

**Board Staff Interrogatory #022**

**Ref:** Ex. D2-T1-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please provide variance explanations for (i) the difference between 2008 actual and 2008 Board-approved and (ii) between 2009 actual and 2009 Board-approved for Nuclear Capital Expenditures.

**Response**

The OEB accepted OPG's 2008 and 2009 forecast of nuclear capital expenditures excluding refurbishment capital expenditures (OEB Decision with Reasons, EB-2007-0905, page 35). The requested variance explanations are provided in Ex. D2-T1-S1, section 7.0, 2008 Actual versus 2008 Budget, and 2009 Actual versus 2009 Budget.

**Board Staff Interrogatory #023**

**Ref:** Ex. D2-T1-S1, Table 2

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please add additional rows to the table (Capital Expenditures Summary-Nuclear Operations) such that "Facility Projects To Be Released" and "Listed Work To Be Released" are sub-categorized by Site.

**Response**

"Facility Projects to be Released" by site have been added to the table below. The funding for "Listed Work to be Released" is not allocated by site and may be associated with any of the projects included in Ex. D2-T1-S2, Table 5a and Table 5b.

Table 2							
Capital Expenditures Summary - Nuclear Operations (\$M)							
Line No.	Sponsoring Division/Category	2007 Actual	2008 Actual	2009 Actual	2010 Budget	2011 Plan	2012 Plan
		(a)	(b)	(c)	(d)	(e)	(f)
	<b>Facility Projects (Released)</b>						
1	Darlington NGS	45.4	67.6	59.1	24.3	12.8	5.6
2	Pickering A NGS	35.4	16.1	51.0	11.8	0.7	0.0
3	Pickering B NGS	55.1	20.1	15.2	10.8	0.8	0.5
4	Nuclear Support Divisions <sup>1</sup>	50.5	59.8	34.1	58.0	3.9	0.7
5	<b>Total Facility Projects (Released)</b>	186.5	163.5	159.4	105.0	18.3	6.7
6	<b>Facility Projects to be Released</b>						
7	Darlington NGS	0.0	0.0	0.0	24.1	38.9	41.9
8	Pickering A NGS	0.0	0.0	0.0	2.6	10.9	0.8
9	Pickering B NGS	0.0	0.0	0.0	5.0	6.1	2.9
10	Nuclear Support Divisions <sup>1</sup>	0.0	0.0	0.0	4.8	18.0	9.4
11	<b>Total Facility Projects (to be Released)</b>	0.0	0.0	0.0	36.6	74.0	55.0
12	<b>Listed Work to be Released</b>	0.0	0.0	0.0	30.4	79.8	110.3
13	<b>Subtotal Project Capital (Portfolio)</b>	186.5	163.5	159.4	172.0	172.0	172.0
14	<b>P2/P3 Isolation Project</b>	9.3	5.7	14.1	8.8	0.0	0.0
15	<b>Minor Fixed Assets</b>	11.5	14.2	17.0	20.2	19.7	19.5
16	<b>Total Nuclear Operations Capital</b>	207.2	183.4	190.6	201.0	191.7	191.5
Notes:							
1	Nuclear Support Divisions includes Engineering, Projects & Mods, Supply Chain, Programs & Training, Inspection Mtce and Commercial Services, Facilities and PINO.						

**Board Staff Interrogatory #024**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 2

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The BCS for the Fuel Handling Power Track Modifications indicates that the project assumes a Project/Station End of Life of 2018 (p.14).

In light of OPG's plans to refurbish the Darlington units and extend their service life by 30 years, please clarify whether the Fuel Handling Power Track Modifications improvements will continue to be useful beyond 2018.

**Response**

The Darlington Fuel Handling Power Track Modifications will continue to be useful beyond 2018 for the refurbished units.



**Board Staff Interrogatory #025**  
**(NON-CONFIDENTIAL VERSION)**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 3

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) The (Partial Release) BCS for the Improve Maintenance Facilities project indicates that the Full Release BCS was scheduled for May 2009.
- i) Has this occurred? If not, please elaborate on the cause for the delay and what the new target date is for the Full Release BCS.
- ii) If yes, please provide a copy of the Full Release BCS.
- b) On page 9 of the BCS it is stated:

In the Full Release BCS the following items will be included as per Nuclear Oversight Committee/Board of Directors specific request:

- Analysis of existing space currently used by Maintenance staff for the various functions and an explanation of why each function must be moved to the new location (e.g. tabulate: function/space currently used for the function/why the function must be moved to a new location).
- Detailed benchmarking data for similar building construction on a cost-per-square foot basis.

Please provide the aforementioned information.

**Response**

- a) The full release business case summary ("BCS") scheduled for May 2009 did not occur. The information contained in the partial release BCS referenced above was based on a strategy to build the maintenance facility inside the protected area. In May 2009, a revised project charter was approved to move the proposed maintenance facility outside the protected area. As a result, instead of the originally planned full release BCS, a further partial release BCS for the revised maintenance facility project (outside the protected area) was approved by the OPG Board of Directors in May 2010 with the full release BCS targeted for April 2012.

A redacted copy of the partial release BCS approved May 2010 is attached as Attachment 1. OPG is seeking confidential treatment of the redacted portions of this

1 partial release BCS. An unredacted copy of the partial release BCS approved May 2010  
2 has been filed in accordance with the OEB's Practice Direction on Confidential Filings.

- 3 b) As noted above, the full release BCS was not prepared and, as a result, the type of  
4 analysis contemplated in the initial partial release BCS was not completed. To respond in  
5 part, however, please refer to the attached May 2010 partial release BCS (redacted). On  
6 page 2 of 27, in the paragraph beginning "For the past few years..." the shortfalls with  
7 respect to the existing maintenance workspace are summarized. Additionally, beginning  
8 on page 4 of 27, the section entitled "Computer Development Facility" summarizes the  
9 need for new computer development facilities. Beginning on page 7 of 27, Table 4,  
10 entitled "Building Layout and Use Concept", itemizes the area required for each function,  
11 the number of personnel within each function and the reason for staff relocation.

**BUSINESS CASE SUMMARY**

 Filed: 2010-08-12  
 EB-2010-0008  
 L-01-025  
 Attachment 1

**Darlington New Maintenance Facility 16 - 31717**
**Partial Release Business Case Summary D - BCS - 28200 - 10005 - R000**
**1/ RECOMMENDATION:**

Approval of \$5.0 M capital funding is requested for a total release of \$13.55M (including contingency) to complete the preliminary and detailed engineering, procurement of long lead equipment and components, and site preparation for a new maintenance and computer development facility outside the protected area at the Darlington Nuclear Generating Station (DNFS). The forecast to complete the project is \$49.8M (including contingency).

This sustaining project has several business objectives:

- Replace the maintenance work areas that have been or will have to be removed due to nuclear safety and fire code compliance requirements as well as station requirement for the control of transient material.
- Provide replacement facilities for those to be removed for implementation of the station Refurbishment project.
- Provide adequate and improved working space for maintenance staff to improve productivity and morale by addressing the following needs:
  - increased space requirements because of a change in maintenance strategy to day shift from a shift (24/7) operation
  - the implementation of new maintenance management technologies and computerized planning and reporting
  - adequate space requirements for Pre/Post Job Briefings to improve Human Performance results, and also for rehearsals and mock-ups for on-line and outage maintenance support.
- Replace the existing computer support buildings which are to be demolished as part of the station Campus Plan and provide a home for the Shut-Down Systems computer support facility currently located in leased off-site facility.

For the past few years, the challenges introduced by the shortfalls in maintenance workspace have been met by use of empty spaces in equipment rooms, hallways etc and with various temporary/permanent offices or shops inside and outside of the Powerhouse. Such provisions can no longer be continued due to various drivers for removal of the workstations and facilities. The table below shows the number of maintenance work station that are affected by various drivers/problems, resulting in the need to relocate maintenance work and staff.

**Table 1: Number of Maintenance & Computer Staff Affected**

Reason for Relocation of maintenance workstation	Number of affected mtce workers
Health and Safety and code issues (regulatory)	28
Facilities to be dismantled to make room for Refurbishment (sustaining)	50
Life-expired Computer facilities to be demolished as per Campus Plan. Cost saving opportunity (value enhancing)	14
Part of Strategic Consideration and integration for office space and relocating unavailable off site facilities (sustaining)	12
Part of strategic consideration and integration of office space for managing maintenance work. Facilitate Improvements (sustaining)	16
Total	120

In the previous partial release (May 2008), the project had recommended a New Maintenance Facility (NMF) inside the protected area. Since then, further engineering and cost estimations, including the lessons learned from the Darlington Construction Change Room project, has determined that the proposed facility could not be built inside the protected area within the funding limit of \$50M set by the Board of Directors. The current estimate for the NMF inside the



## BUSINESS CASE SUMMARY

Filed: 2010-08-12  
EB-2010-0008  
L-01-025  
Attachment 1

protected area is about \$83M including contingency. The decision was made to relocate the facility outside the protected area to reduce costs and to stay within the funding limit. The \$50M estimate for this project includes the cost of the engineering and demolition of the abandoned Powerhouse Annex (\$ ), estimated cost of computer development portion (\$ ) and overall contingency (\$ ). The estimated cost of the maintenance facility before addition of the computer development scope, demolition of Powerhouse Annex is therefore \$40M which includes \$ contingency.

A project scope change since the previous partial release BCS has been to include the needed replacement computer support facilities within the NMF instead of as a stand-alone building. This results in cost savings to OPG of \$3M. The computer development facility was originally part of the station Campus Plan.

A Full release BCS is scheduled for the first quarter of 2012, following the retention of an Engineering/ Procurement/ Construction (EPC) contractor and completion of detailed engineering and release quality estimates. The NMF is scheduled to be in service in 2013, just in time to free up space within the protected area required by the station refurbishment project.

**Table 2: Release Summary and Cash Flow**

\$000's (incl contingency)	Type	LTD 2009	2010	2011	2012	2013	2014	Later	Total
Currently Released	Partial	8,538							8,538
Requested Now	Partial	(3,810)	1,640	4,280	2,900	-	-		5,010
Future Funding Req'd	Full			-	26,828	9,438			36,266
Total Project Costs		4,728	1,640	4,280	29,728	9,438	-	-	49,814
Non Project Costs									-
Grand Total		4,728	1,640	4,280	29,728	9,438	-	-	49,814
Investment Type Sustaining		Class Capital		NPV \$6,826k		IRR NA		Discounted Payback 37	

Submitted By:

Wayne Robbins 2010-04-16  
CNO Date

Finance Approval:

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

Donn Hanbidge Apr. 27 / 10  
SVP & CFO Date

Tom Mitchell 2010-Apr-28  
President & CEO Date

**BUSINESS CASE SUMMARY**Filed: 2010-08-12  
EB-2010-0008  
L-01-025  
Attachment 1**2/ BACKGROUND & ISSUES**

The need for additional maintenance space has been in the business plan for years due to removal of office and structures from the station as a result of nuclear and fire assessment reasons, a change in maintenance strategy (day shift vs 24/7), emphasis on human performance and the station Event Free Tools which results in increased frequency of Post and Pre-job briefs as well as life-expired buildings and code compliance.

This project was started in 2005 while the station maintenance management and staff were being continuously challenged by the shortage or inadequacy of the space for conducting day to day maintenance work resulting in management and worker frustrations. Building this facility will demonstrate management's commitment for making adequate provisions for the station maintenance activities.

In May of 2008 a partial release BCS was approved for a new maintenance facility to undertake the following activities:

- Removal and de-commissioning of the building on the selected site within the protected area,
- Design for the tie-ins and/or relocation of the tie-ins,
- Contract procurement process for the building and approval of a full release BCS.

Upon further engineering and cost estimation, including incorporation of lessons-learned in the Construction Change Room project, we are now recommending a facility outside the protected area that will be a better value for money and will meet the stations needs and include a computer development facility. The following are some of the activities that were undertaken to arrive at the recommended approach:

- Completed an initial Value Engineering (VE) workshop to evaluate alternatives using commercial standards with modified layouts, reduced footprint, and a self sustained stand alone Maintenance Facility inside the protected area. The cost of the alternatives ranged from \$51M to \$90M.
- Conducted a benchmarking exercise with other North American Nuclear utilities to obtain cost information for similar buildings inside the protected area and compare with OPG cost estimates. Although other buildings for security purposes were constructed by other utilities, no building comparable to a maintenance facility building had been built inside the protected areas since the events of September 11, 2001.
- The cost of the 19000 sq ft Construction Change Room (CCR) inside the protected area in Darlington amounted to approximately \$24M, or about \$1.3k/sq ft. The CCR did not include some major equipment or features such as overhead crane, overhead doors, loading bays, offices or IT and LAN services therefore, allowances were included in the estimate for the maintenance facility which resulted in a total estimate of some \$83M which included 10% contingency.

Based on the above findings the project team concluded that providing a maintenance facility within the approved limit of \$50M could not be met.

In May 2009 a Project Charter was approved for considering a maintenance facility outside the protected area that could house adequate workspace for station maintenance and the computer development facilities which were earmarked for relocation by the Darlington Campus Plan due to aging of the existing computer buildings.

**Strategic Considerations:**

The plan for building a new maintenance facility outside the protected area expanded the project considerations to some other OPG initiatives and long terms plans such as **Campus Plan, Darlington Refurbishment and Operations Support Building Retrofit**. The summary of such considerations are discussed in the following sections:

**Computer Development Facility:**

Several projects have recently been approved to replace or upgrade the existing computerized systems of the station Shut



**BUSINESS CASE SUMMARY**

L-01-025

Attachment 1

Down Systems (SDS), Fuel Handling (FH) and Digital Control Computers (DCC). The computer development and laboratories supporting these computerized stations systems are currently located in three locations (two on-site and one off-site). The on-site facilities are life expired and targeted for demolition as part of Campus Plan and the off-site facility needs to be returned to the owner. These facilities are now integrated into the Maintenance Facility Project with a cost savings to OPG of approximately \$3M.

**Campus Plan**

The Darlington Campus Plan was approved in May 2009. The Darlington Campus Plan – funded by refurbishment project – will replace all the life-expired facilities at Darlington and build new facilities strategically located around the station on OPG land for long term support of DNGD. At the same time that the Campus Plan was being approved, the decision was made to relocate the NMF outside the protected area and to incorporate the Computer Development Facility into this project (within funding limit of \$50M) as an opportunity for cost saving.

All other proposed facilities in the Campus Plan are proposed for specific usage at various locations on site and on nearby OPG land. Additional integration with the NMF will not result in further cost savings to OPG. For example, a Facility Services Building is planned for 2016 at a location north of the station. Consolidation of this building into the proposed NMF will not be possible or cost effective due the space limitation and the impact of such a large complex on the available parking space near the plant.

In terms of the overall office accommodation needs it is recognized that with the cancellation of the Clarington Energy Center there is a shortage that will need to be addressed through an off site leasing strategy. This shortfall is not within scope of the Maintenance Facility project.

**Darlington Refurbishment**

This project was also reviewed in the light of the Refurbishment project and facility needs. The facilities planned for the Refurbishment varied from the NMF in terms of functionality and use. In order to consolidate these facilities with the proposed maintenance facility, they would need to be designed and constructed as a hybrid complex which would result in much higher cost and they would not become available to the station until 2024, after Refurbishment, which is too late to meet the station maintenance challenges.

The start date for infrastructure construction within the protected area (outside the powerhouse) for the Refurbishment program is early 2013. This will require the current Darlington maintenance facilities in the area targeted to be replaced by Refurbishment facilities to be vacated and ready for demolition by 2013. As such, the NMF project is on the critical path for the Darlington Refurbishment program.

**Operations Support Building (OSB) Retrofit Project**

This project was also reviewed against the Operating Support Building (OSB) retrofit project. The driver for OSB retrofit is the deteriorating condition of the building and will not result in additional space. The swing space for office during construction is being planned separately by the Nuclear Facilities organization.

The maintenance facility is being proposed to support the day to day station maintenance needs and its objectives. Its scope is limited to certain specific maintenance functions which include minimum number of offices. The OSB occupants are made of station planning and operations staff and management that need to have ready and immediate access to the plant. During the building retrofit, some of the staff can be relocated temporarily but permanent relocation of the staff and de-commissioning of the OSB requires significant engineering and strategic planning with major impact on scope, cost and schedule of this project and little or no foreseeable cost benefit to OPG.

**Business Case Justification:****Employee morale**

This project was first initiated in 2001 and later deferred in 2002 due to other priorities. The project was initiated again in 2005 while station maintenance management and staff were being continuously challenged by the shortage or inadequacy of the facilities for carrying out maintenance work. Building the NMF demonstrates OPG's commitment to making adequate provisions for the station maintenance activities and creating an environment where staff can perform their duties more efficiently. This will have a positive effect on employee morale.

**Economic benefits**

A detailed assessment was made of the economic benefits of this facility based on extensive communications and interviews



## BUSINESS CASE SUMMARY

with the maintenance staff, supervisory and management personnel. A challenge meeting was recently held between the project team and maintenance supervisory staff to ensure that their inputs were consistent with the financial assumptions and arguments.

Economic benefits were categorized into the areas of productivity savings and the mitigation of forced and planned outages. Estimates were obtained in terms of loss productivity for each function for normal day to day work, planned and forced outage campaigns, unconditional transfer permits savings, and rental facility savings. Considerations included (i) the list of the work spaces and offices that have been removed and will have to be removed due to life expiry and code compliance, (ii) the more recent need to make room for the station Refurbishment project, (iii) an aging station, (iv) the change in maintenance strategies and (v) more rigorous procedures for managing the station day to day maintenance activities. The economic contributions of each of the work shops have been summarized in the table below.

**Table-3: Breakdown of NPV per each assumption:**

Incremental Benefits	%	NPV (M\$)
<b>Productivity Saving (1)</b>	<b>16.77%</b>	<b>\$1,145</b>
Control Maintenance Valve Shop	1.83%	\$125
Mechanical Maintenance Relief Valve shop	1.64%	\$112
Mechanical Maintenance Supervisors offices	3.42%	\$233
Reactor Maintenance	4.97%	\$339
Control Maintenance Breaker and Relay Shop	3.39%	\$231
Welding shop	0.84%	\$57
Electronics shop	0.68%	\$46
<b>Mitigation of Planned Outage Extension (2)</b>	<b>66.72%</b>	<b>\$4,554</b>
Control Maintenance Valve Shop	16.08%	\$1,098
Reactor Maintenance	35.74%	\$2,440
Control Maintenance Breaker and Relay Shop	14.89%	\$1,016
<b>Mitigation of Forced Outage Extension (3)</b>	<b>14.91%</b>	<b>\$1,017</b>
Mechanical Maintenance Relief Valve shop	0.20%	\$14
Reactor Maintenance	8.59%	\$586
Control Maintenance Breaker and Relay Shop	6.12%	\$418
<b>UTP Saving (4)</b>	<b>0.52%</b>	<b>\$35</b>
<b>Rental Facility Saving (5)</b>	<b>1.08%</b>	<b>\$74</b>
<b>Total</b>	<b>100.00%</b>	<b>\$6,826</b>

### Impact on the Station Business Plan

The current business plan (BP) is built based on having the facility in place by 2013. In case of delay to this project the BP may need to be re-visited.

### Facility Layout and Requirements:

In October 2009, continuing with the project and plan to build a maintenance and computer development facility outside the protected area was endorsed by the station senior management.

In January 2010 a Value Engineering (VE) session was held with strong representation from Maintenance Department, Computer Engineering, Facilities, Radiation Protection, Field Engineering, Contract Management Office and Projects & Modification. The objectives of this workshop were to:

- analyze the current challenges to maintenance production and find ways to optimize the concept that would eliminate/minimize these challenges,
- identify the maintenance functions and activities that could be located outside the protected area,
- identify the computer development facility functions that could be located in the new building,
- identify the work groups that would be residing, using or maintaining the building,
- identify any logistical issues that may arise as the result of relocations to the extent possible,
- Estimate incremental security support and include the cost in the financial analysis,
- outline the functional requirements for the building to support the objectives, and
- estimate footprints

The outcome of the value engineering is summarized in the following Table-4 below.

