17,534
											0
											0

LTD Spent	Feb	2009	1,273	407	497	1,470	260				3,907
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Comments:

BUSINESS CASE SUMMARY

Appendix "C"

Financial Model – Assumptions

Financial Assumptions:

Discount Rate	7%	Cost Escalation (yr)	2%	SR & D Opportunity	Yes
Progress Payments	Yes	Foreign Currency	See Comments	Retainer Fee	No
Income Tax Rate	Generation	PST	See Comments	Interest Rate (Capital)	6%
Depreciation Rate (Capital)	Office, Misc Equipment 20%	Leasing	No	Indexed Priced Contract	No

Comments:

of tool development costs () has been reserved in a specific contingency to cover uncertainties regarding applicability of PST which will not be resolved until the successful completion of Stage I.
Any Stage II foreign exchange issues will be covered by the general contingency requested in this release.

Project Cost Estimate:

Design Complete	Zero to Minimal	Quality of Estimate	Conceptual + 60% to - 25%	3 rd Party Estimate	Yes
Reviewed by Sponsor	Yes	OPEX used	Yes	Lessons Learned	Yes
Similar Projects	Yes	Budgetary Quote(s)	No	First Unit Actual Used	N/A
Cost Sharing	No	Contracts in place	No	Competitive Bid	Yes
Fixed Price Contract	Yes	Fee for Service	No	Firm Vendor Proposal	No

Comments:

Refer to N-REP-30751-10007, "Economic Analysis to Support Weld Overlay BCS N-BCS-30751-10002" for detailed financial model assumptions used in the development of this business case.

Rationale for Cost Classification:

Generation Plan Assumptions:

Station	Unit	EOL		MW	Capacity	Planned Outages for Project Work (eg P1071)						
Pickering A	1	N/A	N/A	N/A	N/A							
	4	N/A	N/A									
Pickering B	5	N/A	N/A	N/A	N/A							
	6	N/A	N/A									
	7	N/A	N/A									
	8	N/A	N/A									
Darlington	1	Sep	2018	935	88%	D1111	D1411	D1711				
	2	May	2016			D1021	D1321					
	3	Mar	2020			D1231	D1531	D1831				
	4	Mar	2021			D1341	D1641					

Comments:

D1021 is included as target commissioning outage.

BUSINESS CASE SUMMARY

Appendix "C"

Financial Model – Assumptions
Impact on Operations

Risk Informed Scenario

Impact on Revenue										
\$Millions	Present	2008	2010	2011	2012	2013	2014	2015	Later	Total
Rate KWH	58.36	52.98	54.58	54.58	56.23	56.23	57.93	57.93		
Probability	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Consequence	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Risk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	(8.6)	(23.0)	(3.0)	(23.7)	(34.2)	(22.0)	(151.5)	(266.0)
Base Case	0.0	0.0	(8.6)	(23.0)	(3.0)	(23.7)	(34.2)	(22.0)	(151.5)	(266.0)
Probability	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Consequence	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Risk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	(8.6)	(10.9)	(1.2)	(11.3)	(18.3)	(12.2)	(83.3)	(145.8)
Recommendation	0.0	0.0	(8.6)	(10.9)	(1.2)	(11.3)	(18.3)	(12.2)	(83.3)	(145.8)
Net Impact	0.0	0.0	0.0	12.1	1.8	12.4	15.9	9.8	68.2	120.2

Comments:

See NPV Calculations for Details and Summary

Impact on OM&A										
\$Millions	Present	2008	2010	2011	2012	2013	2014	2015	Later	Total
Base OM&A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Outage OM&A	0.0	0.0	(2.7)	(11.7)	(1.8)	(13.1)	(25.9)	(10.7)	(104.8)	(170.7)
Project OM&A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Base Case	0.0	0.0	(2.7)	(11.7)	(1.8)	(13.1)	(25.9)	(10.7)	(104.8)	(170.7)
Base OM&A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
Outage OM&A	0.0	0.0	(2.7)	(7.4)	(1.3)	(8.6)	(16.0)	(6.9)	(65.2)	(108)
Project OM&A	0.0	(12.9)	(1.0)	0.0	0.0	0.0	0.0	0.0	0.0	(13.9)
Recommendation	0.0	(12.9)	(3.7)	(7.4)	(1.3)	(8.6)	(16.0)	(6.9)	(65.2)	(122.0)
Net Impact	0.0	(12.9)	(1.0)	4.3	0.5	4.5	9.9	3.8	39.6	48.7

Comments:

See NPV Calculations for Details and Summary

Appendix "C"

Financial Model – Assumptions

Impact on Operations

Current Assessment Scenario

Impact on Revenue										
\$Millions	Present	2009	2010	2011	2012	2013	2014	2015	Later	Total
Rate KWH	58.36	52.98	54.58	54.58	56.23	56.23	57.93	57.93		
Probability	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Consequence	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Risk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	(17.3)	(43.1)	(17.8)	(53.2)	(151.4)	(61.0)	(230.0)	(573.8)
Base Case	0.0	0.0	(17.3)	(43.1)	(17.8)	(53.2)	(151.4)	(61.0)	(230.0)	(573.8)
Probability	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Consequence	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Risk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.0	(17.3)	(19.0)	(8.9)	(23.1)	(83.0)	(34.2)	(126.4)	(311.9)
Recommendation	0.0	0.0	(17.3)	(19.0)	(8.9)	(23.1)	(83.0)	(34.2)	(126.4)	(311.9)
Net Impact	0.0	0.0	0.0	24.1	8.9	30.1	68.4	26.8	103.6	261.0

Comments:

See NPV Calculations for Details and Summary

Impact on OM&A										
\$Millions	Present	2009	2010	2011	2012	2013	2014	2015	Later	Total
Base OM&A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Outage OM&A	0.0	0.0	(10.6)	(23.5)	(7.4)	(29.1)	(101.5)	(37.1)	(161.6)	(370.8)
Project OM&A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Base Case	0.0	0.0	(10.6)	(23.5)	(7.4)	(29.1)	(101.5)	(37.1)	(161.6)	(370.8)
Base OM&A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Outage OM&A	0.0	0.0	(10.6)	(14.6)	(4.9)	(17.8)	(62.9)	(23.3)	(101.4)	(235.5)
Project OM&A	0.0	(12.9)	(1.0)	0.0	0.0	0.0	0.0	0.0	0.0	(13.9)
Recommendation	0.0	(12.9)	(11.6)	(14.6)	(4.9)	(17.8)	(62.9)	(23.3)	(101.4)	(249.4)
Net Impact	0.0	(12.9)	(11.6)	8.9	2.5	11.3	38.6	13.8	60.2	121.4

Comments:

See NPV Calculations for Details and Summary

[illegible]

BUSINESS CASE SUMMARY

Weld Overlay Project 10 – 62435 OM&A
Full Release Business Case Summary N-BCS- 30751-10001-R000

Attachment "A"

Project Cost Summary

\$000's		LTD	2009	2010	2011	2012	2013	2014	Later	Total
Capital		2008								
Scores Basis	Project Mgmtl & Support									-
	Engineering									-
	Procurement									-
	Construction									-
	Other									-
	Project Management (OPG)		166	507	166					839
	Engineering & Drafting (OPG)		108	108	108					324
	Material									
	Contract - Other									
	Interest (Capital Project Only)		46	1,183	760					1,989
	Project Costs									
	General Contingency									
	Specific Contingency									
	Project Costs		5,050	45,060	3,084					53,194
Cash	Adjust to Cash Basis + / -									
	Project Costs		5,050	45,060	3,084					53,194

Funding	Currently Released									-
	This Release		4,995	43,905	3,060					51,960
	Future Release								1,234	1,234
	Project Funding		4,995	43,905	3,060				1,234	53,194

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

Budget	2009-2013 Business Plan		11,000	12,500	1,000					24,500
	Variance to Business Plan		(7,120)	21,948	1,387					16,215

Other	Removal Costs Included above									-
	Inventory to be written off									-
	Spare Parts In Inventory									-

The estimated variance(s) to the 2009-2013 Business Plan will be addressed through the portfolio management process.
 A PCRAF is not required

Reviewed By:

Name
 Carol Gregoris

April 15/09

Date:

Approved By:

Allan Lew
 Eng & Mods Strat IV Manager

Date:

15 APR 2009



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BUSINESS CASE SUMMARY	

Project Name 10 - 62568 Capital 10 - 62435 OM&A
Full Release Business Case Summary N - BCS - 30751 - 10002 - R000

Attachment "B"

Project Variance Analysis

	Capital & OM&A	LTD Feb 2009	Total Project		Variance	Comments
			Last BCS Oct 2008	This BCS Feb 2009		
Scores Basis	Project Mgmt & Support				0	
	Engineering				0	
	Procurement				0	
	Construction				0	
	Other				0	
	Project Management (OPG)		2,095	2,017	-78	
	Engineering & Drafting (OPG)		626	841	215	
	Material					Mock-Up. Add'l feeder samples
	Contract - Other					Add'l costs for WO design, Qualification and commissioning.
	Interest (Capital Project Only)		1,000	1,989	989	
	Project Costs (Scores Basis)	0				
	General Contingency					
Other	Specific Contingency					PST Applicability, Commissioning
	Project Costs (Scores Basis)	0	47,533	70,728	23,195	
	Removal Costs Included above	-	-	-	0	
	Inventory to be written off	-	-	-	0	
	Spare Parts In Inventory	-	-	-	0	

Comments:

[illegible]



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**ENGINEERING & MODIFICATIONS
BUSINESS CASE SUMMARY**

Attachment D

Decision Map

1. Recommendation to CNO

(Process to follow guidelines of Engineering Decision Making N-Guid-01900-10001; Type 3 Decision)

Purpose: To provide a recommendation of either proceeding with Stage II, or canceling the project based on the technical results of Stage I and an updated economic analysis for Stage II. This recommendation will be documented and presented to the CNO, for acceptance.