**Table-4: Building Layout/Use Concept – DNGS Maintenance & Computer Development Facility**

Work Area	Facility Component	Estimated Area (ft <sup>2</sup> )	Functional Requirement	Number of personnel	Reason for Relocation
Mechanical Maintenance	RV Test/Repair	1,500	Area needs to house 4 people with computer stations. Needs ventilation for specialized equipment. Cranes and Hoist.	4	Code issues and Health and safety (4)
Mechanical Maintenance	Supervisors Offices	2,600	Need (FLM) First Line Manager and FLMA work cubicles, private offices for coaching, and two pre-job briefing areas	Included in the shops	Facilitate Improvements and value enhancing
Mechanical Maintenance	Welding Shop	3,500	Need enough room for six welding stations, ventilation for specialized equipment.	12	Facilitate Improvements and value enhancing (12)
Reactor Maintenance	Mock-up Rehearsal and Training, and Machine shop	6,000	Material Transfer/Rehearsal Space to reduce time and possible back injuries. Office space, work stations, and a briefing room. Includes 800 sq.ft for a general machine shop	13	Building 29 to be Dismantled to make room for Refurbishment (sustaining) (13). Improvements to Productivity
Control Maintenance	Multi Function Valve shop and Breaker and Relay, Electronics cards and boards repair	5,000	Must be able to house up 28 people. Office for FLM & FLMA. Hoist and test areas for valves, breakers, relays, and electronic repair area	28	<b>Valve Shop</b> Code issues and regulatory (12) <b>Breaker Shop</b> Code issues and regulatory (12) <b>Electronic Shop</b> Facilitate Improvements and value enhancing (4)
Civil Maintenance	Section Manager offices/PJB Rooms	3,000	Need FLM and FLMA work cubicles for 17 people, two private offices for coaching, one (PJB) pre-job briefing area and	17	Trailers to be Dismantled to make room for Refurbishment (sustaining) (17)



## BUSINESS CASE SUMMARY

			permanent filing system		
Insulators and Building Mechanics	Insulators, mechanics, carpentry and lamacoid shops	5,000	Benches and equipment, and work stations, offices for FLM and FLMA	20	Building 31 to be Dismantled to make room for Refurbishment (sustaining) (20) Building 51 Free up space part of integration
Predictive Maintenance	Assessing and Planning	1,000	Offices and workstations	8	Part of Strategic Consideration and integration to Free up space in OSB (8)
Computer Services	Digital Computer Control (DCC) and Programmable Logic Controllers (PLC).	5,700	Computer Development Facility (5700 ft <sup>2</sup> ) – includes areas: - Lay down and Storage (500 ft <sup>2</sup> ) - Board Repair (626 ft <sup>2</sup> ) - Computer Room (1540 ft <sup>2</sup> ) - Software Development Room (534 ft <sup>2</sup> ) - OH180 Lab (1500 ft <sup>2</sup> ) - Office Area (1000 ft <sup>2</sup> )	10	Part of Strategic Consideration and integration. Current facilities to be demolished as per Campus Plan (4)
Computer Lab	Fuel Handling	1,080	- System simulation testing. Space to house control computer and peripheral devices	4	Part of Strategic Consideration and integration. Current facilities to be demolished as per Campus Plan (4)
Computer Lab	Shutdown Systems	1,739	- Shutdown System computer Hardware and Software	4	Part of Strategic Consideration and integration. No longer available (4).
Services	Loading & Transfer Bay	3,000	Receiving office, roll-up door access, loading elevator with elevated ramp, parking for delivery truck and lay down areas		
Services	Lunchrooms	1,600	Facilities to house 100 employees As per codes		
Services	Shower Facility and Change room (Lockers included)	2,400	Need Shower to service 80 men and 20 women occupants of building. As per codes		
Services	Washrooms	1,000	Need washrooms for occupants of building		
Services	Corridors, Hallways, Elevators & building services space	5,000	To suit building requirements		
Total		49,000		120	

**Note:** The above footprints are estimations and will be finalized during the preliminary engineering phase.

The proposed building will be built south east of the Auxiliary Security Building (ASB) (in place of existing temporary building No. 119). The relative proximity of this new building to the ASB will provide ease of movement between the plant and the new facility. The building will be occupied by about 102 Maintenance personnel on day shifts who will report to work in the building.

**BUSINESS CASE SUMMARY**

L-01-025

Attachment 1

execute the majority of the day shift activities in the building and leave work from the building. The computer development facility would be occupied by up to 18 personnel on days shift.

Building #119 will be vacated by Nuclear East Facilities organization and will be dismantled by this project for site preparation.

The new Maintenance Facility located outside the Protected Area will meet the primary objective to improve maintenance productivity and provide adequate space for a new computer development facility for Fuel Handling, Shutdown Systems, Digital Control and Programmable Logic Controllers computer support services. Improvements or replacement of such computer systems inside the plant have been approved. The new computer support facility will be providing testing, repair and development capabilities to the live systems in the plant. The current computer support facilities are in life expired or leased off-site facilities not suitable for the use and are planned for removal or return to the owner.

**Project Status:**

Under the previous partial release the following activities were completed:

- De-commissioning and removal of Powerhouse Annex and adjacent buildings
- Partial engineering on the relocation of services and tie-ins,
- Value Engineering on various alternatives,
- Conceptual design
- Expression of Interest (EOI) by several contractors including cost estimates for the building.

**Current status:**

- De-commissioning and removal of temp structures complete.
- Preliminary engineering for buried services partially complete.
- Conceptual layout of the new maintenance facility complete.
- Scope of Work for Expression Interest to Engineer Procure and Construct the new building complete.
- Expression of interest from vendors received with estimates.
- Project cost estimate for building a facility inside the protected area significantly in excess of the Board of Directors (BOD) limit of \$50M.
- New implementation strategy for the construction of the facility outside of the protected area has now been endorsed by the station senior management.
- The concept and the functional requirement for a maintenance and computer development facility outside the protected area being proposed via this BCS.

Current approved release is \$8.5M and actual cost to date (Dec 2009) is \$4.7M.



## BUSINESS CASE SUMMARY

**Table 5: ALTERNATIVES AND ECONOMIC ANALYSIS**

	Case	Cost	Cost	2 yr delay	Off Site		
Revenue	(388,252)		313,791	307,580	304,948	304,948	304,948
OM&A	(192,477)		(51,443)	(50,052)	(224,529)	(211,407)	(177,622)
Capital	0	(48,761)	(46,832)	(48,718)		(6,563)	(9,119)
Present Value (PV)	(95,152)	not calculated	(88,326)	(87,636)	(91,882)	(93,889)	(91,141)
<b>Net Present Value (NPV)</b>	N/A	not calculated	<b>6,826</b>	<b>7,516</b>	<b>3,270</b>	<b>1,263</b>	<b>4,011</b>
Internal Rate of Return (IRR) %	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Discounted Payback (Yrs)	N/A	N/A	31	28	28	35	31

### Base Case: Not Recommended - Status Quo

This option is not recommended. The need for upgraded maintenance facilities at Darlington has been escalating for many years resulting in an increased risk to employee health and safety and increasing potential outage extensions and loss of productivity.

Several maintenance areas and shops are neither intended nor suitable for maintenance space or are in life-expired buildings such as Bldg 29 and 31 planned to be demolished by the refurbishment project. Other maintenance functions are in temporary structures that do not meet codes and are planned for removal. Computer Development facilities are in permanent building such as Bldg 115 and temporary buildings that are nearing end of life and are planned for removal by the Campus Plan. Therefore new maintenance and computer development facilities are needed.

#### Alt. 1: Recommended - Build a New Maintenance Facility outside the Protected Area combined with a Computer Development Facility

Proceed with the project through preliminary engineering, detail design, procurement of long lead items, Front End Planning and Full Release BCS for the new Maintenance Facility outside the protected area for non-radioactive work and include space for a new Computer Development Facility.

#### Alt. 2: Not Recommended - Delay

Delay the project. This alternative is not recommended since it will further delay the project for at least 2 years at which time it will be a more expensive project while the station will continue to be challenged with lack of adequate space for maintenance work. Delay of two years will also create a major threat to Maintenance since several building (listed under base case) housing the current maintenance shops and computer labs will be beyond their life span and would be in the demolition stage. The refurbishment project is planning to demolish some existing maintenance buildings and replace with refurbishment support buildings by 2013.

#### Alt. 3: Not Recommended - Build New Maintenance Facility inside the Operating Island (previous Recommended alternative)

This is not recommended due to the extremely high capital cost of over \$83 M based on lessons learned from the Construction Change Room Project 16-31718. The \$33M cost increase can be attributed to full ECC process, additional codes and standards, regulatory, fire, security and legal requirements, complications related to the tie-ins to the Emergency Service Water (ESW) and Class III power supply, requirement for blow-out panels, the potential for discovery issues associated with the adjacent Powerhouse structures and external contractor logistic within the protected area and delays.

#### Alt 4: Not Recommended - Securing facilities away from the site

A number of options for off-site facilities were reviewed and estimated by Corporate Real Estate as follows:

- Lease existing facility
- Buy existing facility
- Have designed/built and own

## BUSINESS CASE SUMMARY

- Have designed/build and lease

Although the financial data were conceptually comparable (within the same estimating range) to the recommended option, when the logistical cost of having to utilize such facilities were taken into account, the alternatives proved to be not attractive from a long term financial analysis and functionality for meeting the station needs.

The proposed maintenance facility is for the day to day station maintenance activities. The proximity of this facility to the plant systems and the need for the presence of key staff in or around the plant are paramount for its usefulness in terms of the intended objectives. Such considerations require a major shift in the station philosophy in approach to the day to day management of the plant with no appreciable cost savings to OPG. Therefore this alternative is not recommended.

### Alt. 5: Not Recommended - Use Refurbishment Facilities Post Refurbishment

This project was also reviewed in the light of the Refurbishment project and facility needs. The facilities planned for the Refurbishment are too varied from a maintenance facility in terms of functionality and use. In order to consolidate these facilities with the proposed maintenance facility, they need to be designed and constructed as a hybrid complex which will, firstly, result in much higher cost and secondly, will not become available to the station until 2024 which is too late to meet the station present maintenance challenges.



**BUSINESS CASE SUMMARY**Filed: 2010-08-12  
EB-2010-0008  
L-01-025  
Attachment 1**4/ THE PROPOSAL**

The funds requested in this release are needed for preliminary and detailed engineering (including site surveys, demolition of temporary building #119, environmental review, final building layout and footprint, technical specification, front end planning, release quality estimates), procurement of long lead material and equipment, site preparation, and submission of a full release BCS in Q1 2012 for execution of the project. Some specific tasks are listed below:

- Complete a Technical Specification and a Scope of Work for the proposed building.
- Issue a Request for Proposal for an Engineering/Procurement/Construction (EPC).
- Review EPC proposals, select preferred vendor and negotiate EPC contract
- Release the first phase of the EPC contract to complete engineering activities and deliverables.
- Complete preliminary and detailed engineering
- Complete Front End Planning documents including a release quality estimate for the Full release.
- De-commissioning, removal of Building #119 and site preparation
- Order/procure long lead equipment and components
- Submit and obtain approval for the full release BCS. Phase 2 of the contract to procure, construct, commission, and turnover a fully functional facility, will be released to the EPC contractor after the approval of the full release BCS.

**5/ QUALITATIVE FACTORS**

The successful completion of this project will improve the following:

**Employee Engagement:**

- New maintenance facility shops and offices will relieve overcrowding and congestion, provides better pre-job and post-job briefing facilities and result in improved staff morale and productivity

**Health and Safety**

- New maintenance facility shall be compliant with latest codes and standards which would provide adequate ergonomic work environment, relieve overcrowding and congestion, and result in improved health and safety concerns.

**Productivity and Efficiency**

- New Maintenance Facility with mock-up, rehearsal, fabrication, repair and refurbishment capabilities will enable the station to implement new and improved maintenance strategies, improve readiness for Outage and Online work.
- Reduction in personnel traffic through security systems and cross-zonal monitoring systems during peak station hours.

## BUSINESS CASE SUMMARY

TABLE 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				Before Mitigation							After Mitigation													
Probability	1	2	3	4	5	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)			
	5	5	5	5	5	12	0	0	0	0	0	0	0	12	6	0	0	0	0	0	0	0	6			
	4	4	4	4	4																					
	3	3	3	3	3																					
	2	2	2	2	2																					
Risk Description		Mitigating Activities																								
Current level of accuracy and quality of estimate could result in exceeding the project released funds		Complete preliminary eng, finalize building layout and include in Tech Spec, prepare Scope of work as part of RFP for EPC. Obtain Itemized EPC fixed price contract Detailed Scope of Work (SOW) to be verified by EPC contractor. Contingency to be reserved to cover the level of accuracy and quality of estimate. Engage a third party estimating company to prepare release quality estimate for the Full release BCS. Utilize Front End Planning process																								
Potential integration of additional Office space during Preliminary engineering phase would increase the scope		Early identification of design gaps to be closely monitored through the review of the Design Conceptual report, liaison with campus Plan, and scoping COMS. Freeze the scope as per the Value Engineering Report					12	15	9	6	6	3	3	0	15	2	6	4	2	2	2	0	6			
Discovery work from poor configuration management could increase scope of work such as re-route buried services in building (footprint). Additional engineering work		Perform configuration management assessment during Prelim eng. Conduct underground surveys to locate underground services, complete geotechnical report and finalize the scope before Full Release BCS and Release of final EPC contract. Liaison with Campus Plan					6	9	9	0	0	0	0	0	9	2	4	4	0	0	0	0	4			
Scope creep from geotechnical analysis of soil indicating soil conditions different from original RFP assumptions.		Employ external agent to perform geotechnical analysis prior to award of second phase of EPC and prior to Full Release BCS.					8	12	12	4	4	4	8	0	12	3	6	6	3	3	3	0	6			
Delays to RFP process than its planned window caused by RFP extension requests by EPC Vendors and more timely evaluation by OPG evaluation Team		Early notification to Supply Chain; Short listing potential contractors; Provide adequate timelines for RFP process. Tight schedule control. Prepare and finalize					3	12	6	0	0	0	0	0	12	2	4	2	0	0	0	0	4			

Filed: 2010-01-01  
EB-2010-01-025  
Attachment



## BUSINESS CASE SUMMARY

Low = 1 to 3		Medium = 4 to 9		Impact		Probability x Impact							Probability x Impact												
Probability	1	2	3	4	5	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)		
	5	5	5	5	5																				
	4	4	8	8	8																				
	3	3	6	9	9																				
	2	2	4	6	6																				
Risk Description					Mitigating Activities					Before Mitigation							After Mitigation								
Schedule delays from extensive Contract negotiations taking longer than planned					an agreed upon evaluation criteria with committed timeline from evaluation Team Issue a well defined RFP for EPC contract prior to full release BCS. RFP will include the preliminary engineering, the Tech Spec and building layouts.					2	6	2	0	0	0	0	6	1	2	1	0	0	0	0	2
Schedule delays due to late Design deliverables and longer design reviews.					Design part of the contract will be based on approved and accepted Technical Specifications. Regular design progress review meetings with EPC contractor and OPG reviewing team.					3	9	9	0	0	0	0	9	2	4	2	0	0	0	4	
Poor configuration management on Tie-ins "Legacy issues on Design (tie-in services)." Lack of adequate supply of present services (Discovery work from Domestic Water Supply, Sewage, Drainage and Fire Protection Services, PA, LAN, and Tel) would require technical assessments to address the gap					Conduct detailed surveys and research during preliminary engineering. Establish early ownership of tie-in points. The facility will not increase overall station loading for these services. Preliminary engineering will address the needs of the shift in the requirements from inside to outside the Protected area for the relocated personnel. Liaison with Domestic/Sewage water upgrades Project and campus plan					6	9	9	0	3	3	3	0	9	2	4	4	0	2	0	4
Lack of adequate supply of current electrical Power supply would add Technical difficulties, additional activities and potential re-work					Contingency has been allowed for potential new scope to upgrade existing Procure new Transformers and/ or Switchgears					10	20	15	10	5	5	5	0	20	2	6	4	2	2	0	6
Change in Engineering Process from FMOD to ECC Process for equipment labeling may be introduced creating more engineering work.					Obtain Facility Design Authority's (DA) approval for implementation processes and configuration management before the full release BCS.					10	20	15	0	0	5	5	0	20	4	6	4	0	2	0	6
Presence of Asbestos, Mold, and other hazardous material in Building 119 that is planned to be demolished would pose Health and safety issues to personnel					Obtain station's DA acceptance as well. Identify all hazards. Prepare and implement Health and Safety plan for project (i.e. Training and monitoring).					3	12	9	0	0	0	0	12	2	6	3	0	0	0	0	6
										0	0	0	0	0	10	10	0	10	0	0	0	0	4	4	

Filed: 2010-01-025  
EB-2010-01-025  
Attachment



## BUSINESS CASE SUMMARY

Low = 1 to 3		Medium = 4 to 9		Impact		Probability x Impact														Probability x Impact																		
Probability	1	2	3	4	5	Mitigating Activities														Before Mitigation							After Mitigation											
	5	5	3	4	5	Ensure Project team develops and obtain approval on a waste management plan according to procedures and include cost to transport to approved waste site. Consider environmental sampling to prepare specific environmental plan.														3	6	0	3	3	3	3	3	0	6	2	2	0	2	2	0	2	0	2
	4	4	8			The scope of the Maintenance facility will be finalized during preliminary engineering phase. The investment benefits of the proposed facility will be justified as part of the full release approval process.														6	10	0	0	0	0	0	0	0	10	6	10	0	0	0	0	0	0	10
	3	3	9			Secure adequate resources via early stakeholder involvement and commitment on required resources. Establish an agreed upon resource plan at an early stage														0	16	4	0	0	0	0	0	0	16	0	9	3	0	0	0	0	0	9
	2	2	4	6	10	Quality additional vendors to complete Design under FMOD process. Project to Solicit qualified vendors involved in the expression of interest process to perform the work. Liaison with Campus Plan and refurbishment														3	15	9	0	0	0	0	0	0	15	2	6	2	0	0	0	0	0	6
Risk Description		Mitigating Activities														Before Mitigation							After Mitigation															
Involved with the demolition activities.		Evaluate codes and standards and environmental requirements during Preliminary engineering. No CNSC requirements outside the Protected Area. Will meet with Provincial and Municipal representatives at applicable quality gates to ensure meeting requirements																																				
Environmental issue from conventional contamination of waste from Excavation, construction, and demolition activities waste which may not be suitable for shipment to a clean landfill site		Get Security involved as part of the design review including layout and proximity to ensure meeting Security requirements																																				
The scope of what is to be included in the Maintenance Facility is not finalized. This may not justify the investment benefits needed for the Full implementation.																																						
Insufficient OPG resources. Resources could be supporting other major projects being executed at the same time in preparation for refurbishment.																																						
Availability of qualified vendors to perform design and execution phases. Vendors could be involved with Campus Plan and Refurbishment buildings on site at the same time.																																						
Poor interpretation of regulatory requirements leading to non compliance issues																																						
Proximity of the building to the security fence and meeting security requirements																																						



**BUSINESS CASE SUMMARY**

 Filed: 2010-08-12  
 EB-2010-0008  
 L-01-025  
 Attachment 1

**TABLE 7: PRELIMINARY POST IMPLEMENTATION REVIEW PLAN**

The Terms of Reference for the PIR are tabled below. The PIR elements will be further defined for the full release BCS in 2011.

Type of PIR:	Targeted Final AFS Date:	Targeted PIR Approval Date:	PIR Responsibility (Sponsor Title)		
Simplified	TBD in Next Release	TBD in Next Release	Director of Operations & Maintenance		
Measurable Parameter	Current Baseline	Targeted Result	How will it be measured?	Who will measure it? (person / group)	
1 Replacement of removed facilities	Buildings # 29, 31 and temporary trailers used by Maintenance, and Bldg. # 115 for computer Labs to be removed by 2013	Replacement Facilities will be provided within the new Maintenance Building complex	The replacement facilities will be in service as part of the New Maintenance Facility AFS in May 2013.	DOM/DNGD Operations and Maintenance	
2 Productivity Savings	Overtime hours by affected work groups	Reduction of OT as per values indicated in Table 2 Appendix C.	Monitor OT costs for affected staff using time reporting systems	DOM/DNGD Operations and Maintenance	
3 Mitigation of Planned Outage Extension	Potential risk of Planned Outage Extension can be as high as 2.6d/year.	Reduction of 2.24 days/year has been estimated as per Table 2 Appendix C due to ready and available workspace.	Monitor each Planned Outage Extension and do appropriate analysis & comparison.	DOM and Outage Manager/DNGD	
4 Mitigation of Forced Outage Extension	Potential risk of Forced Outage Extension can be as high as 0.95d/year.	Reduction of 0.63 days/year estimated as per Table-2 Appendix C due to adequate and ready workspace.	Monitor each Forced Outage Extension and do appropriate analysis & comparison.	DOM and Outage Manager/DNGD	
5 Rental Facility Saving	Computer Lab for Shutdown system off-site is free but will not be available. Potential cost for a rental facility to house the lab can be about \$[redacted]/yr in 2013 dollar value	Replacement lab will be provided in the NMF. Reduce potential Rental Facility cost by \$51K/yr	Off-site computer labs will be relocated and be in service in the NMF. No additional rental facility cost of \$[redacted] will be required.	DOM/DNGD Operations and Maintenance	
6 Unconditional Transfer Permits (UTP) Savings	UTP costs on Feeder Replacement equipment stored in the Protected Area by Vendor is about \$17.5k/Planned Outage in 2009 dollar value or \$[redacted] year in 2013 dollar value	Reduce yearly UTP expenditures by \$[redacted] post AFS until Refurbishment.	Monitor UTP costs on affected work using cost reporting systems	DOM/DNGD Operations and Maintenance	
7 Employee Morale and engagement	Employee concerns related to (pre-job and post job briefing), health and safety, lack of adequate space, poor facilities conditions, logistics for doing work	Provide adequate space and safe working environment for employees. Provide improved pre-job and post job briefing	Conduct surveys, meetings, and interviews with relocated personnel to document satisfaction levels and improvements in morale and engagement	DOM/DNGD Operations and Maintenance	

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

AFI - Area for Improvement  
 AFS - Available for Service  
 ASB - Auxiliary Security Building  
 BCS - Business Case Summary  
 BOD - Board Of Directors  
 BP - Business Plan  
 B&W - Babcock and Wilcox  
 CCR - Construction Change Room  
 CDF - Computer Development Facility  
 CM - Control Maintenance  
 CMO - Contract Management Office  
 COMS - Constructability, Operability, Maintainability, and Safety  
 DA - Design Authority  
 DCC - Digital Controllers Computers  
 DOM - Director, Operations and Maintenance  
 DNGS - Darlington Nuclear Generating Station  
 ECC - Engineering Change Control  
 EM - Elective Maintenance  
 EPC - Engineering, Procurement, Construction  
 EOI - Expression of Interest  
 EOL - End Of Life  
 ER - Event reset  
 ESA - Engineering Services Agreement  
 ESW - Emergency Service Water  
 FFAA - Fueling Facility Auxiliary Area  
 FH - Fuel Handling  
 FLM - First Line Manager  
 FLM (A) - First Line Manager (Acting)  
 FLR - Forced Loss Rate  
 FMOD - Facilities Modifications  
 FTE - Full Time Equivalent  
 H&S - Health and Safety  
 IPG - Integrated Planning Group  
 IRR - Internal Rate of Return  
 LTA - Lost Time accident  
 MM - Mechanical Maintenance  
 MS - Civil Maintenance  
 MSA - Master Services Agreement  
 NIMS - Nuclear Information Management System  
 NMF - New Maintenance Facility  
 NPV - Net Present Value  
 OM&A - Operating, Maintenance and Administration  
 OEM - Online Elective Maintenance  
 OEMB - Online Elective Maintenance Backlog  
 OPEX - Operating Experience  
 OPG - Ontario Power Generation  
 OSB - Operations Support Building  
 OT - Overtime  
 PV - Present Value  
 PCRAF - Project Change Request Authorization Form  
 PEP - Project Execution Plan  
 PIR - Post Implementation Review  
 PLC - Programmable Logic Controllers  
 PO - Planned Outage  
 PJB/PJB - Pre Job Briefing/Post Job Briefing  
 RFP - Request for Proposal  
 RM - Reactor Maintenance  
 RP - Radiation Protection  
 RV - Relief Valve



**SAM** - Small Articles Monitor  
**SATM** - Space Allocation and Transient Material  
**SAVH** - Sickness and Accident Vacation Holiday  
**SDS** - Shut Down System  
**SOW** - Scope Of work  
**TBD** - To be Determined  
**UTP** - Unconditional Transfer Permit  
**VE** - Value Engineering  
**WANO** - World Association of Nuclear Operators  
**WO** - Work Order

## Appendix "B"

### Project Funding History

Table 1.

Release Type	Month	Year	Cumulative Values						2013	Later	Total
			2007	2008	2009	2010	2011	2012			
Developmental	Jul	2007	1,369	2,781	18,679	19,701	15,023				57,553
Partial	May	2008	508	4,194	18,932	19,985	13,599	521			57,739
											0
											0
											0
											0
											0
											0
LTD Spent	Dec	2009			4,728						4,728

Comments:

**Appendix "C"**
**Financial Model – Assumptions**
**Table 1: Financial Assumptions:**

Discount Rate	7%	Cost Escalation (yr)	2%	SR & D Opportunity	No
Progress Payments	Yes	Foreign Currency	No	Retainer Fee	No
Income Tax Rate	Non Generation	PST	No	Interest Rate (Capital)	4%
Depreciation Rate (Capital)	see Comments	Leasing	No	Indexed Priced Contract	

**Comments:**

Depreciation Rate: For New Non-residential buildings 6%.

**ASSUMPTIONS AND METHODOLOGY of NPV Calculations**

The model tries to quantify the following benefits of the New Maintenance Facility over the existing facility:

**Productivity**
**Assumption:**

Overcrowded location, lack of PJB areas, lack of suitable equipment, extra material/ equipment shuffling, & lack of Mock up/Rehearsal area result in OT to recover productivity loss for the existing facility.

**Method:**

1. Input from Maintenance on the OT equivalent to FTE to maintain productivity under current facility and the expected improvement with the new facility
2. Use appropriate labour rate to determine the FTE saving

For Reactor Maintenance Shop, also consider saving from training delivery to a bigger group, Radiation Protection saving on UTP due to allowing only one set of tools in the plant instead of two, and UTP saving associated with fabrication in the Machine Shop. For Welding Shop, also consider saving from UTP and travelling to Fabrication Shop.

**Impact on Planned & Forced Outage Extension**
**Assumption:**

Expect the new facility will improve response time on Valve/ RV/ Breaker preparation and minimize rework as the Mock up/Rehearsal facility and crane are always in place.

**Method:**

1. Input from Maintenance/Engineering on the expected critical path push and the probability of the current facility on Planned/Forced Outage Extension.
2. Input from Maintenance/Engineering on the expected critical path push and the probability of the new facility on Planned/Forced Outage Extension.
3. Determine the risk of the critical path push and the incremental benefit of the new facility.

**Unconditional Transfer Permit Saving**
**Assumption:**

Current practice for Feeder Replacement is to send both sets of replacement tools to Bldg 29. With the New Maintenance Facility, only one set will be sent to the plant. The other set can stay in the NMF.

**Method:**

1. Input from Maintenance on the expected saving from not cleaning & categorizing a trailer of tools by B&W.

**Rental Facility Saving**
**Assumption:**

Existing off-site facility is no longer available for our SDS Lab. The equipment is critical to DN and renting an industrial complex will be required.

**Method:**

1. Input from Engineering on the expected rent & utility cost.

Incremental Benefit/Cost

Table-2: Basis, Assumptions and Estimates for Calculating NPV

Incremental Benefit/Cost	Assumptions	Control Mtce Valve Shop	MM RV Test /Repair	MM Suprvrs. Offices	Reactor Mtce	MC Breaker & Relay Shop	Civil Mtce	Insulators/ Building Mechanics Shop	Welding Shop	CDF/ FH/ SDS Lab	Electronics Shop	Predictive Mtce Shop
Productivity	** OT to maintain productivity (FTE/yr)	2-3-4	1-1.5-2	4-5-6	0.5-1-1.5	1-2-2.5					1	
	Communication loss (min/FTE)											
	** UTP Coordination (FTE/yr)								1 FTE 1.5d per week			
	NMF improvement for ** (%)	20-30-40	40	10-20-20	50	50			60-65-70		20	
	Training Saving with bigger group				1 FTE 1 month per PO							
	Feeder Repl RP UTP saving (FTE hr/PO)				180 (no impact after Retube)							
	Machine Shop RM UTP saving (FTE/yr)				0.5							
	Machine Shop RP UTP saving (FTE/yr)				0.25							
	% of crew in the Fab Shop (%)								15			
	Travelling loss for Fab Shop FTE (hr/d)								0.75			
Planned Outage Critical Path	Current PO Push (d/PO)				1-1.5-2	0-1.5-2						
	Current probability for PO Push (%/PO)				80	50						
	NMF PO Push (d/PO)	8-9-10d in 10 years from rework			1-1.5-2	0-1.5-2						
	NMF Probability for PO Push (%/PO)				20 (benefit of rehearsal to avoid rework)	25 (less rework)						
Forced Outage Critical Path	Current FO Push (d/FO)		0-1.5-2h/FO loss due to occupation of RV stand		1-7-14 (delay due to Mock up not in place & availability of turbine crane)	0-1.5-3						



## BUSINESS CASE SUMMARY

Filed: 2010-08-12  
EB-2010-0008  
L-01-025  
Attachment 1

	Current probability for FO Push (%/FO)		0-5-10		1.75	1.75-10-20							
	NMF FO Push (d/FO)		0		0.5-1-2	0-1.5-3							
	NMF Probability for FO Push (%/FO)		0-5-10		1.75	0.88-5-10 (less rework)							
UTP Saving	B&W saving on tools (\$k/PO)				15-17 5-20 (no impact after Retube)								
Rental Facility Saving	Rent (\$k/month)					0 (Whitby Facility is part of the Whitby Central Warehouse, pay no rent, no utility, housekeeping)					3 (relocate from AECL to an industrial complex)		
	Utility (k\$/month)										1		
	Housekeeping (\$k/month)										0		
Effectiveness	Factor due to % function & location (%)	0-60-60	50-80-80	100	100	100	100	100	100	100	100	100	100
UTP Cost	IPG Work	5-5-6 valves/wk (no work during Intensive Outage Valve Program)	26-28-30 RV/wk			Med Volt bkr - o/h every 12yr, PM every 6yr. Only do 600V bkr PM every 6yr.			Consider very min UTP for BM.				
	Outage Work	10 valves/d	120-125-130 RV/PO			347 Med Volt bkr & 658 600V bkr in total			Consider 10% insulators stay in the NMF all the time & save 40min travelling time/d & 90% insulators in the field will lose 25% of time on UTP				
	Function of Shop in NMF (%)	60	80			Do 10% Med Volt bkr o/h & 100% PM at DN							
	Factor by using SAM or bundling (%)		20										
	Mice UTP Handling Time (FTE hr/comp)	4	4			24 for Med Volt bkr & 16 for 600V							
	RP UTP Handling Time (FTE hr/comp)	2	2			2			0 (MS to cover RP)				

**Table 3: Project Cost Estimate:**

Design Complete	Zero to Minimal	Quality of Estimate	Budget + 30% to - 15%	3rd Party Estimate	No
Reviewed by Sponsor	Yes	OPEX used	Yes	Lessons Learned	Yes
Similar Projects	Yes	Budgetary Quote(s)	Yes	First Unit Actual Used	N/A
Cost Sharing	No	Contracts in place	No	Competitive Bid	Yes

## BUSINESS CASE SUMMARY

Filed: 2010-08-12

EB-2010-0008

L-01-025

Attachment 1

Fixed Price Contract	No	Fee for Service	No	Firm Vendor Proposal	No
----------------------	----	-----------------	----	----------------------	----

Comments:

### Project Estimate Assumptions:

- Procurement of new or relocation of existing maintenance or computer equipment and tools are not included in the scope of this project but have been accounted for in the economics analysis (NPV).
- Project EPC estimates are based on Expression of Interest Proposals from EPC Vendors in July 2009
- Project Support, design and Tie-ins estimates are based on historical data of similar projects and OPEX from Darlington Construction Change Room Project.
- Project estimates are based on an AFS in 2013.
- Project will be implemented under an owner only EPC type contract using F-MOD commercial process for the new Building
- The existing security protocols for the movement of the equipment between the station and the proposed building will be followed. The building will also be equipped with security access controls and other security features as required.
- Final tie-ins will be implemented using design services of preferred design agencies under ESA, and preferred construction vendors under MSA. The final tie-ins to the station systems will be under Risk based ECC process.
- New Building will be owned and maintained by Facilities.
- Location of new building is south of ASB in the current building 119 and adjacent parking lot. Campus Plan will be revised to reflect that.
- Overall cost for the New Maintenance facility and tie-ins is about \$35.0 M including contingencies, and the new computer development facility is about \$10.0 M. Life to date cost 2009 is 4.728 M.

### Rationale for Cost Classification:

Capital – new construction.

**Table 4: Generation Plan Assumptions:**

Station	Unit	EOL	MW	Capacity	Planned Outages for Project Work (eg P1071)						
Pickering A	1										
	4										
Pickering B	5										
	6										
	7										
	8										
Darlington	1	Feb	2018								
	2	Oct	2016								
	3	Sep	2019								
	4	Jan	2021								

### Comments:

The analysis was based on the above Darlington End Of Life EOL with a 30 years extension after the Refurbishment. For simplicity, benefits of the New Maintenance Facility during Refurbishment period (2016 to 2023) or final EOL (2046-2050) have not been scaled back. Notice that NPV of future years (2016-2023) and (2046-2050) should be relatively small.



**BUSINESS CASE SUMMARY**

 Filed: 2010-08-12  
 EB-2010-0008  
 L-01-025  
 Attachment 1

**Financial Model – Assumptions**
**Impact on Operations**
**Table 5**

Impact on Revenue										
\$000's	Present	2009	2010	2011	2012	2013	2014	2015	Later	Total
Rate KWH						48.10	52.90	60.09	2009 SEV	
Probability										0.0%
Consequence										0
Risk						(3,660)	(4,025)	(4,572)	(375,994)	(388,252)
Other										0
Base Case	0	0	0	0	0	(3,660)	(4,025)	(4,572)	(375,994)	(388,252)
Probability										0.0%
Consequence										0
Risk						(702)	(772)	(877)	(72,110)	(74,460)
Other										0
Recommendation	0	0	0	0	0	(702)	(772)	(877)	(72,110)	(74,460)
Net Impact	0	0	0	0	0	2,958	3,253	3,696	303,885	313,791

**Comment**

Impact on Revenue is based on the mitigation of the risk of Planned Outage and Forced Outage Critical Path extension.

**Table 6**

Impact on OM&A										
\$000's	Present	2009	2010	2011	2012	2013	2014	2015	Later	Total
Base OM&A						(2,220)	(2,309)	(2,355)	(124,911)	(131,795)
Outage OM&A						(1,042)	(1,063)	(1,084)	(57,492)	(60,682)
Project OM&A										0
Base Case	0	0	0	0	0	(3,262)	(3,372)	(3,440)	(182,403)	(192,477)
Base OM&A						(7,211)	(4,011)	(4,093)	(219,527)	(234,842)
Outage OM&A						(135)	(138)	(141)	(8,664)	(9,078)
Project OM&A										0
Recommendation	0	0	0	0	0	(7,347)	(4,149)	(4,233)	(228,190)	(243,920)
Net Impact	0	0	0	0	0	(4,084)	(777)	(794)	(45,787)	(51,443)



**Darlington New Maintenance Facility 16 - 31717**
**Partial Release Business Case Summary D - BCS - 28200 - 10005 - R000**
**Attachment "A"**
**Project Cost Summary**

\$000's		LTD	2010	2011	2012	2013	2014	2015	Later	Total
Capital		2009								
Scores Basis	Project Mgmt & Support	1,694	313	313	400	227				2,947
	OPG Engineering Support	405	107	164	251	107				1,034
	OPG Material	131			250					381
	EPC Contract									
	Furniture									
	Installation Contracts									
	Design Contracts									
	Tie-ins									
	OPG Installation Support									
	SAVH @17.25% OPG Labor	138	46	78	325	99				686
	CMO Support @ 1.25 %	38	100	97	168	75				420
	OPG Furniture			150	250	60				598
	Interest (Capital Project Only)	320	280			1,500				1,500
	<b>Project Costs</b>	<b>4,728</b>	<b>1,426</b>	<b>3,722</b>	<b>21,714</b>	<b>7,183</b>				<b>3,050</b>
	General Contingency									38,773
	Specific Contingency									
	<b>Project Costs</b>	<b>4,728</b>	<b>1,640</b>	<b>4,280</b>	<b>29,728</b>	<b>9,438</b>				
Cash	Adjust to Cash Basis +/-									49,814
	<b>Project Costs</b>	<b>4,728</b>	<b>1,640</b>	<b>4,280</b>	<b>29,728</b>	<b>9,438</b>				
Funding	Currently Released	8,538								49,814
	This Release	(3,810)	1,640	4,280	2,900					8,538
	Future Release									5,010
	<b>Project Funding</b>	<b>4,728</b>	<b>1,640</b>	<b>4,280</b>	<b>29,728</b>	<b>9,438</b>				<b>36,266</b>
Note: Scores Basis = Cash Basis = Funding Basis (Timing differences only)										
Budget	BP 2010-2014	4,569	13,686	15,373	10,460	401				44,489
	Variance to Business Plan	159	(12,260)	(11,651)	11,254	6,782				(5,716)
Other	Removal Costs included above		1,862							1,862
	Inventory to be written off		1,053							1,053
	Spare Parts in Inventory									

The estimated variance(s) to the 2010-2014 Business Plan will be addressed through the portfolio management process.  
 A PCRAF will be approved by June 2010.

Reviewed By:

 Morad Solaimani  
 Project Manager

Approved By:

 Jack Ballard  
 Strat IV Manager

Date

Date

## BUSINESS CASE SUMMARY

Filed: 2010-08-12  
EB-2010-0008  
L-01-025  
Attachment 1

### Darlington New Maintenance Facility 16 - 31717 Partial Release Business Case Summary D - BCS - 28200 - 10005 - R000

#### Attachment "B"

#### Project Variance Analysis

Capital	LTD Dec 2009	Total Project		Variance	Comments
		Last BCS May 2008	This BCS Mar 2010		
Project Mgmt & Support	1694	3190	2947	-243	Includes 200 k for Estimating Contracts
Engineering	405	1141	1034	-107	
Procurement					
Construction					
Design Contracts					
EPC Contract					
Installation Support					
SAVH	138	2003	686	-1317	
CMO	38		420	420	
Interest (Capital Project Only)	320	3195	598	598	
<b>Project Costs (Scores Basis)</b>	<b>4728</b>	<b>44551</b>	<b>3050</b>	<b>-145</b>	
General Contingency			<b>38773</b>	<b>-5778</b>	
Specific Contingency					
<b>Project Costs (Scores Basis)</b>	<b>4728</b>	<b>57739</b>	<b>49814</b>	<b>-7925</b>	
Other	Removal Costs included above	1,862	1,862	1862	
	Inventory to be written off	1,053	1,053	1053	
	Spare Parts in Inventory			0	



Attachment "C"

### Milestones and In Service Declarations

### Key Milestones

[illegible]

A Project Execution Plan (PEP) will be approved by Jul 2010

**In Service Declarations: (Capital Only)**

[illegible]

## 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	

**Board Staff Interrogatory #026**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 4

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The BCS for the New Change Room Facility (p.3) states that "The new CCR is being constructed in time to support the March 2009 Vacuum Building Outage at Darlington."