Chair/Sponsor: Paul Spekkens, VP Science & Technology Development

Attendees:

- (1) CNE *
- (2) Darlington Director of Engineering *
- (3) At least one other Station Engineering Director * (Contrarian Role)
- (4) Senior Manager Plant Design Darlington *
- (5) Director Engineering Services *
- (6) Manager Feeder Integrity Project
- (7) Manager Performance Engineering Darlington
- (8) Director Nuclear Finance
- (9) Manager Nuclear Finance
- (10) Manager Darlington Maintenance
- (11) Weld Overlay Team Representatives

Format:

Presentation:

- Project Team to present the results of Stage I and an updated risk table based on these results.
- Project Team to present an assessment of the regulatory risk.
- Project Team/Nuclear Finance to present an updated economic analysis incorporating updated:
 1. Costs (vendor proposal in-hand),
 2. Schedule, and
 3. Assumptions.
 - Feeder repair numbers (based on Spring 2009 inspections)
 - Tool limitations (based on clearances vs. conceptual design)
 - Time to apply repair (estimated)
 - Cost of application (budgetary)
 - Monte Carlo analysis results
 4. Other alternatives considered (including lower minimum thickness requirements)

Discussion:

Open discussion and questions

Decision:

CNE makes the decision. Dissenting opinions are to be noted.

Criteria for a decision to proceed should include the following:

- Revised BCS updated economic analysis continues to have a positive NPV.
- Technical risks low; limited medium technical risks may be accepted.
- Regulatory Risk low.



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ENGINEERING & MODIFICATIONS BUSINESS CASE SUMMARY	

Minutes:

- Presentations, major discussion items, decision, and dissenting opinions are to be recorded.
- Actions with dates should be captured and A/Rs created as appropriate.
- The Recommendation is to be documented and the revised BCS presented for signature by the CNE.

2. CNO acceptance meeting

- CNO acceptance or rejection of the recommendation is to be documented and the revised BCS presented for signature.
- Attendees:
 - CNE
 - VP Science & Technology Dev (Project Sponsor)
 - SVP Darlington (or delegate)
 - Director Station Engineering, Darlington
 - VP Nuclear Finance
 - Manager, Feeder Integrity Projects
 - Project Manager – Weld Overlay Project
- Any actions should be captured and A/Rs created as appropriate
- CNO to take the recommendation and revised BCS to the COO for approval.

3. COO acceptance meeting

- COO acceptance or rejection of the recommendation is to be documented and the revised BCS presented for signature.
- Attendees:
 - CNO
 - CNE
 - VP Science & Technology Dev (Project Sponsor)
 - SVP Darlington (or delegate)
 - VP Corporate Investment Planning

4. President Approval of Revised BCS

BUSINESS CASE SUMMARY

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

Rank	Financial	Project Schedule	Quality	Community Reputation	Regulatory / Legal	Health & Safety	Environment	Public 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 related system
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 God	

Type 3 Business Case Summary

Final Security Classification of the BCS: Internal Use Only

To be used for investments/projects meeting Type 3 criteria in OPG-STD-0076.

Executive Summary and Recommendations

Project Information			
Project #:	16-31518	Document #:	D-BCS-78110-10002
Title:	Darlington Restore Emergency Service Water and Fire Water Margins		
Class:	Capital	Investment Type:	Sustaining
Phase:	Definition	Release:	Full
Facility:	DNGS	Target In-Service or Completion Date:	2016-09-30
Project Overview			
We recommend the release of \$28,431 k, including [REDACTED] of contingency.			
The estimated total project cost is \$47,078 k, including [REDACTED] of contingency.			
The quality of the estimate for this release is Class 4, and for the total project is Class 4.			
This release will fund the following scope of work:			
- Start and complete the detailed design for the new water supply system - Initiate construction planning activities - Purchase long-lead (approx 12 months) materials such as seismic valves, ULC-listed fire pumps and diesel engines. (Under normal circumstances, for project of such a large scale, a substantial portion of Definition scope should have been completed before committing OPG to Execution Phase activities such as purchasing fixed assets like property, plant and equipment. (However, upon considering the very low likelihood of cancellation and writing off the project, a one-time exception is granted to allow the purchase of the listed fixed assets (equipment) in this Definition Phase release due to the long procurement time coupled with the constricted timeline this project has with respect to its impact on meeting the overall schedule of Darlington Refurbishment – the most significant OPG strategic initiative for the decade. It is anticipated that most of the \$7M material costs will be high value long lead items such as seismic valves, code compliant fire pumps and diesel engines, etc.) - Permit the Master Service Agreement (MSA) vendor to enter into long-term contracts with their sub contractors. This will facilitate the procurement of long lead materials, and permit the vendor to secure uninterrupted services from their sub-contractors. - Initiate the Request for Proposal (RFP) process for construction activities to permit a more detailed and accurate Execution-Partial BCS to be submitted in 2015.			
Background			
The Fire Protection system at Darlington is supplied with water from the station's Emergency Service Water system. A modification completed in 2003 to upgrade the fire protection system included the installation of a significant number of additional sprinkler heads. Neither the project nor the original design of the station considered the possibility that the Emergency Service Water (ESW) system could be impaired by an excessive flow from the sprinklers.			
In the event of a Main Steam Line Break (MSLB) in the powerhouse, the resulting high temperature generated by escaping steam will activate a substantial number of sprinkler heads in the accident unit as well as its adjacent unit.			
The demand for emergency water that will be created by the sprinklers in the area affected by the MSLB far exceeds Fire Protection System design demand of the 315 litre per second, and is calculated to be enough to impair the flow of sufficient cooling water to all the other required nuclear safety loads.			
In the event of a MSLB, the considerable number (approximately 1,800) of activated sprinkler heads in the Fire Water (FW) system would divert a disproportionately large flow from the ESW system, leaving no safety margin of cooling water to the other nuclear safety loads in the ESW system.			
In addition to this potential safety hazard of failure to keep the associated major components/systems in the nuclear power			

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plant cool, the excessive flow will damage the ESW pumps due to the resulting pump run-out condition.

A Discovery Issue Resolution Process (DIRP) was conducted to analyze the impacts of this event. As a compensatory action, one of the two 100% FW supplies to the station was isolated from the ESW system to limit the flow available to the FW system and prevent ESW pump run-out. Hydraulic modelling and pump performance calculations confirmed that with one FW branch isolated, the ESW pumps would survive in this event, and would therefore be capable of supplying enough cooling water to the other required nuclear safety loads.

Problem Statement

The DIRP solution is only intended as a temporary solution to alleviate the situation because the available ESW operational flow margin is reduced and redundancy in the fire water supply system is impaired. The best practice is to rectify the situation by:

1. Modifying the FW system so that it would no longer be an inherent demand threat to the ESW system, and as a result also a threat to the other associated safety loads (e.g., room cooling loads, vault cooling loads, feed water to the steam generators);
2. Restoring the ESW operational margin to its original design requirement of 17% excess flow capacity, or greater.
3. Restoring the FW system water supply redundancy.

Other Key Business Drivers

The original project driver was to eliminate the threat to ESW water supply margins. A subsequent revision to the project Charter increased the project scope to include several Safety Improvement Opportunities in the following four areas:

4. Darlington Refurbishment

During the refurbishment period, the station will be placed in unusual configurations where critical pieces of equipment are taken out of service to be repaired or replaced. There is a risk that a particular configuration may compromise access to sufficient cooling water in case of an emergency. There is a business need to add reliability that would provide another source of emergency cooling water.

5. Commitment to CNSC in OPG's Environmental Assessment (EA) submission

The Darlington Refurbishment team has committed to the Canadian Nuclear Safety Commission (CNSC) as part of the EA submission to implement a suite of plant modifications that would significantly increase the station safety margins following a natural disaster greater in magnitude than the original design parameters of the station. A regulatory requirement of the 2012 Provincial EA hearings for prolonged operation of the station was the addition of an independent supply of cooling water to supplement the existing systems.

6. Single Line of Defence (SLOD) emergency cooling strategy

This is also a Darlington Refurbishment related business need to provide an additional reliable supply of water to the ESW distribution system, should a failure of the ESW pumps occur during a simultaneous secondary side pipe break.

7. Fukushima

Lessons learned from the Fukushima event that portable backup electrical and cooling equipment are crucial. There is a need for a permanently installed connection point for portable cooling water pumps, to supply water to the ESW distribution piping.