Please confirm whether or not the CCR project is completed. If it isn't, please provide a status update.

**Response**

The project was completed in June 2010, including demolition and close-out work.

The change room was placed into service in March 2009, and was used to support the Darlington Vacuum Building Outage.



**Board Staff Interrogatory #027**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 8

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The BCS for the Steam Generator Controls Replacement identifies 30 May 2008 as a key milestone date (Attachment C, p.15) for a Full Release (Phase 1) BCS.

- a) What is the status of the Full Release BCS?
- b) Please clarify whether the replacement SG Controls will continue to be useful beyond the projected station end-of-life of 2018.

**Response**

The correct title for the project is Standby Generator Controls Replacement.

- a) The Full Release BCS is scheduled for June 30, 2011. The delay has been specifically planned to incorporate lessons learned from retrofitting controls on similar equipment at Pickering and Darlington.
- b) The replacement Standby Generator controls will continue to be useful beyond 2018 on the refurbished Darlington units.

**Board Staff Interrogatory #028**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 15

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The BCS for the Pickering B Chemistry Standards project identifies that this project would be completed by December 15, 2008 (p 19). What is the status of this project?

**Response**

The project completed 7 of 8 sub-projects by December 2008. The outstanding sub-project is the installation of a new mass flow controller on the heat transport hydrogen control system of each unit during a planned outage. The modification was installed on one unit in 2008; however, during commissioning, hydrogen flow could not be controlled as expected. Testing with the original equipment manufacturer was initiated in 2009 and a solution was developed and tested later that year. Installation on the remaining units will follow the planned outage schedule and be completed by the end of 2011.

**Board Staff Interrogatory #029**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 29

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The evidence indicates that OPG capitalized \$11.8M of 2009 expenditures for engineering, fabrication and installation of some of the modifications and \$0.2M of MFA (Minor Fixed Assets) tools associated with the 2009 Darlington Vacuum Building Outage (VBO).

- a) Have the same or similar modifications been used in the previous Darlington Vacuum Building Outage? Were any of those modifications applied to the 2009 VBO as re-usable modifications?
- b) On page 2 of the BCS, it is stated that “significant savings could be realized over the life of the station if the designs and assemblies were developed as permanent, reusable assemblies”. Please provide further details on the scope and extent of these future savings.
- c) In view of the long (12-year) cycle between Vacuum Building Inspections, what provisions have been made to ensure that the equipment, components and systems that have been disassembled and put away in storage will be readily retrievable and available for future use?

**Response**

The final full release amount was \$11.4M capital (Ex. D2-T1-S2, Table 1a), not the \$11.8M quoted in the question, along with \$0.2M for MFA. The reduction was due to a disallowance of certain demobilization costs from the requested capitalization, as described in the section entitled “Cost Summary” in the covering letter dated July 20, 2009 found at Ex. D2-T1-S2, Attachment 1, Volume 4, Tab 29.

- a) Yes, the same or similar modifications were used in the previous Darlington vacuum building outage (“VBO”). However, the modifications used in the previous Darlington VBO were not applied to the 2009 VBO, as the engineering change control process in place at the time (“Temporary Modifications”) did not allow re-use. Through continuous improvement at OPG, the engineering change control process has evolved such that in 2009, the VBO modifications were executed as “Alternate Configurations” and can now be reused for future VBOs (on a 12-year cycle) and Station Containment Outages (smaller scope outages, conducted at the midpoint between VBOs).



- 1 b) The future savings from the alternate configurations over the life of the station from these  
2 permanent, reusable assemblies will be realized as follows:  
3  
4 • Vacuum Building Outages: 2021, 2033 and 2045 (approx. \$10M per VBO)  
5 • Station Containment Outages: 2015, 2027 and 2039 (approx. \$3M per Station  
6 Containment Outage)  
7  
8 c) The modifications installed during the 2009 VBO were dismantled and prepared for  
9 storage in preparation for their next use, with complete cataloguing and storage of all  
10 components.

**Board Staff Interrogatory #030**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 30

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The BCS identifies Alternative 1 as the recommended alternative, and as being the most economical option to meet the back-up heating steam supply to Pickering A and B in the event of a six-unit shutdown in winter. Alternative 1 includes a new Auxiliary Heating System with increased heating steam capacity (including a new oil-fired boiler with capacity of 70,000 lb/h, sufficient to accommodate six shutdown units, i.e., two Pickering A, and four Pickering B units).

Based on the above, is the selection of Alternative 1 predicated on the assumption that the Pickering A units will be shut down concurrent with the projected end of life dates (extension of nominal end of life from 2014-2016 to 2018-2020) of the Pickering B units resulting from the Pickering B Continued Operations?

**Response**

The selection of Alternative 1 was not predicated on whether or not Pickering A units are to be shut down concurrent with the projected end of life dates of the Pickering B units. It was selected as being the most cost-effective means of meeting the business objective as stated in the business case summary; i.e., to provide a reliable back-up supply of heating steam to Pickering A and B during a six unit shutdown in winter, and thereby prevent equipment freeze damage and to support the safe return to service of the shutdown units.



**Board Staff Interrogatory #031**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 31

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The evidence indicates that the recommended permanent solution for the Pickering A Inter Station Transfer Bus (ISTB) capacity is Alternative 1 and is dependent on Pickering B (U5/6 and U7/8) for the supply of power to the ISTB.

Given this interdependency between Pickering A and Pickering B, please clarify to what extent the long-term operability of the Pickering B units and their implications on the Pickering A units were considered during the assessment of the various alternatives, in particular, with respect to the alternatives based on Pickering A independent solutions.

**Response**

The long-term operability of the Pickering B Generating Station units and their implications on the Pickering A Generating Station units were not part of the assessment of alternatives for this project.

The selected alternative met the technical and timing requirements and had the highest net present value ("NPV"). It also avoided the issues (i.e., regulatory issues, complexity and technical challenges) associated with other high-potential alternatives outlined on page 7 of the business case summary in Ex. D2-T1-S2, Attachment 1, Tab 31.

**Board Staff Interrogatory #032**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 32

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The BCS for the Feeder Repair by Weld Overlay project states that "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."

Please provide a status update with respect to the following:

- a) Has Stage I been completed in the meantime?
- b) If Stage I has been completed, what were the technical results? Based on these results, has a recommendation and/or decision been made to proceed with Stage II or to cancel the project?
- c) If Stage II is to proceed, has a revised BCS with updated economic analysis been prepared and what is its status?

**Response**

- a) Stage I is not yet complete. The first vendor completed the scope of work successfully. However, technical issues with the welds of the second vendor have required some additional effort. Because of the fixed price nature of the contracts, there was no benefit to OPG cancelling the second vendor's work when it was partially completed.
- b) Although Stage I work by the second vendor continues, OPG was able to assess whether to proceed with Stage II based on: the successful results of the first vendor; an economic assessment incorporating the Stage II quotes; and, an updated estimate of the number of feeder repairs required. This assessment showed a low economic return and a moderate risk. As a result, a decision was made to defer Stage II of the Weld Overlay project.

The deferral period is three years. During this time the business needs will be monitored and if there are other factors influencing the feeder repair requirements, the project will be reconsidered. If OPG decides to proceed with Stage II, a revised business case summary will be prepared.

Filed: 2010-08-12  
EB-2010-0008  
Issue 4.5  
Exhibit L  
Tab 1  
Schedule 032  
Page 2 of 2

- 1
- 2 c) No. As noted above, Stage II is not proceeding at this time.



**Board Staff Interrogatory #033**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 33

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) Were the feeders in the Upper Feeder Cabinet inspected for fitness-for-service during the refurbishment of Pickering A units 1 and 4?
- b) If the response is affirmative, what were the results of the inspections relative to the need for development of the Upper Feeder Cabinet Inspection Robot for Pickering A (and B) at this time?
- c) Does OPG intend to pursue feeder cabinet inspection work with Bruce Power in the future? If not, what are the implications on the BCS scope and preferred alternative.

**Response**

The interrogatory incorrectly refers to the refurbishment of Pickering A Units 1 and 4. The Unit 1 and Unit 4 return-to-service project was not a refurbishment.

- a) Yes. Upper feeder cabinet feeders were inspected for fitness-for-service as part of the return-to-service work for Pickering A Units 1 and 4. The inspections found the components to be fit for continued service with the completion of a number of routine maintenance items.
- b) While these inspections were successful, there is an ongoing requirement to inspect feeder cabinet components at all stations. As indicated in the referenced business case summary ("BCS"), this project reduces the worker radiation dose of these required inspections and the forecast impact of future inspections on the length of outage critical path.
- c) OPG plans to stop providing external inspection and maintenance services to Bruce Power and others as of June 2011 (Ex. G2-T1-S1) so it will not be pursuing feeder cabinet inspection work with Bruce Power in the future. As a result, OPG is re-assessing BCS Alternative 3. Alternative 3 is development of the inspection system for Pickering and Darlington stations only, and excludes construction of a robot to service Bruce Power.

**AMPCO Interrogatory #011**

**Ref:** Ex. D2-T1-S2

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Both Darlington and Pickering have major capital programs associated with standby, emergency and auxiliary generators. Common themes to the underlying problems with Darlington and Pickering include obsolescence, lack of spare parts and performance decline.

- a) Please comment on the degree of equipment standardization between stations and within this general class of generation equipment.
- b) Please comment on whether Bruce Power uses related equipment and whether there are opportunities for sharing spares with Bruce Power or other opportunities for efficiencies.

**Response**

- a) The standby, emergency, and auxiliary electrical power generators at OPG's nuclear facilities are driven by combustion turbine engines. However, for the reasons noted here, there is little opportunity for standardization across systems or stations.

For the standby and emergency generators, the design and controls are not interchangeable between the stations, as they were purchased over a span of time from the 1960's to the 1980's, for the Pickering A, B, and Darlington Generating Stations. The power ratings among stations and within the standby and emergency power generator classifications also vary significantly. These factors make upgrades using identical or common designs and components impractical.

More recently, the Auxiliary Power System has been installed at Pickering Generating Station. Again, the associated electrical generators are supplied by different manufacturers than the existing standby and emergency generators and are of different vintage, making it impractical to standardize replacement components or upgrade components to common designs. The power rating is also significantly higher than other generators.

- b) OPG is not able to comment on the generator equipment used by Bruce Power.

**AMPCO Interrogatory #012**

**Ref:** Ex. D2-T1-S2, Table 1a, 2a and 2b

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please produce a revision of Table 1a to include the originally approved final in-service date. Please produce a revision of Tables 2a and 2b to include the originally approved final in-service date and cost, where different from the figures shown.

**Response**

The modified Tables 1a, 2a and 2b are presented as Attachment 1.

In preparing this response, OPG discovered transcription errors in the supporting tables, specifically:

- Ex. D2-T1-S2, Table 1a, line 14, "Final In-service Date" should be Aug-10.
- Ex. D2-T1-S2, Table 1a, line 19, "Total Project Cost" should be \$15M.
- Ex. D2-T1-S2, Table 2a, line 4, "Final In-service Date" should be Dec-12. "Total Project Cost" should be \$6.9M and "In-Service 2012" should be \$1.5M.

These corrections have been incorporated into the modified tables.



Numbers may not add due to rounding.

Table 1a - Modified for Ex. L-2-12  
Capital Project Listing - Nuclear Operations Facility Projects  
Projects >\$10M Total Project Cost<sup>1</sup>

Line No.	Facility	Project Name	Project Number	Category	Start Date	Original In-Service Date	Final In-Service Date	Total Project Cost (M\$) (Note 2)	Partial/Devmt Release (\$M)	Initial Full Release (\$M)	Superceding Full Release (\$M) (Note 3)
	(a)	(b)	(c)	(d)	(e)	(New)	(f)	(g)	(h)	(i)	(j)
<b>ONGOING PROJECTS FROM EB-2007-0905</b>											
1	DN	DLC Modifications – Simulator Based Training	28453	Sustaining	Sep-06	May-09	Mar-10	11.8		11.8	
2	DN	Fuel Handling Power Track Improvement	31438	Sustaining	Sep-06	Mar-10	Mar-10	17.4	14.3		
3	DN	Improve Maintenance Facilities at Darlington	31717	Sustaining	Jan-02	Dec-11	Dec-11	57.7	6.9		
4	DN	New Change Room Facility	31718	Sustaining	Jul-07	Sep-09	Jun-10	23.8		23.8	
5	DN	Chiller Replacement to Reduce CFC Emissions	33631	Regulatory	Jan-04	Dec-11	Dec-11	14.9	10.4		
6	DN	FH Computer Replacement	33815	Sustaining	Aug-05	Oct-06	Feb-12	12.5		12.5	
7	DN	Shutdown System Computer Aging Management	33955	Sustaining	Nov-06	Nov-13	Nov-13	17.2	1.8		
8	DN	DN SG Controls Replacement	33973	Sustaining	Dec-06	Apr-13	May-12	17.9	1.5		
9	DN	DN DCC Replacement / Refurbishment / Upgrades	33977	Sustaining	Sep-03	Sep-10	Dec-10	82.2	22.1		
10	PA	Reactor Structures-Calandria Vault Inspection	46537	Sustaining	Aug-06	Feb-08	Apr-10	26.4		23.9	<b>26.4</b>
11	PA	PA Unit 2/3 D2O Storage Tanks	46576	Sustaining	Dec-06	Mar-08	Mar-10	16.3		11.2	<b>16.3</b>
12	PA	New Redundant Calandria Vault Dryer	49252	Sustaining	Sep-05	Jun-08	Mar-10	11.0		7.2	<b>11.0</b>
13	PA	Switchyard Relay Building Cable Replacement	49266	Value Enhancing	Dec-06	Jun-10	Jun-10	15.8		15.8	
14	PA	P2/P3 Isolation Project	Various	Sustaining	Aug-05	Aug-10	Aug-10	38.5		38.5	
15	PB	Emergency Power Generator Control Upgrade	49110	Sustaining	Mar-06	Jan-10	Jan-10	12.3	9.5		
16	PB	Chemistry Standards (CH-002) at PB	79147	Sustaining	Jan-01	Sep-03	Mar-10	18.4		17.4	18.4
17	NPT	Physical Barrier System	25609	Regulatory	Nov-05	Sep-09	Jun-10	49.4		49.4	
18	NPT	Security Hardening Project	25901	Regulatory	Nov-05	Nov-11	Dec-11	14.4	5.5		
19	NPT	Controlled Area Improvements	25902	Regulatory	Nov-05	Nov-13	Nov-13	15.0	2.0		
20	NPT	Security Monitoring Room	25905	Regulatory	Nov-05	Dec-08	Nov-10	20.4		20.4	
21	NPT	Security Doors Upgrade	25908	Regulatory	Aug-06	Nov-10	Nov-10	15.0	9.0		
22		<b>Subtotal</b>						<b>508.4</b>			
<b>COMPLETED/DEFERRED FROM EB-2007-0905</b>											
23	DN	Second Darlington Full Scope Simulator	28452	Sustaining	Sep-06	Jul-09	Nov-09	16.2		16.2	
24	DN	Main Control Room HVAC	33293	Sustaining	May-01	Mar-05	Jan-09	11.9		6.0	11.9
25	DN	Used Fuel Dry Storage In Station Modifications	33925	Sustaining	Jan-01	Mar-08	Jan-09	44.6		47.8	
26	DN	DND Feeder Replacement ALARA/Optimization	34008	Value Enhancing	Jan-06	Jun-08	Nov-09	14.0		11.7	<b>14.0</b>
27	DN	Fire Protection Upgrade Program Phase 3	79148	Regulatory	Aug-01	Dec-05	Dec-08	29.7		23.5	<b>29.7</b>
28	PB	CFC Replacement (Freon Removal)	40543	Regulatory	Oct-03	Aug-09	Dec-09	19.5		22.4	
29	PB	Auxiliary Power System for PB	49104	Regulatory	May-04	Sep-07	Dec-09	107.2		116.7	
30	PB	Standby Generator Governor Upgrade	49109	Sustaining	Oct-05	Apr-08	Aug-08	22.3		23.3	
31	PB	Fire Protection Phase 2	79016	Regulatory	Oct-97	Oct-02	Jul-08	19.0		18.7	19.1
32	ENG	Additional Feeder Cut and Weld Tooling	62567	Sustaining	Jun-07	Dec-08	Dec-08	10.7		15.8	
33	NPT	Security Optimization (Capital)	62558	Regulatory	Jan-02	Jan-08	Nov-09	172.3		174.7	
34	DN	D2O Storage Facility	31555	Sustaining	Nov-06	N/A	Deferred	36.4	3.6		
35	DN	Auxiliary Heating System	34000	Regulatory	Mar-06	N/A	Deferred	23.5	2.2		
36	PA	PA Site - D2O Storage Facility	49251	Sustaining	Nov-06	Jul-10	Deferred	17.4	2.5		
37		<b>Subtotal</b>						<b>544.6</b>			
<b>PROJECTS NOT IN EB-2007-0905</b>											
38	DN	Vacuum Building Outage Recurring Alterations	34012	Sustaining	Jan-09	Dec-09	Dec-09	11.4		11.4	
39	PA	Replacement of Standby Boilers	49267	Sustaining	Sep-06	N/A	Dec-12	17.0	1.6		
40	PA	PA ISTB Cabling Permanent Modification	49270	Regulatory	May-08	Dec-09	Jun-10	19.4		19.4	
41	ENG	Feeder Repair by Weld Overlay	62568	Sustaining	May-09	Jun-11	Jun-11	53.2		53.2	
42	IMS	Upper Feeder Cabinet Inspection Robot	66266	Sustaining	Jun-06	Aug-10	Aug-10	11.4	6.2		
43	NPT	Security Project F	25909	Regulatory	May-08	Nov-11	Oct-11	30.5	16.4		
44		<b>Subtotal</b>						<b>142.8</b>			
<b>Table continues on Ex. D2, Tab 1, Sch 2 Table 1b</b>											

Notes:

- 1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2007-0905 or subsequent).
- 2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown).
- 3 Bold font indicates variance ≥ 10%, with explanation in Exhibit D2-T1-S2. Superceding Full Release is the new Total Project Cost.
- 4 Italicised entries reflect corrections as indicated in the Response to Ex. L-2-12 (lines 14 and 19).

Filed: 2010-08-12  
EB-2010-0008  
L-02-012  
Attachment 1

Filed: 2010-04-15  
EB-2010-0008  
Exhibit D2  
Tab 1  
Schedule 2  
Table 2a

Numbers may not add due to rounding.

Table 2a - Modified for Ex. L-2-12  
Capital Project Listing - Nuclear Operations Facility Projects  
Projects \$5M - \$10M Total Project Cost<sup>1</sup>

Line No.	Facility	Project Name	Category	Project Description	Start Date	Original In-Service Date	Final In-Service Date	Original Final Cost (\$M)	Total Project Cost (\$M) (Note 2)	In-Service 2010 (\$M)	In-Service 2011 (\$M)	In-Service 2012 (\$M)
	(a)	(b)	(c)	(d)	(e)	(New)	(f)	(New)	(g)	(h)	(i)	(j)
		<b>ONGOING PROJECTS FROM EB-2007-0905</b>										
1	DN	Replacement of Obsolete Computer Components	Sustaining	Replace components of the digital control computers that are obsolete.	Jun-00	Nov-06	Aug-10	9.1	9.1	1.5	0.0	0.0
2	DN	Turbine Generator Vibration Monitor System Replacement	Sustaining	Upgrade the turbine generator vibration monitoring system. Current system has already reached end of life and uses obsolete hardware & software with no spares.	Mar-06	Dec-13	Dec-13	8.0	8.0	0.0	3.4	0.6
3	DN	Reactivity Mechanism Replacement Tooling	Sustaining	Develop tooling for the replacement of reactivity mechanisms.	Oct-01	Dec-05	Oct-10	8.0	8.0	0.8	0.0	0.0
4	PB	Radioactive Emission Reduction (EV-005)	Regulatory	Improve the Radioactive emissions monitoring and control performance per CNSC Operating License requirements	Mar-99	Dec-12	Dec-12	6.9	6.9	0.0	0.0	1.5
5	IMS	CIGAR Control System Replacement Obsolescence/Configuration Management (Channel Inspection, Gauging and Relocation System)	Sustaining	Upgrade the CIGAR control system by replacing obsolete PDP computer hardware, drive system hardware and software.	Feb-06	Dec-10	Dec-10	6.7	6.7	4.6	0.0	0.0
6		<b>Subtotal</b>							38.7	6.9	3.4	2.1
		<b>COMPLETED PROJECTS FROM EB-2007-0905</b>										
7	DN	Liquid Chlorination System Upgrade	Sustaining	Improve reliability of chlorination system to more effectively combat zebra mussel infestation.	Jun-00	Dec-08	Dec-09	7.5	8.7	0.0	0.0	0.0
8	PA	Pickering Admin Building Cafeteria Modifications	Sustaining	Refurbish Cafeteria to address health & safety concerns, improve functionality and upgrade systems to current requirements.	Aug-05	Dec-07	Apr-09	5.6	8.2	0.0	0.0	0.0
9	PB	Reactor Controller Upgrades	Sustaining	Improve reliability of reactor and safety system controllers, which have reached design life.	Apr-01	Dec-06	Dec-08	6.4	9.2	0.0	0.0	0.0
10	NPT	Pickering A Modular Buildings 1,2 & 3 Refurbishment	Sustaining	Carry out major renovation of the existing modular buildings to address issues relating to aged building structure and health & safety concerns arising from potential mold infestation.	Oct-07	Jun-08	Sep-09	6.3	5.1	0.1	0.0	0.0
11		<b>Subtotal</b>							31.2	0.1	0.0	0.0
		<b>Table continues on Ex. D2, Tab 1, Sch 2 Table 2b</b>										

Notes:

- 1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2007-0905 or subsequent).
- 2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown).
- 3 Italicised entries reflect corrections as indicated in the Response to Ex. L-2-12 (line 4).

Numbers may not add due to rounding.

Table 2b - Modified for Ex. L-2-12  
Capital Project Listing - Nuclear Operations Facility Projects  
Projects \$5M - \$10M Total Project Cost<sup>1</sup>

Line No.	Facility	Project Name	Category	Project Description	Start Date	Original In-Service Date	Final In-Service Date	Original Final Cost (\$M)	Total Project Cost (\$M) (Note 2)	In-Service 2010 (\$M)	In-Service 2011 (\$M)	In-Service 2012 (\$M)
	(a)	(b)	(c)	(d)	(e)	(New)	(f)	(New)	(g)	(h)	(i)	(j)
		<b>PROJECTS NOT IN EB-2007-0905</b>										
12	DN	Main Generator/Hydrogen Slipring Cooling	Sustaining	Modify generator slipring cooling system to add humidification to prevent sparking.	Apr-00	Dec-04	Nov-09 (Completed)	5.1	5.1	0.0	0.0	0.0
13	DN	Fuel Handling Simulator Project	Sustaining	Develop and install a simulator to train operators on the fuel handling systems instead of on the actual equipment, thereby minimizing wear on equipment.	May-06	Dec-09	Dec-13	3.4	5.9	0.0	0.0	0.0
14	PA	Feeder Weld Area Thickness Measurement	Sustaining	Develop remote tooling to measure thickness of feeders in the area of welds for fitness-for-service determination.	Jun-06	Nov-07	Jan-09 (Completed)	0.5	8.3	0.0	0.0	0.0
15	PB	Calandria Tube Cutting Tool	Sustaining	Develop tooling to cut and remove calandria tubes.	Jan-08	Jul-08	May-09 (Completed)	6.3	5.9	0.0	0.0	0.0
16	PA	Channel Isolation and Draining Tool for Feeder Replacement	Sustaining	Develop tools to isolate and drain fuel channels without tying up the fuelling machines	Aug-08	Mar-10	Mar-10	5.9	5.9	5.3	0.0	0.0
17	IMS	ANDE/CIGAR Hybrid	Sustaining	Increase the speed of fuel channel inspections by integrating the ANDE (Advanced Non-Destructive Examination) probe with the CIGAR delivery system	Apr-09	Dec-11	Dec-11	6.5	6.5	0.0	5.7	0.0
18		<b>Subtotal</b>							37.6	5.3	5.7	0.0
19		<b>Total</b>								12.4	9.1	0.6
		<b>DIVISION TOTALS</b>										
20		<b>Darlington</b>								2.3	3.4	0.6
21		<b>Pickering A</b>								5.3	0.0	0.0
22		<b>Pickering B</b>								0.0	0.0	0.0
23		<b>Nuclear Support Divisions</b>								4.8	5.7	0.0
24		<b>Total</b>								12.4	9.1	0.6

Notes:

- 1 Projects with expenditures during Test Period OR In-Service Amounts in Bridge or Test Period, AND Completed/Deferred Projects (from EB-2007-0905 or subsequent).
- 2 "Total Project Cost" reflects BCS amounts, with the exception of Completed/Deferred Projects (for which actual costs are shown).



**AMPCO Interrogatory #013**

**Ref:** Ex. D2-T1-S2, Table 2a, line 8

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Renovations to Pickering's administrative building cafeteria took almost 4 years from the time of project approval. Please comment on why such conventional commercial renovation requires such a protracted time period when implemented by OPG.

**Response**

OPG financial approval for projects occurs before project execution begins. This allows for better planning and execution. Typically a project is approved in the year before execution begins, making it appear that the duration of the project has increased by as much as a year. OPG's project management process also allows six months after the project being placed in-service for close-out of documentation and declaration of final In-service. The timeline for the referenced project was less than three years from start of work to in-service date. The BCS was approved in August 2005 with work starting in mid-2006.

Unlike a standard conventional commercial renovation, this work was carried out within the protected area of a nuclear power station. The schedule of the project was driven by the location. Constructing inside the protected area of a nuclear facility requires the design, procurement and installation to follow the nuclear engineering change process. This process is more rigorous than a standard commercial process. It needs to take into account the potential impact on safe operation through the engineering, procurement, planning, construction and commissioning phases of the project, and it needs to provide more detailed documentation supporting the modification. Building inside the protected area also requires that materials and staff entering the area follow the nuclear security requirements. These requirements did not allow the use of a standard Engineer-Procure-Construct contract that would be used for a conventional commercial facility located off-site.

**AMPCO Interrogatory #014**

**Ref:** Ex. D2-T1-S2, Attachment 1, Tab 4

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The replacement of Darlington change rooms is scheduled to take almost three and a half years from the time of first approval for developmental funding. The cost of the project is in the order of \$1,260/square foot. Please comment on why such conventional commercial construction requires such a protracted time period and significant cost when implemented by OPG.

**Response**

OPG approves projects months before the project execution begins. This allows for better planning and execution. The Darlington Generating Station change room project received its developmental release in July 2007 and was placed in-service March 2009, which is 21 months. The remainder of time was required for the demolition of an existing structure and the completion of documentation.

Unlike a standard conventional commercial renovation, this work was carried out within the protected area of a nuclear power station. The cost of the project was driven by the location. Constructing inside the protected area of a nuclear facility requires the design, procurement and installation to follow the nuclear engineering change process. This process is more rigorous than a standard commercial process: it needs to take into account the potential impact on safe operation through the engineering, procurement, planning, construction and commissioning phases of the project, and it needs to provide more detailed documentation supporting the modification. Building inside the protected area also requires that materials and staff entering the area follow the nuclear security requirements. These requirements did not allow the use of a standard Engineer-Procure-Construct contract that would be used for a conventional commercial facility located off site.

**AMPCO Interrogatory #015**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) For the Darlington refurbishment project, please provide a PPA equivalent and revenue requirement for the first full year in service for the first unit equivalent to the LUEC prices OPG has claimed.
- b) Please provide the analysis that OPG relies upon in its “review of current refurbishment experience in the industry.” For each of the following, provide the originally approved cost and final costs whether estimated or actual: Bruce 3 and 4 return to service; Bruce 1 and 2 retubing, reboiling and return to service; Pickering A retubing; Pickering A return for service; and Point Lepreau retubing. If the data is available, do not include replacement power costs but include interest cost.
- c) In Figure #1 OPG expresses near-100% confidence that the LUEC cost for Darlington could never exceed 8 cents/kWh. Given the uncertainties with respect to capital costs, contractor reliability, operating costs, productivity, life expectancy, interest costs, fuel costs, changing safety requirements, and other cost factors, please explain how OPG supports its assertion of near-100% certainty that the LUEC cost will never exceed 8 cents/kWh.
- d) What assumptions have OPG made with respect to the role of AECL in the Darlington refurbishment project?
- e) What is the lead time currently estimated for ordering pressure and calandria tubes? Please comment on factors driving the trend in recent years toward longer lead times for ordering pressure and calandria tubes.
- f) What is the currently estimated date to begin replacement of Darlington’s boilers?

**Response**

- a) OPG has not calculated a power purchase agreement (“PPA”) equivalent and revenue requirement for the Darlington Refurbishment project. However, OPG has provided (see Ex. D2-T2-S1, Attachment 4, page 32) a fully allocated Levelized Unit Energy Cost (“LUEC”) range of \$0.053/kWh – \$0.077/kWh.



- b) OPG has reviewed the publicly available information on similar nuclear refurbishment projects which included Bruce Units 1 and 2 refurbishment (retubing and re-boiling) and Point Lepreau retubing. The Bruce Units 3 and 4 return to service and the Pickering A Generating Station return to service are not projects of similar scope.

Provided below is the information OPG has on original cost estimates for these projects and the estimated final costs, based on publicly available information. In its review, OPG notes that the refurbishment of Bruce Units 1 and 2 includes the replacement of steam generators, while the planned refurbishment of Darlington Generating Station does not include replacement of the steam generators.

	<b>Bruce Units 1 &amp; 2 Refurbishment</b>	<b>Pt. Lepreau Refurbishment</b>
Original Estimates	\$2.75B <sup>1</sup> = \$1.38 B/Unit	\$1.02 B <sup>2</sup>
Estimated Cost at Completion	\$3.8 B <sup>3</sup> = \$1.9 B/Unit	\$1.5 B <sup>4</sup>

- c) OPG has high confidence that the LUEC of Darlington Generating Station will be less than \$0.08/kWh based on the methodology used and the conservative assumptions that underpin the analysis.

OPG has included a significant degree of variability into the inputs to the LUEC calculation (e.g., refurbishment costs, post-refurbishment costs and performance, and post-refurbishment station life). This variability in inputs was used, in conjunction with a Monte Carlo analysis, to derive the distribution of potential Darlington Refurbishment project costs as shown in the curve in Figure 1, Ex. D2-T2-S1, Attachment 4, Appendix C page 28. A Monte Carlo analysis is a standard approach to quantifying the impact on expected outcomes of variability in inputs. OPG has also been careful to ensure that its preliminary estimates of refurbishment costs are conservative based on prior experience with complex projects.

In addition, as noted in the interrogatory in Ex. L-10-003, approximately 55 per cent of the typical LUEC for Darlington Refurbishment is associated with OM&A. Given that OPG has over 20 years of operational experience with the Darlington Generating Station, OPG does not expect that there would be significant unanticipated increases in the future operating costs of Darlington over the post-refurbishment life.

- d) OPG has made no assumptions with respect to the role of Atomic Energy of Canada Limited ("AECL") in the Darlington Refurbishment project.

<sup>1</sup> Ministry of Energy, Ontario (News Release), Oct. 17, 2005; TransCanada News Release, October 17, 2005.

<sup>2</sup> FAQs on Point Lepreau Refurbishment, New Brunswick Power internet site.

<sup>3</sup> TransCanada Q4 2009 Investor Report, February 23, 2010, TCP Internet site.

<sup>4</sup> "Premier confident of results from talks on Lepreau refit", New Brunswick Telegraph-Journal, Apr 29, 2010.

- 1 e) The current lead time for ordering pressure and calandria tubes is approximately 24 to 27  
2 months. The trend in recent years towards longer lead times was a result of increasing  
3 demand from a number of stations embarking on refurbishment work. Until very recently,  
4 a single vendor has supplied exclusively all the pressure and calandria tubes to all the  
5 existing CANDU units, both domestically and worldwide. A second vendor has now been  
6 qualified and is able to supply both pressure tubes and calandria tubes. As a result, lead  
7 times may be shorter in the future due to increased manufacturing capacity.  
8
- 9 f) The replacement of the Darlington Generating Station steam generators is excluded from  
10 the scope of the Darlington Refurbishment project, as indicated in Ex. D2-T2-S1,  
11 Attachment 4, page 4 and discussed in Ex. L-7-028.

**AMPCO Interrogatory #016**  
**(NON-CONFIDENTIAL VERSION)**

**Ref:** Ex. D2-T2-S1, Attachment 1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) Regarding page 8, please indicate the total estimated costs for road, parking, vehicle garage, and related projects. Given the size and duration of the original Darlington construction effort, please comment on why existing road, parking, vehicle garage and related facilities are now inadequate. Please compare the peak site employment during construction with the peak site employment during refurbishment.
- b) Regarding page 9, the “key risks” identified for the nuclear refurbishment project appear to relate only to risks associated with the timing of initiation of the refurbishment, and not with the undertaking and completion of the refurbishment. Is this a complete list of key risks? If not, please identify and describe any other key risks.

**Response**

- a) The total estimated costs provided at Ex. D2-T2-S1, Attachment 1, page 8 (Darlington Refurbishment Preliminary Planning Release #3 Infrastructure) includes [REDACTED] for certain road and parking upgrades by 2013. There is an expectation that additional funding will be included in the overall Darlington Campus Plan for additional road and parking upgrades in future years.

Existing parking spaces will continue to be occupied by staff in support of station operations, outages and station projects. New parking spaces will be required for staff in support of refurbishment. There is no vehicle garage on site except a garage for Transport & Work Equipment. Existing road and bridges are more than 20 years old requiring repairs and resurfacing.

The peak site employment during construction of four units was about 7,700 as compared to a peak of 1,200 to 1,500 staff during refurbishment.

- b) Ex. D2-T2-S1, Attachment 1, page 9 includes key risks relevant to the 2010 – 2014 business plan period only. The Darlington Refurbishment project team is developing a comprehensive risk register as part of the project risk management program. The risk register includes risks that apply to all phases of the project’s life cycle, from the present Definition Phase through Execution Phase to Post-Refurbishment Operation. Please refer



1 to the Risk Management and Contingency Plan in the Project Execution Plan (Ex. D2-T2-  
2 S1, Attachment 2, pages 27-29) for a description of the process for risk identification and  
3 analysis.

**AMPCO Interrogatory #017**

**Ref:** Ex. D2-T2-S1, Attachment 2

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) Attachment 2 is the Darlington Refurbishment Project Execution Plan issued October 30, 2009. Please confirm that the Project Execution Plan is approved by senior management.
- b) Figure 3 indicates that the Darlington refurbishment "initiation" was completed in early 2009. Section 5.4.1 indicates that during this phase of the project, asset condition assessment of all major station components would be completed and the technical scope of the project would be proposed. However, in D2/2/1 Attachment 4, issued at almost the same time, there is a discussion of the technical scope of the project at section 3.0 wherein incomplete scoping work is noted with respect to fuel handling, turbine/generators, retube and feeder, and balance of plant. Was the asset condition assessment of all major station components completed in early 2009?
- c) Please indicate what OPG's schedule is for ordering long lead time items.
- d) What contractual flexibility will OPG be seeking (or has OPG obtained) to adjust the scope and/or schedule of the refurbishment project to accommodate longer-than-expected lead times for such items?

**Response**

- a) Confirmed.
- b) The asset condition assessment of all major station components was completed in 2009.
- c) The schedule for ordering long lead time items is now being developed in concert with the development of OPG's contracting strategies.
- d) In developing its contracting strategies, OPG will take into account the risk that lead times may be longer than expected for some items and will include appropriate mitigation measures.

**AMPCO Interrogatory #018**

**Ref:** Ex. D2-T2-S1, Attachment 4

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) Regarding page 23, please comment on why OPG is not pursuing a Low Void Reactivity Fuel option for Darlington.
- b) At Appendix C Section 1.1.2 OPG refers to having completed benchmarking on the refurbishment projects “such as Pt. Lepreau and the Bruce 1 & 2 Units”. Please provide this analysis.
- c) Regarding Appendix C Section 1.1.4, please compare the duration estimate OPG has made for calandria tube installation for each unit with the experience currently underway at Point Lepreau and comment on the difference.

**Response**

- a) OPG is not pursuing a Low Void Reactivity Fuel option for Darlington Generating Station because the safety analysis performed for the Darlington Generating Station reactor design, and submitted to the Canadian Nuclear Safety Commission (“CNSC”), has demonstrated that the safety margins using natural uranium fuel are adequate.
- b) The interrogatory response in Ex. L-02-015 provides a listing of publicly available information OPG considered in the preparation of its economic feasibility assessment. Additionally, OPG is a member of the Plant Refurbishment Working Group of the CANDU Owner’s Group. This group meets informally to share their operating experiences (“OPEX”) around refurbishment planning and execution activities. OPG has visited CANDU units at Bruce, Pt. Lepreau, Wolsong (Korea) and Gentilly 2 to review and observe their ongoing activities.
- c) Our schedule estimates were based upon the details from the retube feasibility study prepared for OPG by GE/Hitachi, which incorporated operating experience from Pt. Lepreau and Bruce. The estimates also incorporated the fact that Darlington Generating Station has about 100 more fuel channels in its reactor core than those at Pt. Lepreau, Wolsong and Gentilly 2.

At the time the study was underway no CANDU unit under refurbishment had progressed beyond the tube and feeder removal stage. Currently all the CANDU in-



1 progress refurbishments are now into Calandria Tube ("CT") installation work. A  
2 significant issue has arisen with respect to the ability to complete a reliable leak tight  
3 rolled joint, resulting in suspension of the CT work. Atomic Energy of Canada Limited  
4 ("AECL"), working with the impacted utilities, has made changes to the tooling and  
5 installation processes to solve the problem and the CT installation work is anticipated to  
6 resume shortly. OPG will consider this OPEX when developing its final project plans.

**CCC Interrogatory #018**

**Ref:** Ex. D2-T1-S1, page 2

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The evidence states that the nuclear project portfolio is approved via the OPG business planning process with the Board of Directors approving the OM&A and Capital Projects portfolio budget. Please provide copies of all presentations and reports presented to the Board of Directors when seeking approval of the nuclear project portfolio.

**Response**

The nuclear project portfolio is presented to the Board of Directors as part of the Nuclear Operations Business Plan (Ex. F2-T2-S1 Attachment 1, page 18 and 20/21). There are no other presentations or reports presented to the Board of Directors seeking approval of the nuclear project portfolio.

**CCC Interrogatory #019**

**Ref:** Ex. D2-T2-S1, page 1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please explain specifically how the Darlington Refurbishment project reduces the revenue requirement by \$207.5 million during the test period.

**Response**

The derivation of the net revenue requirement reduction of \$207.5M resulting from the Darlington Refurbishment project is provided in Ex. D2-T2-S1, Table 2. The specific aspects of revenue requirement affected by the project are outlined in Ex. D2-T2-S1, page 4, lines 8-17.



**CCC Interrogatory #020**

**Ref:** Ex. D2-T2-S1, page 2

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please explain the relationship between the Darlington Refurbishment and the Bruce Lease costs.