Summary of Preferred Alternative:

The project recommends that a new diesel-powered fire water supply system be installed in the existing DNGD ESW building. The recommendation to construct a diesel-driven fire water supply system was endorsed at an Executive Decision Making (EDM) meeting held on June 25, 2012. Further scope additions were recommended by the Refurbishment organization, and were incorporated into revision 01 of the Project Charter in March 2013.

These new requirements limited the alternatives available to locate the water supply system, as proximity to connection points to the ESW and Fire water system were now required, and the fixed time line effectively precludes the construction of a new pump house.

A further walk down of remaining locations identified an unused room in the lower level of the existing ESW pump house. This space already exists, is seismically robust, and provides ready access to a source of water as well as to piping which connects to both the ESW and Fire water systems.

There are a number of challenges posed by this recommendation:

- The basement location will require further measures to ensure water resistance from potential flooding
- Storage of a specific quantity of combustible fuel oil is permitted, subject to additional code requirements
- Installation of fuel-burning appliances inside a building will require additional ventilation and air monitoring

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- A new sprinkler system must be installed
- Ventilation, combustion air and exhaust must be waterproof and be ducted through the ceiling level and sufficiently high so as not to be affected by potential flooding conditions
- Diesel-generator sets must also be installed to ensure that electrical power is available to drive auxiliary systems such as ventilation and water filtration equipment
- Environmental concerns related to the transfer of oil and chemicals near the lake, and of noise and exhaust emissions need to be addressed.

The all-diesel line up and mixed-duty of FW and ESW supply will need to be endorsed by the regulator. These are predominantly engineering design issues which may be addressed through conventional means. It is believed that these can be addressed in a more cost-effective manner than undertaking the more costly and risk prone route of constructing a new pump house.

Alternatively, for a new pump house to meet seismic design requirements and provide a water intake for self-priming fire pumps, the foundations must be excavated down to bedrock immediately adjacent to the station forebay. Most of the new building's structure will therefore need to be constructed below water level.

History of BCS releases and project cost estimates:

The total project cost is now estimated at \$47078 including [REDACTED] of contingency, compared to the \$26,140 k including [REDACTED] of contingency in the previous release.

Variances are due to the significant increase in project scope resulting from revision 01 of the project charter. Increased design costs reflect the greater complexity of the project, while material and construction estimates reflect savings from removing the need to construct a new pump house.

The project is currently funded by a Partial Definition release of \$810 k (including [REDACTED] of contingency). Preliminary Design activities such as the Modification Design Requirements and Modification Outline document package have been prepared and approved.

An Extended Services – Master Service Agreement (ES-MSA) vendor's quotation has been obtained, which provides a budget performance fee estimate of the project. To expedite the initiation of detailed design activities, a sole source justification was approved for the design portion of the work.

This project is within the original scope of the Business Plan, and will meet the key business objective of continued safe plant operation.

Funding source & variance from business plan (BP):

k \$	2014	2015	2016	2017	Total
BP2014-16 from Forecast (excl. contingency)	[REDACTED]				
BCS (excl. contingency)					

The forecast was based on estimates obtained from a third party estimator. Estimates presented in this BCS are derived from a current ES-MSA bid. Variances are due to the significant increase in project scope resulting from revision 01 of the project Charter. Increased design costs reflect the greater complexity of the project, while material and construction estimates reflect savings from not constructing a new pump house.

Due to the need for this system to be in service prior to the start of Refurbishment in 2016, the annual cash flows cannot be deferred to future years to meet the previous forecast values. Financial offsets will therefore need to be identified to permit the work to proceed on schedule. The offset process is still being developed between Finance and Station Engineering.

Future releases will provide funding for the installation of the fire water supply system, testing, commissioning, AFS, and project and document close-out.

History of scope and schedule changes:

Darlington capital project 16-31518 was initiated in response to Project Charter NK38-PCH-72800-10001. This Charter identified a risk to the station's emergency water supply as a result of a potential MSLB event and consequential damage to the ESW pumps. The Charter's recommendation was to install a new fire water supply system with its own power source, to operate independently from the station's ESW system.

A revision to this Charter (R001) was approved in March 2013, which added several new requirements to the proposed diesel-driven fire water supply system. These requirements are to satisfy the need for a more reliable supply of emergency cooling water to the station, that could be caused by a diversity of events such as a complete loss of electrical power at the Darlington

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site, a beyond design basis earthquake, Fukushima-type events, and to provide reliable alternate cooling water supplies to provide added safety and operational flexibility during refurbishment work.

This is a major increase in project scope, as the system now must be built to more stringent reliability and design standards applicable to nuclear Group-2 Safety systems, including the ability to survive and operate after a more powerful earthquake or other natural disaster than the station was originally designed for.

Since some of the new system requirements are to provide alternate cooling supplies during abnormal equipment configurations during Refurbishment, the system is considered a pre-requisite to the start of refurbishment and must be in service prior to October 2016. This provides a significantly shorter timeline than is typical for this scale of project.

Project Cash Flows, NPV, and OAR Approval Amount

k\$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	474	336							810
Requested Now	-	13695	14736	0					28431
Future Required	-		6,000	8698	3137				17835
Total Project Cost	474	14031	20736	8698	3137				47078
Ongoing Costs	-								
Grand Total	474	14031	20736	8698	3137				47078
Estimate Class:	Class 4			Estimate at Completion:		\$47,078 k			
NPV:	\$35,161 k			OAR Approval Amount:		\$28,431 k			

Additional Information on Project Cash Flows (optional):

- Cash flows shown include interest and contingency.
- The funding requested now includes [REDACTED] contingency (i.e., [REDACTED]).
- The Emergency Mitigating Equipment (EME) portable pump connection being installed as part of this modification fulfills one of the Fukushima response strategies. The MSA vendor has combined the design and construction costs together for this portion of the work, into the overall estimate of the project.
- Fukushima-related costs may be categorized independently when work begins. It is anticipated that these costs will represent only be a small portion of the overall project cost.

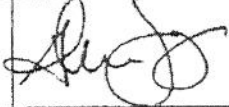
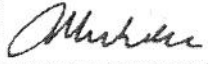
OPG-FORM-0076-R004

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Document #: D-BCS-78110-10002

Title: Darlington Restore Emergency Service Water and Fire Water Margins

Approvals			
Project #:	16-31518	Document #:	D-BCS-78110-10002
Title:	Darlington Restore Emergency Service Water and Fire Water Margins		
Phase:	Definition	Release:	Full
	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by: Glenn Jager Chief Nuclear Officer Project Sponsor			2014-2-11
I concur with the business decision as documented in this BCS.			
Finance Approval: Robin Heard Interim SVP & Chief Financial Officer			2014/2/18
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Tom Mitchell President & CEO, per OAR 1.1			2014-02-22

Project #: 16-31518

Title: Darlington Restore Emergency Service Water and Fire Water Margins

Final Security Classification of the BCS: Internal Use Only

Business Case Summary**Part A: Business Need**

A reliable supply of cooling water for accident mitigation in a nuclear power plant is a licensing requirement for continued station operation. To ensure that this requirement is met, the system is provided with redundant equipment, and is designed to withstand the highest earthquake and tornado loads predicted for the station. Multiple power supplies are also provided so that the system will operate in the event of a loss of normal electrical power supplies.

Recent analyses resulting from the Fukushima event, past upgrades to the station's fire protection system, and nuclear industry trends have identified gaps in Darlington's emergency cooling water supply.

It is proposed that these can be addressed with the installation of a new, independent water supply system to supplement the existing ESW system in certain emergency scenarios.

A new water supply system will increase the reliability of the emergency water supply, address concerns raised during the recent Environmental Assessment, address certain states which occur during unit outages or station refurbishment, and prevent ESW pump damage due to run-out conditions.

Project Drivers**Main Steam Line Break (MSLB)**

The turbine hall in a multi-unit nuclear power plant is a large open space, which houses the turbines, generators and auxiliary equipment for each unit. Due to the risk of a generator hydrogen leak, or of a turbine lubricating oil leak and fire, the turbine hall is fitted with a large number of sprinkler heads to comply with nuclear fire protection codes.

Another risk in any thermal generating station is the remote possibility of a break in the main steam line that transports high energy steam from the boilers to the turbines.

It has recently been identified that in the event of a Main Steam Line Break, the resulting high temperature steam plume will activate approx 1800 of these sprinklers in the accident unit and its neighbor. The resulting flow of water through the large effective unrestricted openings will place an unexpectedly high demand on the fire protection water supply.

Since the ESW system provides fire protection water at Darlington, most of the flow from the ESW pumps will take the low pressure path to the sprinklers and lead to reduced flows to the nuclear cooling loads. The resulting reduction in line pressure will cause the ESW pumps to enter a high-flow, low pressure condition known as run-out, which is characterised by a pump supplying a water flow which is beyond its design performance curve. The reduced system pressure will lead to impeller lift and shaft vibration, which will damage the pump's bearings.

This course of events is predicted to occur in less than the 30 minute's time that an Operator will require to be dispatched to the ESW building and take corrective actions.

The sudden loss of one half of Darlington's emergency cooling equipment at the outset of a MSLB event is unacceptable. The recommendation is install new pumps to supply the station fire water system, so that the risk of ESW pump damage caused by the consequences of a MSLB or similar event will be eliminated.

Refurbishment

The refurbishment process will first put the unit in a safe state where the reactor is shut down and the fuel is removed. During the refurbishment period, the station will be placed in unusual configurations where critical pieces of equipment are taken out of service to be repaired or replaced. Some station systems that transit the refurbishment unit will still be required to provide safety functions to the unit under refurbishment or adjacent units. There is potential that a particular configuration may put the station at risk of not having access to sufficient cooling water in case of an emergency.

The added reliability of the diesel fire water system to provide another source of emergency cooling water will reduce these risks. For this reason, the installation of the diesel fire water supply system is considered a pre-requisite to the beginning of refurbishment maintenance activities.

Environmental Assessment (EA)

Periodically, nuclear power plants must undergo a review of their systems and procedures to ensure that the impact of continued operation of the station on the natural environment is acceptable. Such a review analyses the effect of normal waste streams, as well as the effects of potential accident scenarios. A requirement of the 2012 Provincial Environmental Assessment hearings for prolonged operation of the station was the addition of an independent supply of cooling water to supplement the existing systems.

This commitment is necessary to maintain the public's confidence that multiple independent layers of protection exist and can be relied on to prevent disasters such as Fukushima from occurring at a CANDU plant.

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Single Line of Defence (SLOD) emergency cooling strategy

Since Darlington is a multi-unit station, credit has been given for operating units to provide emergency power or cooling services to an adjacent accident unit, should the need ever arise.

If an operating unit is flanked by units in a shutdown or refurbishment state, then those units may not be able to provide their credited safety services to the operating unit, if an accident were to occur in this configuration.

To provide better confidence and additional reliability of the ability to provide emergency cooling, the diesel fire pump / ESW supply is proposed to address this gap.

Another potential scenario was identified whereby a failure of secondary piping compromises control functions in the non-nuclear portion of the station, coupled with a simultaneous loss of ESW. Secondary side piping includes systems, which are capable of discharging large quantities of water, potentially damaging reactor control equipment. A diesel fire water supply system providing water to ESW system will make such a scenario very much less probable.

Fukushima

After the Pacific earthquake and tsunami, nuclear stations around the world began to identify any potential weaknesses in their safety systems, and developed ways to improve on them. These have been collectively labelled as "Fukushima" safety improvement opportunities. At Darlington, they are focussed on providing portable backup electrical and cooling equipment, with modifications made to the station to allow them to be implemented quickly. Delays in implementing backup cooling measures were central to the disaster that unfolded at the Fukushima reactors in Japan.

Projects are already underway to enable portable pumps to supply cooling water directly into critical nuclear heat exchangers on individual units. Additionally, it is proposed to install a common water injection system directly into the main ESW supply piping, to enable cooling water to be directed to any point in the station. To comply with the station operating license, it is essential that one of these backup cooling systems be permanently installed. The diesel fire water supply system will meet this need.

Part B: Preferred Alternative: Diesel Fire Pumps**Description of Preferred Alternative**

The project recommends that a new diesel-powered fire water supply system be installed in the existing DNGD ESW building.

The recommendation to construct a diesel-driven fire water supply system was endorsed at an Executive Decision Making (EDM) meeting held on June 25, 2012. Further scope additions were recommended by the Refurbishment organization, and were incorporated into revision 001 of the Project Charter in March 2013. These new requirements limit the available alternative locations available to locate the water supply system, as proximity to connection points to the ESW and Fire Water system were now required, and the fixed time line effectively precludes the construction of a new pumphouse.

Further walkdowns identified an unused room in the lower level of the ESW pump house. This space already exists, is seismically robust, and provides ready access to a source of water as well as to piping which connects to both the ESW and Fire water systems.

The major expenditures during the Full Definition phase in 2014 and 2015 (approximately \$16M) are to complete the detail design packages by an ES-MSA vendor, procurement of long lead materials such as code-listed fire pumps and diesel engines, seismically qualified valves, and associated project management and oversight.

There are a number of challenges posed by this recommendation. The basement location will require further measures to ensure water resistance. Storage of a specific quantity of combustible fuel oil is permitted, subject to additional code requirements. Installation of fuel-burning appliances inside a building will require additional ventilation and air monitoring. A new sprinkler system must be installed. Ventilation, combustion air and exhaust must be waterproof and be ducted through the ceiling level and sufficiently high so as not to be affected by potential flooding conditions. Diesel-generator sets must also be installed to ensure that electrical power is available to drive auxiliary systems such as ventilation and water filtration equipment. Environmental concerns related to the transfer of oil and chemicals near the lake, and of noise and exhaust emissions need to be addressed.

Deliverables:	Associated Milestones (if any):	Target Date:
Design Complete	ECP Design Complete	8 April 2015
BCS approved	EXE Execution-Full BCS approved	6 July 2015
EME connection in-service	AFS Available for Service	30 Nov 2015

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Type 3 Business Case Summary**Part C: Other Alternatives**

Summarize all reasonable alternatives considered, including pros and cons, and associated risks. Other alternatives may include different means to meet the same business need, and a reduced or increased scope of work, etc.

Base Case: No Project

ESW system margin, redundant nuclear cooling, and fire water supply are and will remain challenged. The long term requirement to provide fire protection and alternate means to cool the fuel will be compromised.

Commitments made to the Regulator, Province and Refurbishment will not be met.

Alternative 2: Delay Work – Delay the Project start by one year

Delay the project by one year. The time remaining to complete the project will be reduced to approx 18 months.

ESW system margins, nuclear cooling, and fire water supply will remain compromised. Commitments made to the CNSC and the Province for in-service date of Oct 2016 will be challenged, and increased costs will be incurred to compress the schedule. The schedule to design and install a fire water system in the ESW building is already compressed. Lead time for critical components such as the fire pumps and engines are 18 – 24 months, and may not be available in time to meet the required in-service date. This project is identified as critical to Refurbishment, and this strategy may delay the start of Refurbishment.

Alternative 3: New Pumphouse for Diesel Fire Pumps

Install new diesel-driven fire pumps in a new pumphouse building. This is not recommended due to the added cost and time required to design and construct a new pumphouse beside the forebay. A new pumphouse must withstand the Design Extension Conditions for earthquake, tornado and flood. In-service dates will be extremely challenged.

A new pumphouse for a diesel fire water supply system is estimated to add approximately \$22 M to the total project cost. There are construction risks due to the short timeline, the need to work below water level, and from other work in the vicinity such as the refurbishment security building, and the third emergency power generator.

Part D: Project Cash Flows, NPV, and OAR Approval Amount

k\$	LTD	2014	2015	2016	2017	2018	2019	Future	Total
Currently Released	474	336							810
Requested Now	-	13695	14736	0					28431
Future Required	-		6,000	8698	3137				17835
Total Project Cost	474	14031	20736	8698	3137				47078
Ongoing Costs	-								
Grand Total	474	14031	20736	8698	3137				47078

Estimate Class:	Class 4	Estimate at Completion:	\$47,078 k
NPV:	\$35,161 k	OAR Approval Amount:	\$28,431 k

Additional Information on Project Cash Flows (optional):

- Cash flows shown include interest and contingency.
- The funding requested now includes [REDACTED] contingency (i.e. [REDACTED]).
- The Emergency Mitigating Equipment (EME) portable pump connection being installed as part of this modification fulfils one of the Fukushima response strategies. The MSA vendor has combined the design and construction costs for this portion of the work into the overall estimate of the project.
- Fukushima-related costs may be categorized independently when work begins. It is anticipated that this represent only be a small portion of the overall project cost.

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Part E: Financial Evaluation

k\$	Preferred Alternative	Base Case	Delay Work	Alternative 3	
Project Cost	47,078	N/A	N/A	69,078	
PV (Present Value)	35,161	N/A	N/A	51,737	

Summary of Financial Model Key Assumptions or Key Findings:

No quantified impact has been calculated for the base case, as there are no costs associated with mitigation unless initiated by a MSLB or a natural disaster.

The costs associated with the delay of Refurbishment are prohibitive.

The main drivers for this project are the improvements in nuclear safety, ESW reliability, eliminating the risk of MSLA damage to the ESW pumps, reducing the duration of the non-standard configuration of the fire water system, and meeting the scheduling commitments for Refurbishment.

Alternative 3 is to construct the new diesel fire pump system inside a new pump house. Budget estimates price this option as \$22M higher than using the ESW basement.