**Response**

The impact of the Darlington Refurbishment on Bruce Lease costs is a revenue requirement reduction of \$54.4M for the test period as presented in Ex. D2-T2-S1, Chart 1. The primary impacts result from the \$293M increase in both Asset Retirement Obligations ("ARO") and Asset Retirement Costs ("ARC") described in Ex. C2-T1-S2, section 4.1 and the consequential impact on depreciation expense, accretion and used fuel storage and disposal variable expenses.

This increase in ARO/ARC has been allocated to the stations and has resulted in decreases to both the ARO and ARC for the Bruce facilities as presented in Ex. C2-T1-S2, Table 3 and as described in interrogatory L-1-132.

With respect to the Bruce facilities, the lower ARO has resulted in lower accretion costs of \$18.3M for the test period, and the lower ARC has resulted in lower depreciation costs of \$40.2M for the test period. In addition, the Darlington Refurbishment project has resulted in higher used fuel storage and disposal variable expenses for the Bruce facilities of \$4.2M for the test period as shown in Ex. C2-T1-S2, Table 4, line 8.

**CCC Interrogatory #021**

**Ref:** Ex. D2-T2-S1, page 2

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

OPG indicates that the LUEC of the Darlington Refurbishment is 8 cents/kWh. Did OPG retain any outside expertise to assess those numbers. If not, why not? If so, please provide any such studies.

**Response**

The interrogatory incorrectly states that OPG indicates that the Levelized Unit Energy Cost ("LUEC") of the Darlington Refurbishment is \$0.08/kWh. OPG has high confidence that the project will have a LUEC of between \$0.06/kWh and \$0.08/kWh (2009 dollars) as stated at Ex. D2-T2-S1, page 5, line 1.

OPG did not retain any outside expertise to assess the LUEC of Darlington Refurbishment. The calculation of LUEC is an activity for which OPG has significant internal expertise.

As described at Ex. D2-T2-S1, pages 11-12, OPG has entered into the project definition phase for the Darlington Refurbishment project. OPG will be completing a detailed cost estimate for Darlington Refurbishment. A release quality project cost and schedule will be prepared at the end of the definition phase in 2014. OPG will have a third party review of the release quality project cost estimate and other key assumptions. The release quality project cost estimate will be used as an input to the calculation of an updated LUEC at that time.

**CME Interrogatory #015**

**Ref:** Ex. B1-T1, Ex. D1, Ex. D2, and Ex. D3

**Issue Number: 4.2**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the regulated hydroelectric business appropriate and supported by business cases?

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please provide a breakdown of the Capital Budgets for Hydroelectric and Nuclear, separately, listing, year by year beginning January 1, 2011, each of the projects that will be one year or less in duration, each of the projects that will be two years or less in duration, and each of the projects that will take more than two years to complete and put in service.

**Response**

**Hydroelectric**

OPG interprets this as a request for information on the duration of Regulated Hydroelectric capital projects that are forecast to begin in 2011 and end in 2011; or begin in 2012 and end in 2012; or begin in 2011 and end in 2012. These projects are listed in the table below.

**Regulated Hydroelectric - Capital Projects Starting and Ending in 2011 and 2012**

Line No.	Project Description	Number of Projects	Total Project Cost (\$M)	Average Cost Of Projects (\$M)
		(a)	(b)	(c)
	<b>Projects starting and ending in 2011</b>			
1	Projects >\$10M Total Project Cost	0	0.0	0.0
2	Projects \$5M - \$10M Total Project Cost	0	0.0	0.0
3	Aggregate Total All Projects <\$5M	2	1.2	0.6
	<b>Projects starting and ending in 2012</b>			
4	Projects >\$10M Total Project Cost	0	0.0	0.0
5	Projects \$5M - \$10M Total Project Cost	0	0.0	0.0
6	Aggregate Total All Projects <\$5M	3	1.3	0.4
	<b>Projects starting in 2011 and ending in 2012</b>			
7	Projects >\$10M Total Project Cost	0	0.0	0.0
8	Projects \$5M - \$10M Total Project Cost	0	0.0	0.0
9	Aggregate Total All Projects <\$5M	3	2.5	0.8
10	<b>Total</b>	8	4.9	0.6

**Nuclear**

OPG interprets this as a request for information on the duration of Nuclear capital projects that are forecast to begin in 2011 and end in 2011; or begin in 2012 and end in 2012; or begin in 2011 and end in 2012. OPG Nuclear has no such projects.



## CME Interrogatory #016

**Ref:** Ex. B1-T1, Ex. D1, Ex. D2, and Ex. D3

### **Issue Number: 4.2**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the regulated hydroelectric business appropriate and supported by business cases?

### **Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

### Interrogatory

For those projects that will not be completed and in service by December 31, 2012, show, year by year and cumulatively, the amounts that OPG plans to spend in order to complete each of those multi-year projects.

### Response

#### Hydroelectric

Regulated Hydroelectric capital projects are listed in Ex. D1-T1-S2, Tables 1, 2, and 3. There are three projects over \$10M, three projects between \$5M and \$10M, and four projects under \$5M with both cash flows in 2011 or 2012, and in-service dates after 2012. They are listed with their cash flows in the table below.

**Regulated Hydroelectric - Capital Projects In-Service after 2012**

Line No.	Project Name	Project Number	Final In-Service Date	Total Project Cost (M\$)	2009 LTD Actual (\$M)	2010 Budget (\$M)	2011 Plan (\$M)	2012 Plan (\$M)	Future Plan (\$M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
	<b>Projects &gt;\$10M Total Project Cost</b>								
1	Niagara Tunnel Project	EXEC0007	Dec-13	1,600.0	648.0	241.8	288.0	199.0	223.2
2	Sir Adam Beck I GS - Unit G10 Upgrade	SAB10050	Dec-14	29.5	0.0	0.0	0.0	2.4	27.1
3	R.H. Saunders - Station Service Replacement	SAUN0080	Dec-17	10.7	0.0	0.0	0.2	0.9	9.6
	<b>Projects \$5M - \$10M Total Project Cost</b>								
4	Sir Adam Beck Pump GS - Governor Replacement	SABP0033	Dec-13	5.6	0.0	0.5	1.5	1.8	1.8
5	Sir Adam Beck Pump GS - 13.8 kV Breaker Replacements	SABP0034	Mar-13	5.9	0.0	0.1	2.0	3.0	0.8
6	R.H. Saunders GS - Replace Static Exciters	SAUN0079	Dec-13	5.1	0.0	0.0	0.1	2.5	2.5
7	<b>Aggregate Total All Projects &lt;\$5M</b>				0.0	0.2	1.3	2.9	9.6

Forecast project costs beyond 2012 are provided in aggregate form, as the requested level of detail is unrelated to OPG's current application

Witness Panel: Hydroelectric  
Nuclear Projects

## Nuclear

As shown in Ex. D2-T1-S2 Tables 1a, 2a and 2b (taking into account data corrections as noted in Ex. L-2-012), there are six projects that are planned to be completed after December 31, 2012. None of the projects making up the totals shown in Ex. D2-T1-S2, Table 3 have completion dates after December 31, 2012.

The requested information on these six projects is presented in the table below.

Line No.	Facility	Project Name	Project Number	Final In-Service Date	Total Project Cost (M\$)	2009 LTD Actual (\$M)	2010 Budget (\$M)	2011 Plan (\$M)	2012 Plan (\$M)	Future Plan (\$M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
1	DN	Fuel Handling Power Track Improvement	31438	Feb-13	17.4	7.6	4.4	2.8	1.7	0.9
2	DN	Improve Maintenance Facilities at Darlington	31717	May-13	57.7	4.7	13.7	15.4	10.5	0.4
3	DN	Shutdown System Computer Aging Management	33955	Nov-13	17.2	1.9	3.2	4.9	2.7	4.4
4	NPT	Controlled Area Improvements (1)	25902	Nov-13	15.0	1.5	0.5	3.3	9.4	0.4
5	DN	Turbine Generator Vibration Monitor System Replacement	33819	Dec-13	8.0	1.2	0.3	2.5	0.3	3.7
6	DN	Fuel Handling Simulator Project	31430	Dec-13	5.9	1.8	0.3	2.5	1.0	0.3
Note 1: Total project cost (as presented in from Ex. D2-T1-S2 Table 1a) has been corrected here.										

Forecast project costs beyond 2012 are provided in aggregate form, as the requested level of detail is unrelated to OPG's current application.

**GEC Interrogatory #016**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please provide a copy of the Management Report and other documents considered by the Executive Committee and the NGPC leading to acceptance on April 14<sup>th</sup> and April 24<sup>th</sup>, respectively, of Management's report to exclude Steam Generator's from the Refurbishment scope of Darlington. Please provide the reports or motions of those committees.

**Response**

See attached and the response to the interrogatory in Ex. L-7-028.

# Overview of Darlington Steam Generators Scope Decision

**Presentation to Executive Committee**

**April 14, 2009**

**W. Robinson & T. Karaim**







## Background & Summary

- June 2008: CEO approved interim recommendation not to include steam generators in preliminary scope for Darlington refurbishment.
- 2<sup>nd</sup> half 2008: Dominion Engineering Inc (DEI) was contracted to perform a detailed condition assessment of the DNGS Steam Generators and their final report was submitted Dec 2, 2008.
- DEI concluded: *"It is expected that the Darlington SGs can be operated in a safe, reliable and cost effective manner through the end of the planned extended operating period"*.
- Dec 2008 to Feb 2009: OPG performed a technical and economic assessment of the DNGS SG's and concluded that it is more economical to retain existing steam generators than replace them during refurbishment. There was a low risk of needing to replace in post-refurbishment life.
- The following slides summarize the outcome of this technical & economic assessment and provide the basis for management's recommendation.





## Summary of Technical Assessment

- DEI reviewed both active and plausible degradation mechanisms for tubing, internals and shell of the Darlington SGs
- Quantitative predictions of maintenance required, outages impacts, potential forced outages done at a range of confidence levels from very low to very high.
- Only two tubing degradation mechanisms (one active, one plausible) were considered likely to significantly impact future performance.
- DEI conclusions:
  - *From a long term structural degradation perspective: "It is expected that the Darlington SGs can be operated in a safe, reliable and cost effective manner through the end of the planned extended operating period"*
  - *"Current aging management practices for Darlington SGs are considered well thought out, comprehensive and thorough"*
- DEI also suggested alternative life management strategies in the event that the plausible degradation mechanism occurred. They also indicated that there was a minimal risk of shortened operating periods late in post-refurbishment life.
- OPG concluded from the DEI assessment that there was a very high (>90%) probability that the SG's will not require replacement any earlier than 15-20 years post-refurbishment.





## Summary of Economic Assessment

- A comprehensive economic analysis of two alternatives was completed:
  1. **Keep SGs** (including required maintenance to address degradation)
  2. **Replace SGs in Refurb Outage**
  - A “Replace Later” alternative was addressed as a sensitivity.
- The assessment of steam generator performance included degradation due to tube fouling, as well as costs of mitigation. A range of costs & performance were utilized in assessment.
- A range of SG replacement costs during refurbishment was also assumed.
- **Results:**
  - *Medium Confidence (30 – 70%) that the “Keep SGs” alternative was better economically than “Replace SGs” alternative by **\$200M to \$750M PV**.*
  - *The “Replace Later” PV costs would be the same as the “Replace during Refurbishment” PV costs provided the replacement could be done in 10 months and takes place more than 18 years post refurbishment. However there is a very high confidence in achieving 18 years safe, reliable, cost-effective operation post-refurbishment, with the existing SGs.*



## Risks

- Risks were assessed for both the “Keep SGs” and “Replace SGs ” alternatives
- Key Risks – “Keep SGs”
  - *Potential for larger than predicted production losses due to maintenance requirements*
  - *If plausible degradation mechanism occurs, potential that regulatory relief from tube plugging and inspections could be denied (despite forecast of likely NRC acceptance in the U.S.).*
- Key Risks – “Replace SGs”
  - *Procurement lead time could push refurbishment start date*
  - *More complex outage, additional skilled labour required – could impact refurbishment duration and/or critical path*
  - *Post refurbishment performance risk (some U.S. plants have experienced unexpected early degradation in new SGs)*





## Summary Recommendations

- ***Do not replace Darlington Steam Generators; plan to retain and operate the existing SGs through to the end of post-refurbishment life.***
- ***Maintain strict adherence to the Steam Generator Life Cycle Management Plan requirements both leading up to and post-refurbishment.***

Full details of the technical and economic assessment are provided in the attached presentation.





# Darlington Steam Generators: Condition Assessment and Economic Analysis Additional Backup Information



W. Robinson/T. Karaim

# Agenda

- Background
- Condition Assessment Results
- Economic Analysis Results
- Risks
- Recommendation





## Background

- May 23, 2008 - Darlington Refurbishment Advisory Committee agreed with preliminary recommendation that scope should not include SGs, pending results of a detailed condition assessment
- Dominion Engineering Inc. (DEI) contracted to perform a condition assessment of the DNGS Steam Generators - submitted final report Dec 2, 2008
- DEI report outputs (options, projected tube plugging, inspection & maintenance costs, lost production) used as inputs to economic assessment
- OPG internal assessment of SG tube fouling integrated with DEI outputs to assess overall forecast performance and costs and to perform NPV calculations.
- Engineering Decision Meetings on December 16, 2008 and February 20, 2009 - Recommendation to Retain Existing SGs was endorsed.





## Objectives & Scope of DEI Assessment

- Determine if it is technically feasible to operate the existing Darlington SGs for ~ 30 years post refurbishment.
- Recommend improved inspection and maintenance strategies to be followed to ensure SG extended life is feasible and economic
- SG Component Assessment; not a Heat Transport System Assessment
- Considered both tube and non-tube (shells and internals) degradation
- Did not address SG performance degradation due to tube internal diameter magnetite fouling – addressed by Nuclear Refurbishment



# DEI Methodology

- Degradation mechanism assessment
  - *Tubing - reviewed 24 active and plausible mechanisms. 21 active and plausible mechanisms selected for further consideration*
  - *Internals and Shell-reviewed 23 mechanisms. None selected for further evaluation as none were considered to have a high probability of seriously affecting SG life or performance.*
- Active and plausible mechanisms were modelled using Monte Carlo Simulation and Weibull statistics.
- Quantitative predictions of future degradation at a range of probabilities (confidence levels), i.e. 5%, 16%, 50% (best estimate), 84% and 95% developed.
- Quantitative predictions for forced and extended outage lost production days and major events due to unexpected degradation were done at the five confidence levels



## Conclusions of Condition Assessment

- From a long term structural degradation perspective, Dominion Engineering International concluded:
  - *“It is expected that the Darlington SGs can be operated in a safe, reliable and cost effective manner through the end of the planned extended operating period”*
- “Current aging management practices for Darlington SGs are considered well thought out, comprehensive and thorough”
- Report focussed on alternative strategies which could be implemented to address potential degradation mechanisms if they arise. Risk of needing to replace SGs during post-refurbishment life not discussed – hence no explicit discussion of confidence levels of needing to replace.





# DEI Maintenance Strategies Development

- DEI developed one base (current Life Cycle Plan) and five alternative mitigating inspection and maintenance strategies to reduce the forecast tube plugging and lost production days.
- Predicted degradation and forced outages translated to dollars and lost production days on a tri-annual basis at the full range of probabilities (confidence levels) for the six plans (Plans 1 – 6).
- Nuclear Refurbishment completed the assessment of tube internal diameter fouling.
- OPG Economic Assessment focused on:
  - **DEI Plan 1:** Assumes that OPG would move to 100% Inspections of All SGs and plugging of all tubes with detected cracks in each outage for the remaining life of units following detection of deep tubesheet crack initiation – likely bounding “high cost” case for retain SGs alternative
  - **DEI Plan 6:** Assumes that OPG would obtain CNSC Acceptance of “Alternate Repair Criteria” following detection of deep tubesheet crack initiation; thereby avoiding 100% inspections and plugging of tubes with deep tubesheet cracks after first event – likely bounding “low cost” case for retain SGs alternative







## DEI Results – Best Estimate

Parameter	Plan 1 – Plug all indications of deep tubesheet stress corrosion cracking; 100% tubesheet Insp. every outage	Plan 6 - Alternate Repair Criteria for tubesheet stress corrosion cracking Accepted
% Tubes Plugged at Refurb	2.2%	2.2%
% Tubes Plugged at End of Post-Refurb Life	5.0%	4.3%
Outage Impacts:	17 – 21 d/outage	4 – 7 d/outage
Increased insp	12 d	0 d
F.O contribution	4 d	4 d
Incr. tube plugging	1-5 d	1-3 d
Additional Costs per Outage	\$4.8 - \$5.2M	\$0.7 - \$0.9M

*NOTE: 3.9% tubes plugged contributes a Reactor Inlet Header Temperature increase of 0.5°C (exceeds 3.9% in approximately 2037 in Plan 1 and approx. 2040 in Plan 6)*



## OPG Comments on DEI Results

- DEI most pessimistic case (95% CL) predicts OD IGA/SCC at other locations (not deep tubesheet) in later life (2034-2046); could negatively impact outage durations and costs due to increased inspections, but 3-year interval between inspections can be maintained
- Recent German operating experience with Alloy 800 SGs:
  - *OD IGA/SCC deep within tubesheet confirmed (by tube removal)*
  - *One plant with possible OD IGA/SCC like indications at top of tubesheet (both circ. and axial/volumetric) and at supports*
  - *German OPEX for OD IGA/SCC was considered in DEI projections*
  - *Applicability to CANDU is currently being assessed under COG R&D*



# OPG Economic Analysis

- OPG Economic Analysis includes assessment of impact of internal diameter fouling, tube plugging, and heat transport system aging on Neutron Over Power (NOP) margins
- Focus of Analysis is on 2 Alternatives
  - **Keep SGs** - *Perform Primary Side Cleans (PSC) – assessed as follows:*
    - *DEI Plan 1 (High Cost/High Lost production Bounding Case}*
    - *DEI Plan 6 (Low Cost/Lost Production Bounding Case)*
  - **Replace SGs in Refurb Outage**
- Focus of Analysis is on “Post-Refurb” Costs – costs until refurb are identical for both alternatives.