Part F: Qualitative Factors

- Added reliability of redundant diesel powered fire pumps
- Separation of the ESW and Fire Water supplies
- Provision of a fixed backup system to supply ESW loads
- Injection point for EME pumps to supply water to the ESW header for the entire station
- Pro-active improvement to perceived shortcomings in the safety systems
- More robust and diverse Fukushima-type response strategies
- Continued good relations with the Regulator, Province and local community

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that the final project cost will exceed present estimates. Project costs are based on a Budgetary Performance Fee estimate from an ES-MSA vendor. OPG design has completed the Modification Outline and Modification Design Requirements, but detailed design has not yet been initiated.	The ES-MSA estimate has been validated against an estimate provided by an external estimating agency. The project plans to obtain updated estimates and releasing the contract in phases, as the project progresses and more detail is available.	High	High
Scope	There is a risk that changes may be made to building or fire codes, requiring rework to comply. Code changes or Nuclear Safety requirements may change during the life cycle of the project.	Ensure knowledgeable staff are part of the design team. Maintain awareness of Codes and Standards by Stakeholders to minimize impact on the project.	Medium	Medium
Schedule	There is a risk that milestones maybe challenged as the full scope of the modification has not yet been detailed. Risk to delays in design or installation due to minimal float and accuracy of the budgetary estimate.	Incorporate milestone dates into the contractor's purchase order and ensure the vendor's schedule realistically addresses the required in-service dates.	High	Medium
Resources	There is a risk that critical qualified design or trades resources may not be available	Incorporate qualification requirements into the Purchase Order (PO). Ensure	Medium	Medium

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Type 3 Business Case Summary

	when required. The ES-MSA vendor may not be able to provide or retain qualified resources to design or install a nuclear fire protection system.	the vendor staffs the project with experienced personnel. Obtain support from OPG fire systems specialists		
Quality/ Performance	There is a risk that code-compliant equipment may not be available when required. Suppliers of fire water pumping equipment may not be qualified or on the ASL.	Identify long lead and critical components early so that alternate suppliers can be located or qualified without impacting the project schedule	Medium	Low
Technical	There is a risk that certain design assumptions may need to be re-evaluated and alterations made to the design. Discovery issues in the ESW pumphouse or limited output of listed fire pumps may require alternate design or construction strategies. Design Packages may not be prepared to the required level of detail.	Ensure the design vendor has participated in system walkdowns and are provided with all relevant information. Obtain OPG resource commitments to provide timely review and acceptance of design deliverables.	Medium	Medium
Additional Risk Analysis:				
Due to the high estimated dollar value of this project, an Extreme Risk Assessment was conducted. Monte-Carlo risk and financial analysis was performed. The 85 th percentile calculation for project contingency based on identified project risk factors is approx [REDACTED]. Since the detailed design stage of the project has not yet been initiated, the contingency values have been increased to approx [REDACTED] or [REDACTED].				

Part H: Post Implementation Review (PIR) Plan				
☐ It is determined appropriate that only a Project Closure Report (PCR) is needed as the PIR for this project due to its straight forward deliverables, which do not require any measures other than confirmation of completion or delivery.				
Type of PIR Report		Target In-Service or Completion Date	Target PIR Completion Date	
Comprehensive PIR Report		2016-09-30	2017-09-06	
Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
ESW and FW margin will be restored	Current ESW water supply margin with the mitigating actions in place is approx 0%	ESW margin is restored to original value of 17%	Flow measurements during Commissioning	ES-MSA vendor and ERT
New FW system will survive Review Level Conditions for External Events and be available during Design Extension Conditions to supply critical nuclear cooling loads.	Darlington has no permanently installed system credited to supply nuclear cooling flows following a beyond design basis event.	System is designed and constructed in accordance with applicable codes and guidelines.	By PRA analysis	Nuclear Safety Analysis group
New FW system will support licensing basis EQ heat sink strategy during the Refurbishment Outage	Refurbishment is at risk since the SLOD strategy for LPSW supply from neighboring Units is not credited during Refurb.	Configuration of the new fire water supply meets EQ licensing requirements.	Acceptance of design and AFS documents	Concurrence from OPG Nuclear Safety
A connection point for Fukushima project	No connections exist for external water	Suitable hook-ups are available for EME	Observation, verification of flows	ERT, MSA vendor, commissioning data

*Associated with OPG-STD-0076, Developing and Documenting Business Cases

Type 3 Business Case Summary

Document #: D-BCS-78110-10002

Project #: 16-31518

Title: Darlington Restore Emergency Service Water and Fire Water Margins

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
EME supply to ESW	supply	pump hose connections	through fire water system	

Part I: Definitions and Acronyms

AFS – Available for Service
 ASL – Approved Suppliers List
 BCS – Business Case Summary
 B-DBE – Beyond Design Basis Event
 CNSC – Canadian Nuclear Safety Commission
 DBR – Design Basis Event
 DEC – Design Extension Conditions
 DIA – Discovery Issue Assessment
 DIRP – Discovery Issue Resolution Process
 EA – Environmental Assessment
 EDM – Executive Decision Making
 EME – Emergency Mitigating Equipment
 EPC – Engineering, Procurement, and Construction
 EPG – Emergency Power Generators
 EPS – Emergency Power Supply
 EQ – Environmental Qualification
 ERT – Emergency Response Technicians
 ES-MSA – Engineering Services – Master Services Agreement
 ESW – Emergency Service Water
 LPSW – Low Pressure Service Water
 MDR – Modification Design Requirements
 MO – Modification Outline
 MSLB – Main Steam Line Break
 OPG – Ontario Power Generation
 PM – Project Management
 PMP – Project Management Plan
 PRA – Probabilistic Risk Assessment
 RfP – Request for Proposal
 SIO – Safety Improvement Opportunity
 SLOD – Single Line of Defense

Filed: 2016-05-27

EB-2016-0152

Exhibit D2-1-3

OPG-FORM-0076-R004

Attachment 1, Feb 18, 2016

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Type 3 Business Case Summary

Document #: D-BCS-78110-10002

Project #: 16-31518

Title: Darlington Restore Emergency Service Water and Fire Water Margins

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Exhibit D2-1-3

Attachment 1, Tab 18, 31518 OPG-FORM-0076-R004

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Type 3 Business Case Summary

Project #: 16-31518

Document #: D-BCS-78110-10002

Title: Darlington Restore Emergency Service Water and Fire Water Margins

For Internal Project Cost Control

Project #: 16-31518

Title: Darlington Restore Emergency Service Water and Fire Water Margins

Appendix A: Summary of Estimate (Numbers may not add up due to rounding.)										
Project Number:	16-31518									
Title:	Restore Emergency Service Water and Fire Water Margins									
k\$ or M\$	LTD	2014	2015	2016	2017	20XX	20XX	Future	Total	%
OPG Project Management	138	1527	1195	932	1194				4986	11
OPG Engineering (including Design)	136	575	325	325	155				1516	3
OPG Procured Materials		700	6,600						7,300	16
OPG Other										
Design Contract(s)										
Construction Contract(s)										
EPC Contract(s)										
Consultants										
Contractor Project Management										
Interest										
Subtotal										
Contingency										
Total	474	14,031	20,736	8,698	3137				47078	100

Notes			
Project Start Date	2012-09-12	Definition Cost Included (includes contingency only if spent)	
Target In-Service (or AFS) Date	2016-09-30	Contingency Included in this Release	
Target Completion Date	2017-09-20	Total-to-Date Contingency	
Escalation Rate	2.0%	Total-to-Date Released (excluding contingency)	
Interest Rate	5.0%	Total-to-Date Released (including contingency)	\$810 k
Removal Costs	\$n/a Choose an item	Estimate at Completion (includes contingency only if spent)	

Prepared by:	Approved by:
 R. Fiorini Section Manager Design Projects Darlington Date	 D. Popovic Director-Infrastructure Projects Darlington Date

Type 3 Business Case Summary

Document #: D-BCS-78110-10002

Project #: 16-31518

Title: Darlington Restore Emergency Service Water and Fire Water Margins

Appendix B: Comparison of Total Project Estimates

Phase	Release	Date	Total Project Estimate in k\$ or M\$ (by year including contingency)						Future	Total Project Estimate
			2012	2013	2014	2015	2016	2017		
Definition	Partial	11-Dec 2012	41	591	3,681	17,575	421			26,140
Definition	Full	14-Feb-2014		474	14,031	20,736	8,689	3,137		47,078

Project Variance Analysis

k\$ or M\$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	138	980	4986	4006	First BCS was based on Charter revision R0, which only specified an independent fire pump system. Charter revision 01 now requires diesel fire pumps capable of supplying water to nuclear cooling loads, and operate following a beyond design basis event. Limited vendor capability, fast track, and increased functionality will demand greater OPG Project Management and oversight.
OPG Engineering (including Design)	136	946	1516	570	OPG design support will be provided by Refurbishment Design, using OSS vendors.
OPG Procured Materials		16,500	7,300	(9,200)	There is now no need for a new pumphouse building.
OPG Other					
Design Contract(s)					
Construction Contract(s)					
EPC Contract(s)					
Consultants					
Other Contracts/Costs					
Interest					
Subtotal					
Contingency					
Total	474	26,140	47078	21136	

Project #: 16-31518

Title: Darlington Restore Emergency Service Water and Fire Water Margins

Appendix C: Financial Evaluation Assumptions

Key assumptions used in the financial model of the Project are (complete relevant assumptions only):

Project Cost:

- All EPC work will be performed by an ES-MSA vendor

Financial:

- "Standard" OPG interest and depreciation rates apply.

Operating Cost:

- Operation and maintenance of the new equipment can be performed by existing resources.

Other:

- The new diesel fire water supply system can be installed in the ESW basement with readily available access to water supply and discharge piping.

Type 3 Business Case Summary

Document #: D-BCS-78110-10002

Project #: 16-31518

Title: Darlington Restore Emergency Service Water and Fire Water Margins

Appendix D: References

Project Charter: NK38-PCH-72800-10001 and NK38-PCH-72800-10001-R001

DIA: NK38-DIA-00531-10010

CDR: NK38-DRT-72800-10026

CDR: NK38-REP-78100-10002

BCS: D-BCS-78110-10001

SOW: NK38-SOW-72800-10005

CSA N293-07

Type 2 Business Case Summary

Final Security Classification of the BCS: **OPG Confidential**

To be used for investments/projects meeting Type 2 criteria in OPG-STD-0076.

Part A: Project Information					
Project #:	16-31524	Title:	Darlington Station Roofs Replacement Project		
Phase:	Initiation and Definition	Release:	Partial	Records File:	D-BCS-20000-10002
Facility:	Darlington	Class:	Capital	Investment Type:	Sustaining

Business Need:

We recommend the release of \$811k (base costs plus contingency)

This release is to proceed with the Initiation and Definition phase of the Darlington Station Roofs Replacement Project. The total project is estimated to cost \$36,259k, with a target completion date in 2018.

The station's existing roofs have reached the end of their 25-year design life. Currently there are 135+ Station Condition Record's and 60+ work orders associated with roof leaks. There has also been an Aging Management Program Component Condition Assessment (NK38-REP-20000-10003) carried out for Roofing Construction for buildings inside the protected area, which concluded that station roofing is in poor condition.

The current condition of the station roofs exposes Darlington to nuclear and conventional safety risks. Most, if not all systems on both the nuclear and conventional side were designed with the assumption that system operations will take place below a leak-proof roof and no precipitation introduced into the systems environment. Introducing leaked water into any system puts the station in an unpredictable condition that is outside the design basis and therefore creates a potentially hazardous situation.

In addition, addressing the problem of the station's roof condition has been added to the Fukushima response actions and as such will receive special attention from the CNSC and the public. At present, there is an opportunity to avoid threats to the station's Power Reactor Operating License.

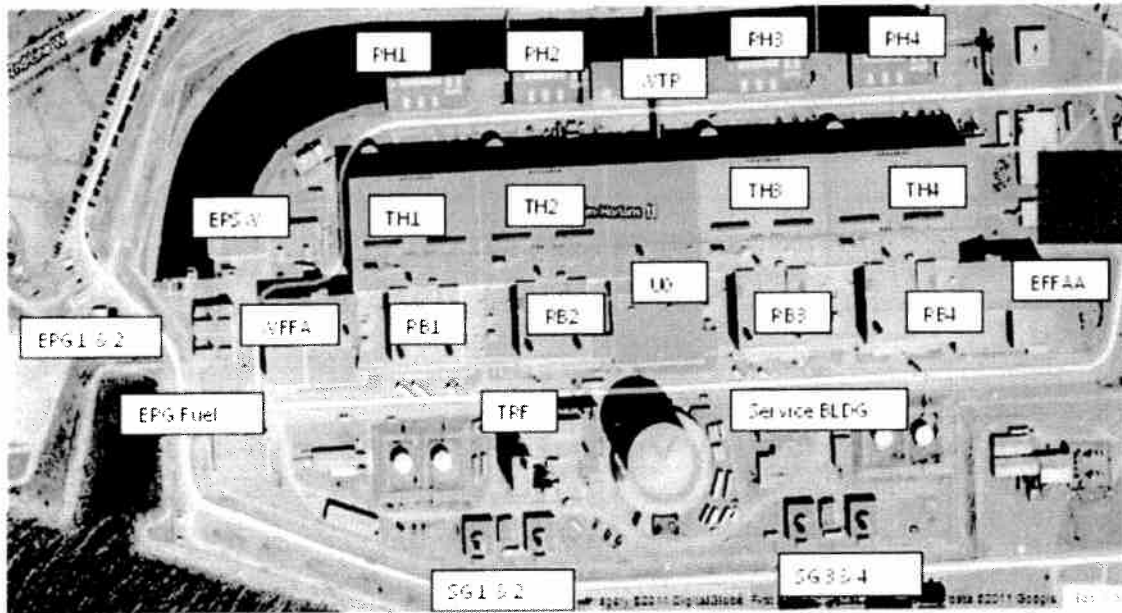
The roofs that are included in the proposed scope are:

- Turbine Halls Unit 1 to 4 (TH1 to TH4)
- Common Service Area (U0)
- Reactor Buildings Unit 1 to 4 (RB1 to RB4)
- West and East Fuel Bays (WFFA and EFFA)
- Pump Houses Unit 1 to 4 (PH1 to PH4)
- Water Treatment Plant (WTP)
- Emergency Power Supply Electrical Building (EPSW)
- Emergency Service Water Pump house (ESW)
- Emergency Power Generator Buildings (EPG1&2 and EPG Fuel)
- Tritium Removal Facility (TRF)
- Service Building
- Standby Generator Buildings (SG1 to SG4)

The Project will also address the need to modify the design of the Pump House Roof Equipment Hatches as well water sealing of the roofs penetrations.

Please see figure below for aerial photo diagram of the roofs included in the scope of this project.

Type 2 Business Case Summary



Preferred Alternative: Replace existing Station Roofs

The Station Roofs have reached the end of their 25 year design life and need to be replaced. The best roof replacement alternative will be decided during the preliminary and detailed engineering phases of the Project. Roofing options will be evaluated with economic assessments; waste management plans assessed and defined Engineering Change Control requirements.

Base Case: Status Quo – No Project

Water leaks into the station are wide spread and expected to increase due to continued degradation. If this project is not implemented, roof leaks will continue to occur, increase in overall cost and be disruptive to plant operations.

Alternative 2: Delay Work – Fix leaking roofs on an as needed bases

It is not economically beneficial and does not support operational needs to repair roofs on an as needed bases. This alternative is not a good solution to the business need because roofs may leak where repair meets the old section of the roof.

Alternative 3:

None.

Alternative 4:

None.

Deliverables:

This Release:

The deliverables for this release include: approved Mod Outline, issued Mod Design Requirements, Technical Specification, and Design Release Plan attached to the Master EC.

Milestones:

Preliminary Design Complete

Target Date:

9 Sept 2013

Type 2 Business Case Summary

BCS to release detailed engineering and execution of some buildings with the option price to complete the entire project.	Definition and Execution Partial BCS Approved	9 Jan 2014
References: NK38-PCH-20000-10003 – Project Charter NK38-REP-20000-10003 – Component Condition Assessment Report NK38-REF-20000-0446063 – DNGS Roof Condition Report Pinnacle Group Inc 2011 SCR's on Station Roof Leaks: D-2009-03828, D-2009-03926, D-2009-03996, D-2009-11314, D-2011-01309, D-2011-03042, D-2011-03266, D-2011-14116, D-2012-08286		

Part B: Project Cash Flows									
k\$	LTD	2012	2013	2014	2015	2016	2017	Future	Total
Currently Released	0								0
Requested Now	-	18	793						811
Future Required	-			825	8,989	12,700	12,786	148	35,448
Total Project Cost		18	793	825	8,989	12,700	12,786	148	36,259
Ongoing Costs	-								
Grand Total	0	18	793	825	8,989	12,700	12,786	148	36,259
Estimate Class ¹ :	Class 5		Estimate at Completion ¹ :				OAR Approval Amount:		811
Additional Information on Project Cash Flows (optional):									
Ref. OPG-STD-0076 Section 1.4:									
Project may utilize Type 2 documentation for the Initiation and Definition Phases if the release amount and the other investment/project criteria all meet the requirements for a Type 2 BCS. Modification Risk is low.									
General Project Contingency has been included at [REDACTED] as a Class 5 estimate has been performed by Faithful and Gould and no bids have been received to date.									

¹ Estimate Class and Estimate at Completion are to be stated if known. Other supporting documentation such as a Summary of Estimate (SoE) may be attached. The SoE template can be found on the Finance BCS Toolkit website.

Type 2 Business Case Summary

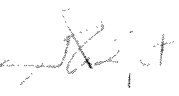
Part C: Financial Evaluation					
k\$	Preferred Alternative	Base Case	Delay Work	Alternative 3	Alternative 4
Project Cost	36,259	N/A	N/A	N/A	N/A
NPV (after tax)	N/A	N/A	N/A	N/A	N/A
Other (e.g., LUEC)	N/A	N/A	N/A	N/A	N/A
Summary of Financial Model Key Assumptions (see Guidance on this Type 2 BCS Form): As per OPG-STD-0076, an economic justification is not required for sustaining investment/projects.					

Part D: Risk Assessment				
Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Roofing Material Waste Disposal (Future Release)	Project to determine in Preliminary Engineering if waste is conventional vs rad waste by taking test samples and having them analysed.	Medium	Medium
Scope	The Pump House Roof Equipment Hatches need to be redesigned as part of the project due to excess leaking. The scope of this work is not well defined at this point.	During the pre bid meetings ensure the contractor walks down the Pumphouse Roof Equipment Hatches in detail to ensure this scope is well understood.	Medium	Low
Schedule	Risk that the Contractors schedule to preform Preliminary Engineering is longer than estimated.	Schedule estimate was based off of other similar Projects.	Medium	Low
Resources	None			
Quality/ Performance	None			
Technical	Existing Electrical Conduits on Roof (Future Release)	Project to determine what systems the conduits are powering and ensure the proper barriers are in place to protect them.	Medium	Low

Part E: Post Implementation Review (PIR) Plan				
Type of PIR		Target Project In Service Date		Target PIR Completion Date
Not Applicable		N/A		N/A
Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)

A PIR Plan will be included in the next BCS release.