## OPG Economic Analysis (cont'd)

- Use of range estimates (DEI had provided costs and production impacts at 5%, 16%, 50%, 84% and 95% confidence levels).
  - *Analysis utilized the 16%, 50% and 84% confidence levels as representative of the Low, Median and High Confidence estimates.*
  - *Monte Carlo Analysis utilized the full range of 5% to 95% confidence estimates*
- Variables considered in the Economic Analysis:
  - *Keep SGs:*
    - ***Assumed some reduction in tube ID fouling post-refurb in median case due to new feeder material***
    - ***Used of a range of Primary Side Cleaning (PSC) costs and effectiveness***
  - *Replace SGs:*
    - ***SG Replacement Costs and Cost Ranges based on Pickering B SG replace study.***





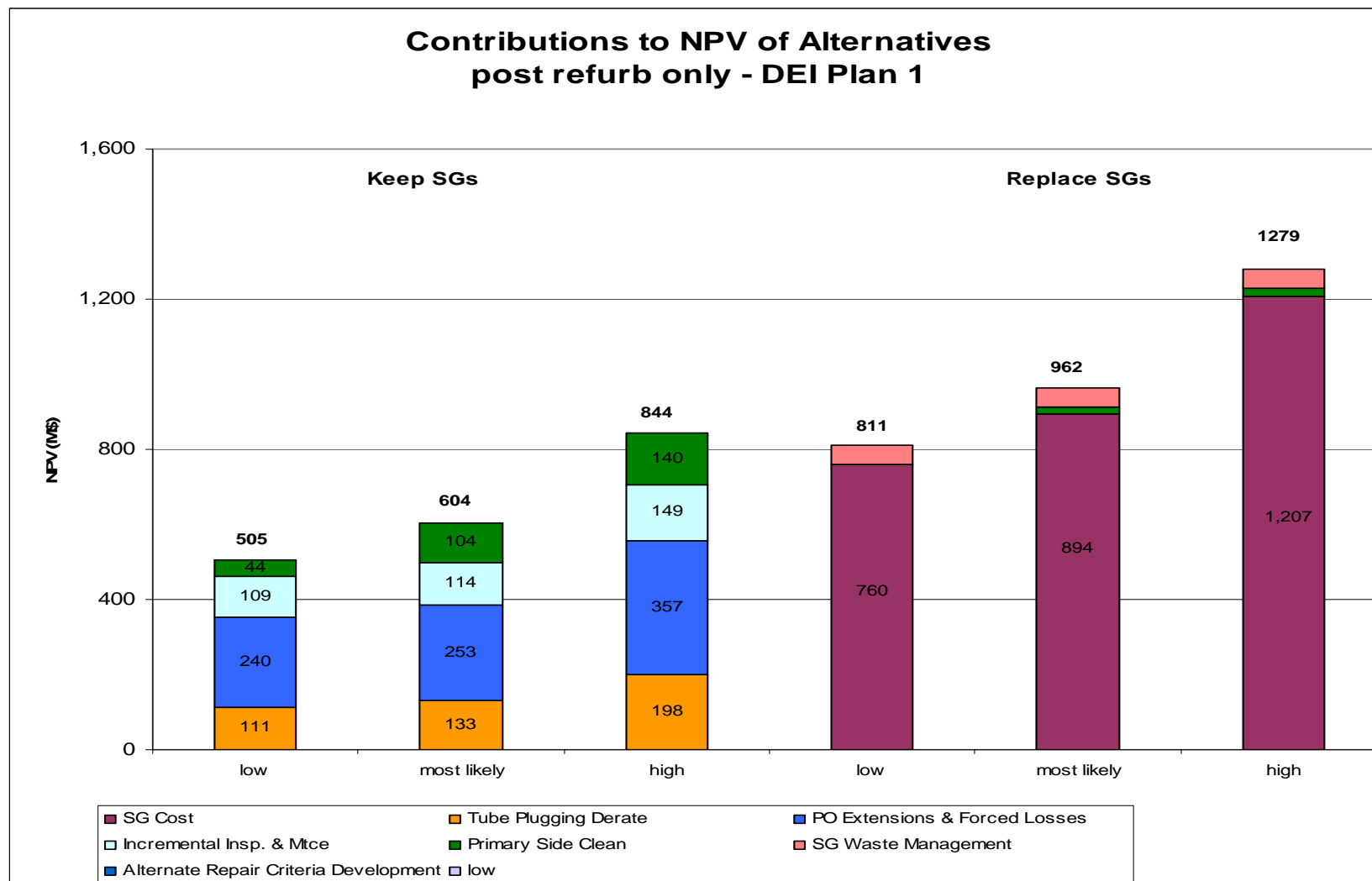
## Economic Analysis Results (Medium Confidence)

Alternatives: based on <b>Plan 1</b> (Post-Refurb Costs Only)	Delta NPV M\$ (All Units)
<b>Keep SGs:</b> Do Primary Side Cleans; 100% Inspections & plugging after crack initiation	<b>+358</b>
<b>Replace SGs:</b> NEW SGs CASE + PSC	<b>0</b>
Alternatives: based on <b>Plan 6</b> (Post-Refurb Costs Only)	Delta NPV M\$ (All Units)
<b>Keep SGs:</b> Do Primary Side Cleans; Alternative Repair Criteria Accepted	<b>+626</b>
<b>Replace SGs:</b> NEW SGs CASE + PSC	<b>0</b>



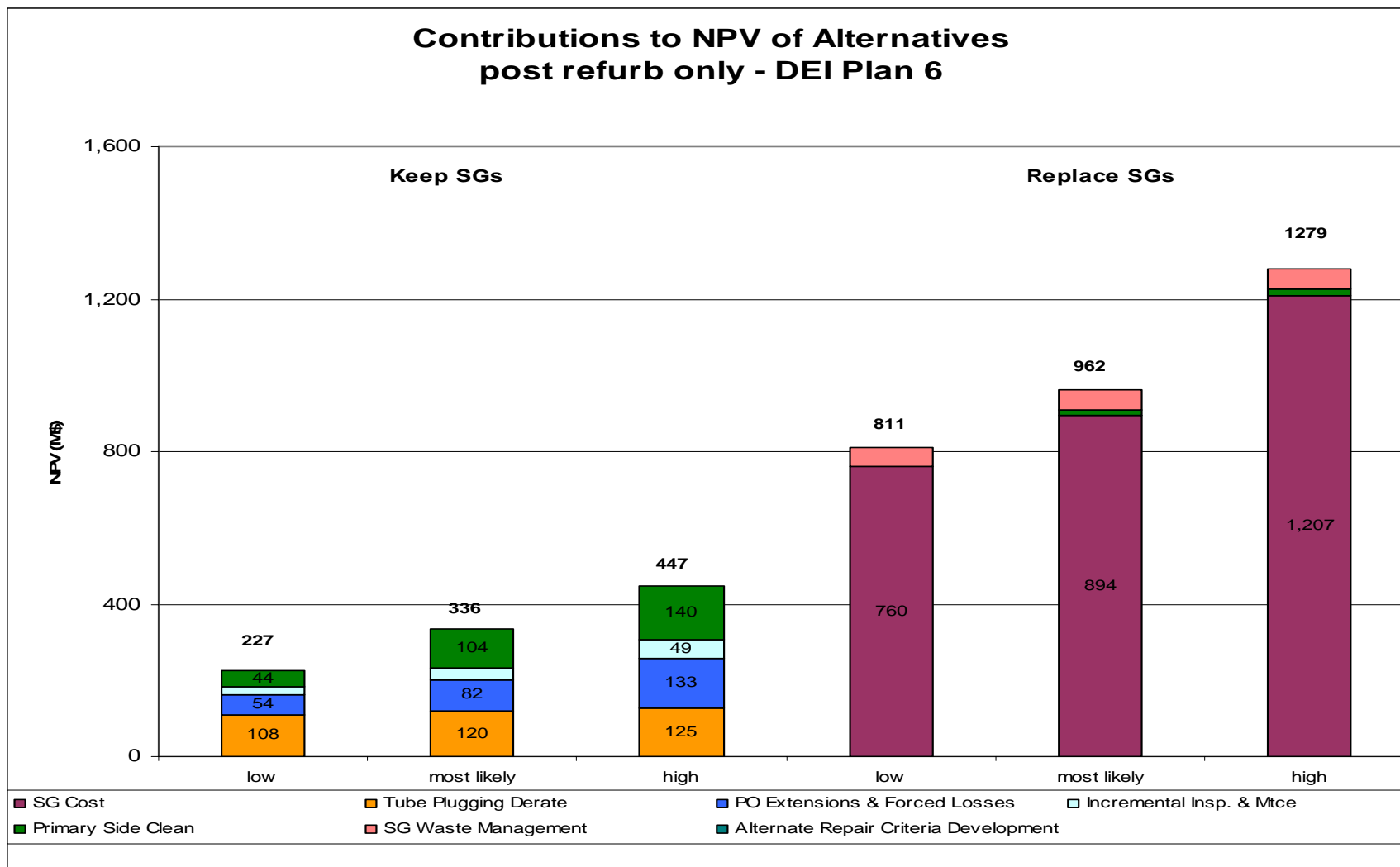


# Comparison of Keep SGs & Replace SGs – Based on DEI Plan 1 – Post Refurb Costs Only





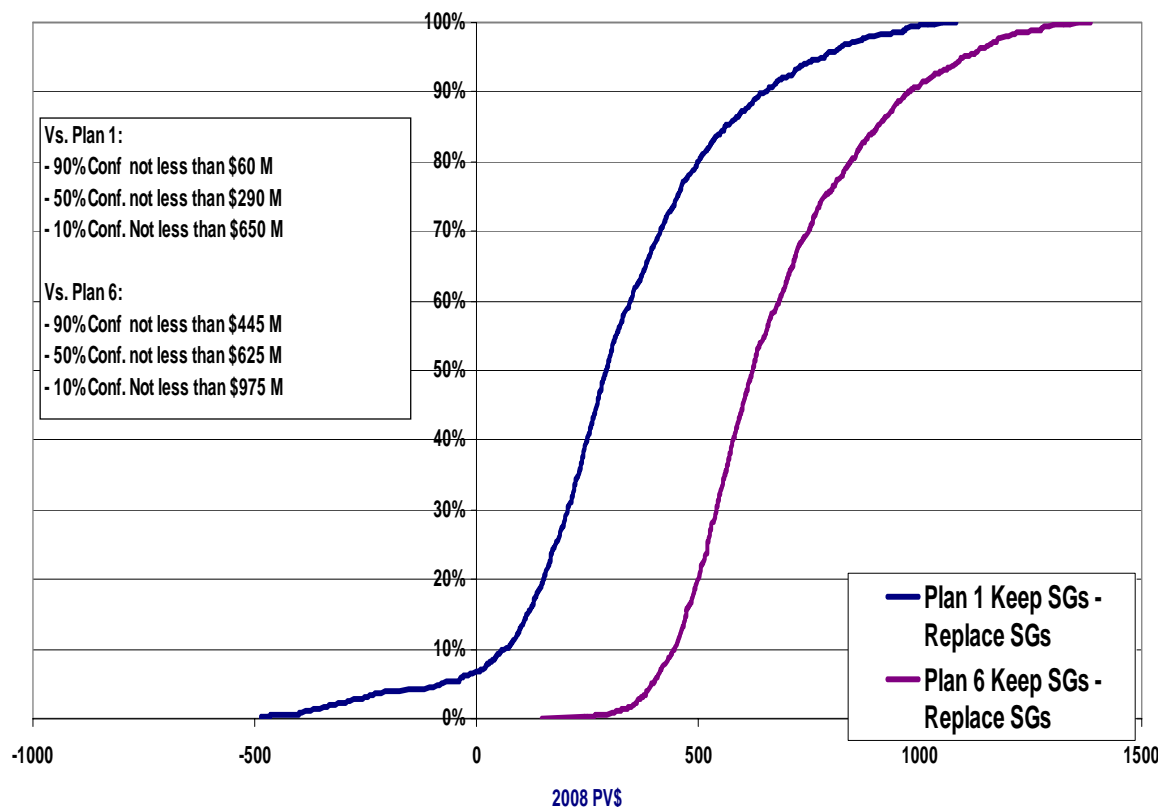
# Comparison of Keep SGs & Replace SGs – Based on DEI Plan 6 – Post Refurb Costs Only



# Probability Distribution of Delta PVs

- 50% Confidence that Keep SGs, Plan 1 (100 % Inspections) would be better by \$290 M PV
- 7% probability that Keep SGs, Plan 1 (Keep SGs) could come out worse than Replace SGs
- 50% Confidence that Keep SGs, Plan 6 (Alternate Repair Criteria) would be better by \$625 M PV
- Zero probability that Keep SGs, Plan 6 could come out worse than Replace SGs

Distribution of Outcomes  
PV Delta for Keep SGs (Plan 1 & Plan 6) Vs. Replace SGs

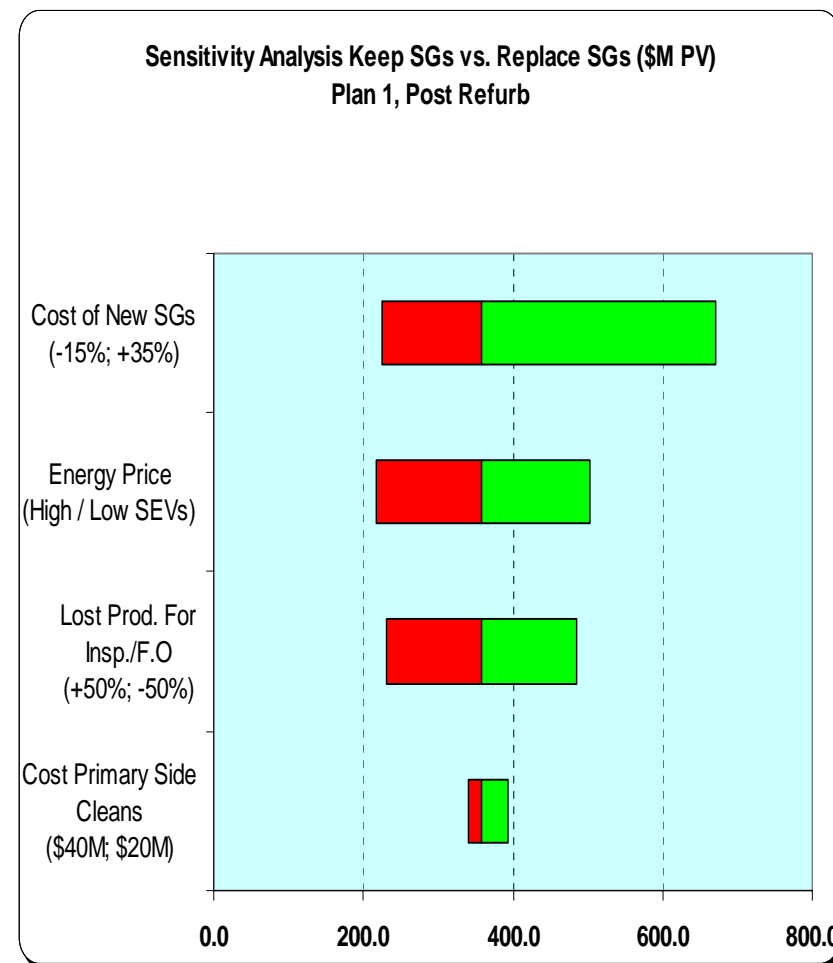




# Sensitivity Analysis

## Keep SGs vs. Replace SGs – Plan 1

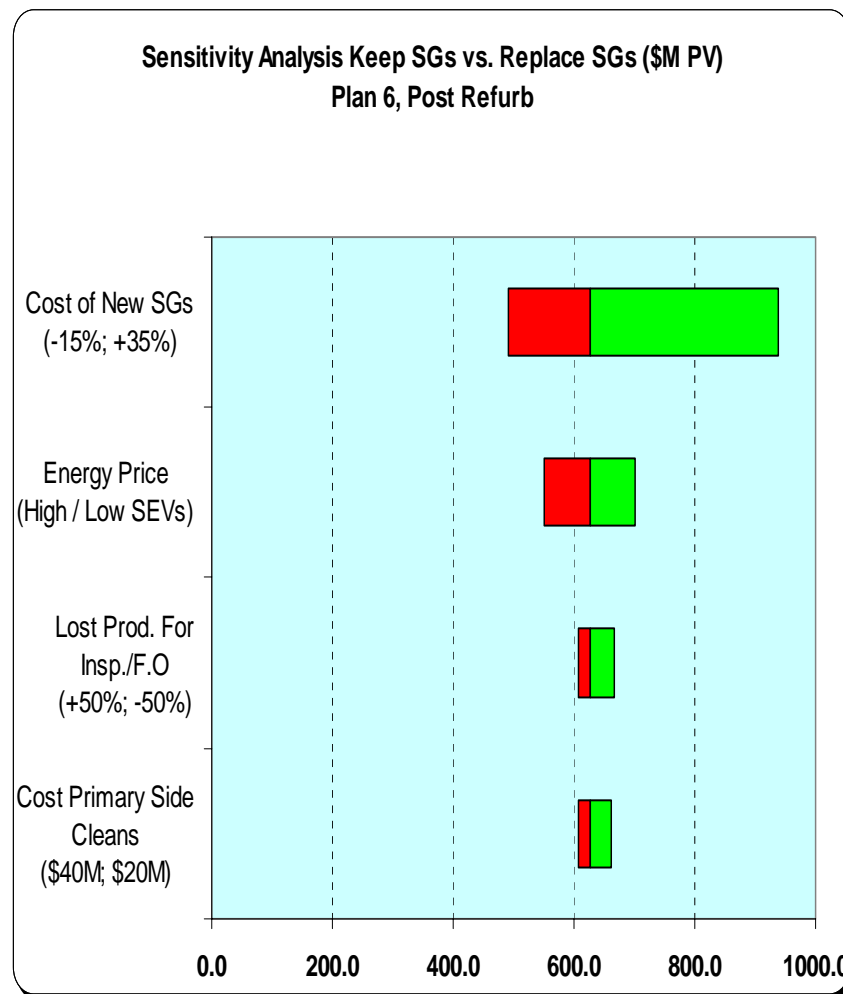
- To “breakeven” with Keep SGs, Plan 1 Median Case, cost of SG Replacement (Replace SGs) would need to be \$270 M per unit (\$1.08 Billion – 4 units)
- Relative PV advantage of “No Replace” Alternative is very sensitive to cost of SG Replacement
- Relative PV advantage is also very sensitive to the assumed electricity prices
  - *Keep SGs, Plan 1 includes significant lost production for inspections / maintenance, thus if energy price is lower, this option becomes more attractive.*
- Outage critical path impacts for Plan 1 are significant, thus the relative PV advantage is very sensitive to assumed production losses
- Relative PV advantage is quite insensitive to the cost of primary side cleans.



# Sensitivity Analysis

## Keep SGs vs. Replace SGs – Plan 6

- To “breakeven” with Keep SGs, Plan 6 Median Case, cost of SG Replacement (Replace SGs) would need to be \$135 M per unit (\$540 M – 4 units)
- Relative PV advantage of “No Replace” Alternative is very sensitive to cost of SG Replacement
- Relative PV advantage is also moderately sensitive to the assumed electricity prices
  - *Keep SGs, Plan 6 includes lost production for inspections / maintenance, thus if energy price is lower, this option becomes more attractive.*
- However, outage critical path impacts for Plan 6 are significantly mitigated compared with Plan 1, thus the relative PV advantage is fairly insensitive to forced production losses
- Relative PV advantage is quite insensitive to the cost of primary side cleans.



## Risks – Keep SGs , Plan 1

- 100% tube inspection, plugging and PSC could push planned outages more than modeled
- On-going need for 100% inspections on outage critical path could result in increased “managerial and organizational stress”
- Increased regulatory scrutiny if SCC becomes active; however, risk of shortened operating intervals is low
- Unknown degradation mechanism: despite best efforts to assess multiple degradation mechanisms (up to 24 for tubing), a new degradation mechanism may arise in the future
- For pessimistic case (fouling rate not reduced, no PSC effectiveness improvement) could be additional impacts of ID fouling not explicitly modeled in the economic assessment (e.g. degraded Non-Destructive Examination capability)



## Risks – Keep SGs, Plan 6 (Alternate Repair Criteria)

- 100% tube inspection, plugging and/or PSC could push planned outages more than modeled
- Despite similar Alternate Repair Criteria acceptance in other jurisdictions (U.S.) and forecast of likely NRC acceptance for permanent use, CNSC acceptance not certain.
- Should deep tubesheet cracks arise, may need to continue with 100% inspections for 1 or 2 outage cycles prior to CNSC granting relief.
- Leaving tubes with deep tubesheet cracks in service could result in chronic low levels of SG primary to secondary leakage. Plugging tubes with detected tubesheet cracks can mitigate above risks with respect to leakage.





# Risks – New SGs

- Risk to Refurb cost and schedule
  - *Procurement lead time – potential to push refurb outage start date*
  - *SG replacement is expected to remain off refurbishment outage critical path, however schedule risk due to first time execution*
  - *Potential for cost overruns on SGs procurement and installation*
  - *More complex outage due to integration of SG replacement with remaining refurbishment outage schedule*
  - *Increased waste storage requirements*
  - *Additional skilled labour required during refurb*



## Risks – New SG Cont'd

- Regulatory risk
  - *Approval to perform heavy lifts over safety systems*
  - *Approval to have an opening in containment during SG removal process*
- Post Refurbishment Risk
  - *Replacement SG performance (Alloy 690TT and Alloy 800NG) has been good with respect to tube corrosion,*
  - *Even with like for like replacement some plants have experienced early degradation such as wear at tube supports (e.g. Ocone)*
  - *Unknown degradation may also occur in new SGs*



# Recommendations

- Do not replace Darlington Steam Generators; retain existing SGs through end of second pressure tube life.
- Plan to perform primary side cleans (if required) pre & post refurbishment.
- Plan to submit a justification to the CNSC for acceptance of the Alternate Repair Criteria should deep tubesheet cracks arise in the Darlington SGs.
- Maintain strict adherence to the SG Life Cycle Management Plan requirements both leading up to and post-refurbishment.