Type 2 Business Case Summary

Part F: Review/Approvals			
	Signature	Comments	Date
This BCS represents the best option to meet the validated business need in a cost effective manner.			
Recommended by: Doug Radford Manager, Maintenance Project Sponsor			22 Nov 2012
I concur with the business decision as documented in this BCS.			
Finance Approval: Carla Carmichael Vice President, Nuclear Finance			21/11/12
I confirm this project will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Steve Ramjist Director, Ops and Maintenance , per OAR 1.1			Nov 20, 2012

Type 2 Business Case Summary

To be used for investments/projects meeting Type 2 criteria in OPG-STD-0076.

Project Information			
Project #:	16-31532	Document #:	D-BCS-73200-10001
Project Title:	Powerhouse Water ACU Replacements		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	Investment Type:	Sustaining
Phase:	Definition & Execution	Release:	Partial
Facility:	Darlington	Target In-Service or Completion Date:	DEC2019

Project Overview
We recommend an additional release of \$10,709 k, including [REDACTED] of contingency. This will bring the total-to-date release to \$ 11,337k, including [REDACTED] of contingency. The estimated total project cost is \$20,045k, including [REDACTED] of contingency. The quality of the estimate for this release is Class 4, and for the total project is Class 5. This release will fund the following scope of work: - Detailed Engineering for Unit 0, 1, 2, 3 and 4 - Procurement of all materials - Preparation and approval for the next release Business Case Summary (BCS) History of BCS releases and project cost estimates: The total project cost was previously estimated for [REDACTED] plus [REDACTED] of contingency. This estimate was based on OPG's internal estimate only. Critical design, procurement and installation issues were not accounted for as the project was still in the early definition phase. Since then, the Modification Outline and the Modification Design Requirements (MDR) have been prepared to better understand the scope of this project. Project has also completed the Collaborative Front End Planning (CFEP) process with the Extended Services Master Services Agreement (ES MSA) contractor to refine engineering and procurement scope. Contractor has submitted their Engineering, Procurement and Construction (EPC) quote, which has been utilized to prepare a cost estimate for this release. History of scope and schedule changes: The overall scope has not changed since the previous BCS, however, the Target In-Service Date has been changed from October 2018 to December 2019. The project will not be able to meet the milestones for the upcoming D1641 outage, therefore Unit 4 ACU replacements will be completed in 2019 during the D1941 spring outage.

Part A: Business Need
The scope for this project includes the replacement of following Air Cooler Units (ACUs): (a) 0-73260-ACU3-16 (b) X-73220-ACU2 to 10 (X= Unit 1, 2, 3, 4) (c) X-73220-ACU17 to 26 (X = Unit 1, 2, 3, 4) The aforementioned ACUs listed above are approaching the end of their useful service life. Cooling coil leaks (due to inadequate condensate drainage resulting in corrosion) and loose fan blades have caused the ACUs to be unavailable on multiple occasions, as recorded in Station Condition Records (SCRs) (Appendix D: References, Item 1). These issues are documented in Component Condition Analysis for Air Cooling Units (Appendix D: References, Item 2). Another issue with the ACUs is the condensation spraying during humid conditions, which have initiated false alarms in rooms where a "beetle" is present.

Type 2 Business Case Summary

Document #: D-BCS-73200-10001

Project #: 16-31532

Project Title: Powerhouse Water ACU Replacements, <Partial> <Definition & Execution> Release

Part A: Business Need

In the worst case scenario, the unavailability of switchgear room ACUs coupled with a loss of Even Division of Standby Class III power, would result in a four unit shutdown within 4 hours.

Part B: Preferred Alternative: Replace all 90 ACUs mentioned in Part A above**Description of Preferred Alternative**

The preferred alternative is to replace all 90 ACUs with new units to improve equipment reliability and maintainability. New ACUs will be of water cooled fin and tube type to provide suitable temperature control for electrical and mechanical equipment in the rooms. They will also minimize spraying of condensate droplets in the nearby areas.

Master Engineering Change (EC) package (Appendix D: References, Item 3) and MDR (Appendix D: References, Item 4) have been prepared and issued, to provide design and functional requirements for the replacement ACUs. As ACUs 1/2/3/4-73220-ACU2-10 are located in critical rooms with sensitive equipment, installations will be performed during planned unit outages (D1711, DNRU2, D1831, D1941) to minimize risk to unit operation. All remaining ACUs will be replaced online.

Deliverables:	Associated Milestones (if any):	Target Date:
This release: 1. Award of EPC contract 2. Issue Design Engineering Change (EC) packages for Unit 0, 1, 2, 3, and 4. 3. Procure all materials and spare parts 4. Planning for Unit 2 online ACUs (2-73220-ACU17-26) 5. Planning for Unit 0 ACUs (0-73260-ACU3-13) 6. Planning of Unit 1 outage ACUs (1-73220-ACU2-10) 7. Prepare and submit next release BCS for station approval	1. Award of EPC contract 2. Unit 2 Online ACUs EC Packages issued 3. Unit 1 Outage ACUs EC Packages issued (D1711) 4. Unit 0 Online ACUs EC Packages issued 5. Next Release BCS Approved	Feb 27, 2015 Dec 15, 2015 Feb 01, 2016 April 01, 2016 April 15, 2016
Next Release: 1. Installation, Available For Service (AFS) declaration and EC Close-Outs for Unit 2 online ACUs (2-73220-ACU17-26) 2. Installation, AFS and EC Close-Outs for Unit 0 ACUs (0-73260-ACU3-13) 3. Prepare and submit full release BCS for station approval	1. AFS Unit 2 Online ACUs 2. AFS Unit 0 Online ACUs 3. Remaining EC Packages issued. 4. Full Release BCS Approved	TBD TBD TBD TBD
Full Release: 1. Installation, AFS and EC Close-Outs for Unit 1 outage ACUs (1-73220-ACU2-10) 2. Planning, installation, AFS and EC Close-Outs for Unit 1 Online ACUs (1-73220-ACU17-26) 3. Planning, installation, AFS and EC Close-Outs for Unit 2 Outage ACUs (2-73220-ACU2-10) 4. Planning, installation, AFS and EC Close-Outs for Unit 3 ACUs (3-73220-ACU17-26, 3-73220-ACU2-10) 5. Planning, installation, AFS and EC Close-Outs for Unit 4 ACUs (4-73220-ACU17-26, 4-73220-ACU2-10) 6. Project Close Out	1. AFS Unit 1 ACUs 2. AFS Unit 2 Outage ACUs 3. AFS Unit 3 ACUs 4. AFS Unit 4 ACUs 5. Project Close Out	TBD TBD TBD TBD TBD

References:

D-PCH-73200-10001 - Project Charter

EC 121839 - Master EC

NK38-MDR-73200-10001 - Modification Design Requirements

References (Continued):

Type 2 Business Case Summary

Document #: D-BCS-73200-10001

Project #: 16-31532

Project Title: Powerhouse Water ACU Replacements, <Partial> <Definition & Execution> Release

NK38-SOW-73200-10001 - Contractor's EPC Scope of Work

Part C: Other Alternatives

Summarize all viable alternatives considered, including pros and cons, and associated risks. Other alternatives may include different means to meet the same business need, and a reduced or increased scope of work, etc.

Alternative 2: Base Case – No Project

This alternative is not recommended as existing ACUs are reaching their end of life and are no longer reliable. Replacement ACUs are required to eliminate issues with leaking cooling coils, condensation spraying, loose fan blades and vibration due to worn bearings. New ACUs are expected to last until the end of plant life.

Alternative 3: Delay Work – Delay project installation by one year.

Delaying the project is not recommended as existing ACUs are failing and are a maintenance burden for the station. The project is targeting to replace Unit 2 Online ACUs (2-73220-ACU17-26) in July 2016 prior to start of Unit 2 Refurbishment outage. A one year delay to the project would cause the replacements to be added to Refurbishment scope or be completed after Unit 2 comes online in 2020. Therefore, project costs would be significantly impacted due to ongoing labour and interest charges and yearly increases in labour rates.

Alternative 4: N/A**Part D: Project Cash Flows, NPV, and OAR Approval Amount**

k\$	LTD	2015	2016	2017	2018	2019	2020	Future	Total
Currently Released	375	253	0	0	0	0	0	0	628
Requested Now	-	2,901	3,816	2,695	1,297	0	0	0	10,709
Future Required	-	0	1,713	3,034	2,359	1,493	109	0	8,708
Total Project Cost	375	3,154	5,529	5,729	3,656	1,493	109	0	20,045
Ongoing Costs	-	0	0	0	0	0	0	0	0
Grand Total		3,154	5,529	5,729	3,656	1,493	109	0	20,045
Estimate Class:	Class 5				Estimate at Completion:				
NPV:	N/A				OAR Approval Amount:		20,045		

Additional Information on Project Cash Flows (optional):

- Project has completed the Collaborative Front End Planning (CFEP) process with the ES MSA vendor and the vendor has submitted their quote for the EPC scope of work. Project cash flows are based on their estimates as well as OPG's internal costs.
- Cashflows and OAR Approval Amount above include [REDACTED] of specific contingency.

Part E: Financial Evaluation

k\$	Preferred Alternative	Base Case	Delay Work	Alternative 4	
Project Cost	20,045	N/A	21,000	N/A	
NPV					
Other (e.g., IRR)					

Summary of Financial Model Key Assumptions or Key Findings:

The Base Case alternative is not recommended as existing ACUs are reaching their end of life and are no longer reliable. Replacement ACUs are required to eliminate issues with leaking cooling coils, condensation spraying, loose fan blades and vibration due to worn bearings. New ACUs are expected to last until the end of plant life.

Delaying the project by one year is also not recommended as it would impact the Unit 2 installation schedule and project completion costs will be higher due to increase in labour rates and ongoing labour and interest charges.

Type 2 Business Case Summary

Document #: D-BCS-73200-10001

Project #: 16-31532

Project Title: Powerhouse Water ACU Replacements, <Partial> <Definition & Execution> Release

Summary of Financial Model Key Assumptions or Key Findings:

This is a Sustaining project and as per OPG-STD-0076, an economic justification is not required for sustaining investments/projects.

Part F: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that actual contractor costs could be significantly higher. Contractor's EPC cost is based on their Class 4 EPC quote. There is a risk that actual OPG costs could be higher as well.	Include calculated contingency (Specific) to ensure sufficient funds will be available to the project if costs are higher than expected. Project costs will be re-evaluated once the first Design EC packages are prepared and project scope is better defined.	Medium	Medium
Scope	There is a risk that project scope may increase if isolation valves or the drain lines are found to be inadequate prior to the start of ACU replacement.	Input work requests for station maintenance to inspect isolation valves, well in advance of installation start date. Deficient valves will then be added to project scope as required. Requirements for the drain lines will also be determined during the detailed design phase and project scope will be re-defined if field modifications are required.	Medium	Low
Schedule	There is a risk that delays during EPC contract assignment, will impact the preparation and timely delivery of Unit 2 design EC packages.	Contractor has submitted their EPC bid for this project. Projects will award the contract once this BCS is approved and funding is released.	Medium	Medium
Resources	There is a risk that due to competing priorities, contractor and OPG design resources may not be fully available to prepare, review and approve design ECs as per project schedule.	Projects will conduct regular stakeholder meetings to monitor progress. There is sufficient float included in the schedule in case of lack of resources or discovery issues.	Medium	Medium
Quality/ Performance	There is a risk that vendor design quality is poor.	Design documents will be reviewed through OPG's review cycles. Comments and feedback from OPG engineers will be provided and tracked by the project to ensure vendor drawings are as per OPG standards.	Medium	Low
Technical	There is a risk that the available flow rate will be insufficient for the new ACUs.	Projects has initiated work orders to take flow measurements at critical ACUs. Test results will be used by the contractor so technical specifications can be prepared according to the available flow rates.	High	Low
Schedule	There is a risk that project schedule will be impacted if Unit 2 Online ACUs cannot be installed prior to start of the Unit 2 Refurbishment outage in October 2016. Projects will then need to seek approval from Refurbishment organization to allow work to proceed in DNRU2 or schedule the installation after Unit 2 comes online in 2020.	Projects will work closely with the ES MSA vendor and monitor their progress on a weekly basis. Any risks will be identified to the station in a timely manner to determine the best path forward.	Med.	Med.
Schedule	There is a risk that project schedule will be impacted if Unit 2 Outage ACUs are not accepted in the Unit 2 Refurbishment	Projects is following up with Refurbishment to determine installation possibilities during DNRU2. Project	Med.	Med.

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Type 2 Business Case Summary

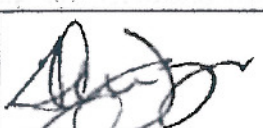
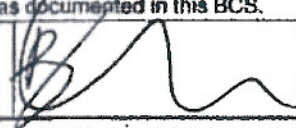
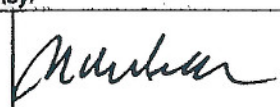
Project #: 16-31532

Document #: D-BCS-73200-10001

Project Title: Powerhouse Water ACU Replacements, <Partial> <Definition & Execution> Release

Part F: Risk Assessment				
Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
	scope. Installation will then be scheduled for the next Unit 2 planned outage in Fall 2022.	schedule will be updated as required once a path forward is provided.		
Technical	There is a risk that the selected ACUs may be of new technology.	The project is buying ACUs used throughout the general industry.	Low	Low
Other	Project cashflows are based on the assumption that the contractor will accept the payment schedule proposed by OPG.	Projects will utilize the PCRAF process to adjust cashflows after award of contract, if required.	Medium	Low

Part G: Post Implementation Review (PIR) Plan				
☐ It is determined appropriate that only a Project Closure Report (PCR) is needed as the PIR for this project, due to its straight forward deliverables, which do not require any measures other than confirmation of completion or delivery.				
Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date		
Simplified PIR	2019-12-15	2020-12-15		
Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Reliability of new ACU Units	ACU unit coil leaks, vibration, and fan blade failures	No leaks, vibration out of specification, or fan blade failures	System Health Reports, number of Work Orders, SCRs and vibration monitoring results	Performance Engineering
Incidents of condensation spraying in ACU rooms	Condensation spray in ACU rooms	No condensation spraying	System Performance Monitoring Plan and weekly walkdowns	Performance Engineering

Approvals			
	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Glenn Jager CNO			2/2/2015
I concur with the business decision as documented in this BCS.			
Finance Approval: Beth Summers CFO			Feb 4, 2015
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Tom Mitchell CEO per OAR 1.1			Feb 2015

Type 2 Business Case Summary

Document #: D-BCS-73200-10001

Project #: 16-31532

Project Title: Powerhouse Water ACU Replacements, <Partial> <Definition & Execution> Release

Appendix A: Summary of Estimate

Project Number:	16-31532									
Project Title:	Powerhouse Water ACU Replacement									
k\$	LTD	2015	2016	2017	2018	2019	2020	Future	Total	%
OPG Project Management	281	142	352	328	227	209	62	0	1,601	8
OPG Engineering	74	345	190	242	133	25	3	0	1,012	5
OPG Other	0	5	5	7	5	5	3	0	30	0
EPC Contractor - Engineering										
EPC Contractor - Procurement										
EPC Contractor - Construction										
EPC Contractor - Project Management										
EPC Contractor - Other										
Interest										
Subtotal										
Contingency										
Total	375	3,154	5,529	5,729	3,656	1,493	109	0	20,045	100
Removal Costs	0	0	86	86	55	55	0	0	282	

Notes

Project Start Date	OCT2012	Total Definition cost (excludes unspent contingency for Nuclear)	
Target In-Service (or AFS) Date	DEC 2019	Contingency included in this BCS (Nuclear only)	
Target Completion Date	DEC 2020	Total contingency released plus contingency in this BCS (Nuclear only)	
Escalation Rate	3%	Total released plus this BCS without contingency (Nuclear only)	
Interest Rate	5%	Total released plus this BCS with contingency (Nuclear only)	\$11, 337K
Removal Costs	\$282K	Estimate at Completion (includes only spent contingency for Nuclear)	

Prepared by:

Approved by:



 Brian Graham
 Section Manager, Design Projects

22 Jan 2015

Date



 Ray Balachorek
 Manager, Design Projects

22 Jan 2015

Date

Type 2 Business Case Summary

Project #: 16-31532

Document #: D-BCS-73200-10001

Project Title: Powerhouse Water ACU Replacements, <Partial> <Definition & Execution> Release

Appendix B: Comparison of Total Project Estimates and Project Variance Analysis**Comparison of Total Project Estimates**

Phase	Release	Approval Date	Total Project Estimate in k\$ (by year including contingency)						Future	Total Project Estimate
			2012	2013	2014	2015	2016	2017		
Definition	Full	OCT2012	3	590	4,010	2,720	996	972	401	9,693
Definition Execution	Partial	JAN2015		226	149	3,154	5,529	5,729	5,258	20,045

Project Variance Analysis

k\$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	281	326	1,601	1,275	Based on other similar project experiences, OPG Project Management costs will be significantly higher during installation periods than previously estimated.
OPG Engineering	74	368	1,012	644	OPG Engineering costs will also be significantly higher as civil, mechanical and electrical design resources will be required to provide oversight to the EPC contractor during EC preparation, installation and EC Close-Outs.
OPG Other					
EPC Contractor - Engineering					
EPC Contractor - Procurement					
EPC Contractor - Construction					
EPC Contractor - Project Management					
EPC Contractor - Other					
Interest					
Subtotal					
Contingency					
Total	375	9,693	20,045	10,352	
Removal Costs	0	233	282	49	Removal costs in this BCS are based on [REDACTED] of contractor's construction costs.