**GEC Interrogatory #017**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Regarding the statement on page 13: "Analysis has shown that OPG's large nuclear operating fleet allows the sharing of Corporate and Support Costs over a broader base of generation, resulting in economies of scale in these costs. A decision not to proceed with the refurbishing of Darlington would add upward pressure on Corporate and Nuclear Support costs on the remainder of OPG's nuclear fleet", given the Pickering nuclear station will be shut down in 2020, please explain how a decision not to refurbish Darlington will increase support costs for "the remainder of OPG's nuclear fleet."

**Response**

The statement referenced in the question was written at a time when the decision to not refurbish the Pickering B Generating Station units had not yet been made. The statement is an observation concerning a potential benefit of proceeding with Darlington Refurbishment and does not affect the economic feasibility assessment that determined with high confidence that the project will have a Levelized Unit Energy Cost ("LUEC") of between \$0.06/kWh and \$0.08/kWh (2009\$).



**GEC Interrogatory #018**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Regarding the statement on page 13: "A decision not to refurbish Darlington would also have a significant impact on staff morale. Significant management oversight would be required to ensure there is no potential impairment of plant performance for the remaining life of the station":

- a) Has OPG studied whether its February 2010 announcement that it would close the Pickering station has had a "significant impact on staff morale"? If so, please provide observations and conclusions.
- b) What "significant management oversight" has OPG put in place to ensure there is no impairment of the performance of the Pickering nuclear station during its remaining life? Please provide cost estimates for this increased management oversight.

**Response**

- a) To date, the February 2010 announcement has not had a significant impact on staff morale. Supporting this conclusion are the following:
  - Feedback from employees, specifically, questions and comments from employees (at several face-to-face meetings, and through an intranet leadership blog page inviting questions from staff to the Chief Nuclear Officer and to the Executive Vice President of Projects, Refurbishment and Support) reflected no significant impact on morale.
  - In the months since the announcement, staff has continued to work productively and with continued regard for the key performance areas of safety, reliability, human performance and value for money. This is exemplified by the completion of a significant and complex project for the Pickering Vacuum Building Outage ("VBO") this past spring. The VBO inspection and maintenance outage involved about 30,000 complex pre-outage and outage tasks and significant teamwork. It was completed ahead of schedule and on budget, meeting established safety targets.
  - The opportunities presented by Darlington Refurbishment provide an offset opportunity.

1 To help support continuation of a good working environment and working relationships,  
2 there are ongoing communication meetings between the management team, staff and  
3 employee representatives.  
4

- 5 b) The increased management oversight that OPG has put in place relates to the  
6 heightened awareness and close monitoring of plant performance and employee morale.  
7 For plant performance, the oversight is done through the station's comprehensive set of  
8 performance metrics. For employee morale, there are a number of direct and indirect  
9 indicators used. Management continues to analyse trends in all of these areas, and will  
10 respond accordingly. There are no incremental costs for this increased management  
11 oversight.

**GEC Interrogatory #019**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

In regard to the statement on page 13 of Attachment 4 of D2-2-1: "If Pickering were to also cease operations in the late 2010s, and no Nuclear New Build were to be in-service by that period, significant workforce downsizing would be required in the OPG nuclear program. The loss of these high quality jobs would have a significant impact on Durham Region":

- a) Please provide expected retirement schedule for OPG's nuclear workforce over the next two decades.
- b) Does OPG agree that the provision of replacement power from renewables and conservation would increase employment elsewhere in the province?

**Response**

- a) The following chart sets out the number of employees who will become eligible to retire each year and the forecast of actual retirements. These numbers include all employees in the Nuclear organization, including those in Refurbishment and New Build.

1

**Nuclear Retirement Eligibility & Retirement  
 Forecasts**  
 (based on 2009 Year End)

Year	Number of Staff	
	Become Eligible*	Retirement Forecast
2010	280	200
2011	320	250
2012	320	290
2013	320	340
2014	270	380
2015	300	420
2016	330	310
2017	340	310
2018	330	320
2019	260	310
2020	270	n/a**
2021	240	n/a
2022	200	n/a
2023	180	n/a
2024	200	n/a
2025	210	n/a
2026	210	n/a
2027	220	n/a
2028	250	n/a
2029	240	n/a
2030	240	n/a

\* As of Dec 31, 2009, over 900 Employees were already eligible to retire

\*\* n/a = not available

2  
 3  
 4

b) OPG has no information related to this question.



**GEC Interrogatory #020**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

An Integrated Safety Review (ISR) is required to be approved by the Canadian Nuclear Safety Commission before the refurbishment of the Darlington can take place. An ISR will require a comparison of the Darlington station against current nuclear safety requirements and require upgrades where appropriate. Please describe how safety upgrades are determined? Specifically, please describe how cost benefit analysis will be considered and approved for the Darlington refurbishment.

**Response**

The Integrated Safety Review ("ISR") is a comparison of the Darlington plant against a list of modern codes and standards agreed to by the Canadian Nuclear Safety Commission ("CNSC") and consistent with international practices which are used to determine the extent to which the plant conforms to modern high-level safety goals and requirements. Gaps with respect to modern requirements are prioritized based on their impact on nuclear safety.

Gaps which are determined to be high priority (i.e., having direct, significant impact on nuclear safety) are assessed using an industry standard benefit-cost analysis process developed and approved by the CANDU Owner's group and accepted by the CNSC. Options for resolution could include physical changes to the plant, operational changes, or other options depending on the nature of the gap. The process weighs the nuclear safety benefits against cost considerations to assess whether the improvement in nuclear safety is sufficient to warrant expenditure of the costs involved.

Gaps determined to be low priority (i.e., having indirect or insignificant impact on nuclear safety) are dispositioned without the use of the benefit cost analysis process.

**GEC Interrogatory #021**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Regarding the statement on page 7 of Attachment 2 of D2-2-1: "Time required to obtain Canadian Nuclear Safety Commission (CNSC) approval of the ISR, currently estimated as 2 years from the Final ISR submission (Tentative Completion Date (TCD): December 2013)", how long did it take for OPG to gain approval from the CNSC for approval of the ISR for the proposed refurbishment of the Pickering B nuclear station?

**Response**

OPG did not obtain Canadian Nuclear Safety Commission's ("CNSC") approval of the integrated safety review ("ISR") for the proposed refurbishment of the Pickering B nuclear station.

OPG submitted the Pickering Nuclear Generating Station Final ISR Report to the CNSC on September 25, 2009. The OPG Board of Directors decided not to proceed with the Pickering B Refurbishment Project on November 19, 2009, a decision concurred by the Minister of Energy in a February 4, 2010 memo (Ref: Ex. D2-T2-S1, Attachment 3). This decision was formally communicated to the CNSC on March 31, 2010. Subsequently, OPG requested CNSC's closure of the ISR study.

**GEC Interrogatory #022**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Regarding the statement on page 7 of Attachment D2-2-1: "Time required obtaining CNSC approval of the EA (TCD: October 2012) – currently estimated as approximately 18 months from the submission of the EA Project Description (TCD: May 2011)". How long did it take for OPG to gain approval from the CNSC for its environmental assessment on the proposed Pickering B nuclear station following its submission of an EA project description?

**Response**

It took 31 months following the submission of the Environment Assessment ("EA") project description until the Canadian Nuclear Safety Commission ("CNSC") accepted its staff EA report for the proposed Pickering B Nuclear Station. The key dates are noted below:

EA project description issued to CNSC	June 15, 2006
OPG Submission of Pickering B EA Screening Report	December 17, 2007
CNSC issued its final Pickering B EA Screening Report	October 10, 2008
One-day public hearing to consider results of EA Screening Report	December 10, 2008
CNSC acceptance of EA Screening Report	January 26, 2009

**GEC Interrogatory #023**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please provide a breakdown of the costs associated with OPG's environmental, safety and economic studies regarding the viability of refurbishing the Pickering B nuclear station?

**Response**

The breakdown of the costs associated with OPG's environmental, safety and economic studies regarding the viability of refurbishing the Pickering B Generating Station as of December 2009 are:

- Environmental studies \$14.2M
- Safety studies \$16.1M
- Economic feasibility studies \$18.8M

The above includes costs from direct work, as well as allocated costs from the Nuclear Refurbishment project management team.

**GEC Interrogatory #024**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Did OPG achieve its original schedule for gaining the regulatory approval for the Pickering B Integrated Safety Review and environmental review – please provide details?

**Response**

OPG did not achieve its original schedule for gaining regulatory approval for the Pickering B Generating Station Integrated Safety Review ("ISR") and Environmental Review.

**Integrated Safety Review**

As noted in Ex. L-07-021, OPG submitted the Final ISR Report to the Canadian Nuclear Safety Commission ("CNSC") on September 25, 2009. The Final ISR Report was submitted close to two years later than originally planned due mainly to evolving regulatory requirements and significant levels of review required between OPG and the CNSC for each of the Safety Factor Reports that ultimately form the basis for the Final ISR Report. On November 19, 2009, the OPG Board of Directors decided not to refurbish the PNGS, a decision concurred by the Minister of Energy in a February 4, 2010 memo (Ref: Ex. D2-T2-S1, Attachment 3). This decision was formally communicated to the CNSC on March 31, 2010. Subsequently, OPG requested CNSC's closure of the ISR study.

**Environmental Assessment**

As noted in Ex. L-07-022, OPG submitted its final Pickering B Generating Station Environmental Assessment ("EA") Screening report on December 17, 2007. This submission date was in line with OPG's original plans. The CNSC accepted the EA Screening Report on January 26, 2009, approximately three months later than originally planned due mainly to the longer than expected review period and a delay in scheduling the one-day public hearing to December 10, 2008.



**GEC Interrogatory #025**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Regarding the statement: "Time needed to design, procure and commission the required retube tooling and mockup, as well as ordering and supply of all long lead retube components. Current estimates suggest this time to be between 2.5 and 4 years prior to outage start", please provide an estimate of lead time for contracting and purchasing essential components such as pressure tubes and feeder pipes before a refurbishment outage can take place?

**Response**

Please refer to Ex. L-2-017, part c).

**GEC Interrogatory #026**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Regarding this statement on page 2 of Attachment 2 to D2-2-1: "Current medium confidence estimates, based on Darlington pressure tubes fitness for service, predict that the Darlington NGS (DNGS) reactors will reach the end of their current operating lives between 2018 and 2020":

- a) What are the low, medium and high confidence end-of-life estimates for the DNGS feeder pipes?
- b) What are the low and high confidence end-of-life estimates for the DNGS pressure tubes?
- c) Please provide an inventory of Darlington's other life-limiting components with the low, medium and high confidence end-of-life estimates for each.

**Response**

- a) Darlington Generating Station feeder pipes are assessed individually, so each feeder has a specific end-of-life date as opposed to specifying a confidence level for feeders in general. OPG's current assessment is that the vast majority of the feeders will still be fit for service when each reactor is shut down for refurbishment. Fewer than 50 feeders are expected to require repair or replacement prior to refurbishment of the units, and work continues to extend the life of these feeders.
- b) The current estimate of pressure tube end of life is as follows:
  - high confidence of attaining 185,000 Effective Full Power Hours.
  - medium confidence of attaining 210,000 Effective Full Power Hours.
  - low confidence of attaining 225,000 Effective Full Power Hours.
- c) There are no other components which are currently believed to be life-limiting for the Darlington Generating Station units.

**GEC Interrogatory #027**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Regarding the statement on page 2 of Attachment 4 to D2-2-1: "Based on publicly available information, the economics of Darlington Refurbishment are more attractive than alternative generation options including New Nuclear and Combined Cycle Gas Turbines (CCGT)", please provide the "publicly available information" used to make this cost comparison.

**Response**

OPG assesses publicly available information from a large number of sources, particularly on the installed costs of new nuclear and combined cycle gas and on the price forecast for natural gas. OPG also depends on its internal expertise and experience to forecast the operating costs for new nuclear and combined cycle gas.

Based on OPG's research, Attachments 1 and 2 show a number of data points OPG used in developing its view of the installed costs of new nuclear. Attachment 2 also shows a number of data points OPG used to develop its estimate of the installed costs of combined cycle gas. The list of publicly available references used to develop the data in Attachments 1 and 2 is provided below.

- Areva, "U.S. Energy Challenge: A Crisis and an Opportunity", September 2008.
- Beck, R.W., "Comparison of Fuels Used in Electrical Generation in the U.S., for Natural Gas Supply Association", February 18, 2009.
- Constellation Energy, "Q2 2008 Earnings Presentation", July 31, 2008.
- Duke Energy Carolinas, "Cover Letter - 2008 Integrated Resource Plan", November 2008.
- EPRI, "Program on Technology Innovation: Integrated Generation Technology Options, Technical Update", November 2008.
- Florida Power & Light, "Commission Filing for Turkey Point 6 & 7", October 2007.
- J. Harding, "Overnight Costs of New Nuclear Reactors", July 2008.
- Lazard, "Levelized Cost of Energy Analysis", June 2008.
- MIT, "Update of the MIT 2003 Future of Nuclear Power Study", May 2009.
- Northwest Power and Conservation Council, "Proposed Nuclear Power Plant Assumptions", October 23, 2008.
- Nuclear Energy Institute, "The Cost of New Generating Capacity in Perspective", August 2008.

Witness Panel: Nuclear Refurbishment

- 1 • Progress Energy Florida, "Commission Filing for Levy 1 & 2", March 2008.
- 2 • South Carolina Electric & Gas, "Form 8-K", December 17, 2008.
- 3 • South Carolina Electric & Gas, "Commission Filing for Summer 2 & 3", May 2008.
- 4 • Southern Co. (Georgia Power), "Commission Filing for Vogtle Units 3 and 4", August
- 5 2008.
- 6 • TVA, "Revised Cost Estimates for Nuclear and Coal and Gas-Fired Generation",
- 7 November 2008.
- 8 • US Congressional Research Service, "Power Plants: Characteristics and Costs",
- 9 November 13, 2008.
- 10 • US Energy Information Administration, "Assumptions to 2009 Annual Energy Outlook",
- 11 March 2009.

### Estimated Costs of Nuclear New Builds

	Proposed Plant	Estimate Basis	Overnight Capital Cost			In-Service Cost (incl. IDC/AFUDC)		
			<u>Median</u>	<u>Low</u>	<u>High</u>	<u>Project Total</u>	<u>Median</u>	<u>Low</u> <u>High</u>
			Constant US\$ / kW			US\$B	Nominal US\$ / kW	
<b>AP1000</b> ( 2 x 1,117 MW)								
South Carolina Electric & Gas <sup>1</sup>	Summer Units 2 & 3	2007\$	3,666			13	5,957	
Progress Energy Florida <sup>2</sup>	Levy Units 1 & 2	2007\$	4,229			14	6,370	
Florida Power & Light	Turkey Point Units 5 & 6	2007\$	3,596	3,108	4,540	14	6,372	5,492      8,071
Duke <sup>2</sup>	William Lee Units 1 & 2	2008\$	5,000					
TVA	Bellefonte Units 3 & 4	2008\$		2,516	4,649			
Georgia Power (Southern Co.)	Vogtle Units 3 & 4					14		
<b>US EPR</b> ( 1,600 MW )								
Constellation Energy	Calvert Cliffs Unit 3	2007\$		4,500	6,000			
AREVA			6,200					
<b>Additional Generic Estimates</b>								
Harding		2008\$	5,000					
NWPCC		2006\$	5,000					
Lazard							5,750	7,550

*Notes*

<sup>1</sup> When deferred cost increases are included, the overnight cost for SCE&G's project exceeds \$4,000/kW.

<sup>2</sup> New sites



**Capital Cost Estimates for CCGT and New Nuclear  
 (US\$ / kW)**

<b>Source</b>	<b>CCGT</b>	<b>Nuclear</b>
Beck <sup>1</sup>	795	3,180
EPRI	800	3,980
Lazard <sup>1</sup>	742 - 928	3975 - 5565
MIT	850	4,000
CRS <sup>2</sup>	1,200	3,900

*Notes*

<sup>1</sup> Owner's costs at 6% of the Engineer, Procure, Construct (EPC) cost added. According to EPRI, owner's cost adds about 5 to 7% to EPC cost.

<sup>2</sup> U.S. Congressional Research Service

**GEC Interrogatory #028**  
**(NON-CONFIDENTIAL VERSION)**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The statement on page 4 of attachment 4 of D2-2-1: "As recommended by Management in April, 2009, steam generator (SG) replacement has been excluded from the reference outage scope" is notable because other CANDU refurbishment projects have included steam generator replacement.

- a) Please provide the low, media and high risk end-of-life estimates for the Darlington steam generators.
- b) Please provide an approximate cost estimate for purchasing replacement steam generators for the Darlington nuclear station.
- c) Please provide a description of the cost and work required to replace Darlington's steam generators?
- d) If steam generator replacement were to take place at a date following of the proposed 36 month refurbishment outages, what would be the outage time required to replace the steam generators?
- e) Have the costs of eventual steam generator replacement at Darlington been included in the LUEC price for the Darlington refurbishment? If not please provide the impact of a subsequent SG replacement on LUEC.
- f) Has the Canadian Nuclear Safety Commission approved the exclusion of steam generator replacement from the scope of the Darlington refurbishment?
- g) Has OPG evaluated the cost effectiveness of replacing Darlington steam generators if refurbishment outages were to take place as originally envisioned post 2018?

**Response**

Contrary to the suggestion in the preamble to this question, not all CANDU refurbishments include steam generator replacements. Steam generator replacement is not included in the project scope for the Pt. Lepreau, Wolsong and Gentilly refurbishments.

- a) See response to the interrogatory in Ex. L-7-016. OPG does not have low, medium and high risk end-of-life estimates.
- b) OPG has a range of estimates for the purchase and installation of new steam generators at the Darlington Generating Station. OPG has also compared the estimated costs of

1 steam generator replacement against the known costs of replacing steam generators in  
2 those United States plants which have either already completed or have planned  
3 replacements.  
4

5 Based on these estimates, OPG estimates the cost of steam generator replacement to be  
6 [REDACTED] M/unit at Darlington. These costs would include purchase and installation. In  
7 addition, there are costs of waste management of the replaced steam generators,  
8 estimated at approximately [REDACTED] M per unit.  
9

10 c) The estimated cost is provided in part b) above. The work involved would include draining  
11 and drying the existing steam generators, removing the existing steam generators,  
12 installing the new steam generators, re-connecting to the existing pipes, then refilling and  
13 testing the new steam generators during re-commissioning of the units.  
14

15 d) The duration could range from 10 – 20 months depending on the assumptions made  
16 about the methodology for carrying out the work.  
17

18 e) No, the eventual cost of steam generator replacement has not been included in the  
19 Levelized Unit Energy Cost (“LUEC”) range provided for Darlington Refurbishment.  
20 However, OPG believes that the range adequately covers such potential costs. The  
21 specific impact on the estimated LUEC if the steam generators needed to be replaced in  
22 a subsequent outage would be less than [REDACTED]. However, the impact on the LUEC is  
23 very dependent on the timing of when that replacement would occur.  
24

25 f) Canadian Nuclear Safety Commission (“CNSC”) approval of this decision is not required.  
26

27 g) OPG has never previously established a plan for the refurbishment of Darlington  
28 Generating Station and therefore cannot respond to this question. The meaning of the  
29 reference to “refurbishment outages ... as originally envisioned post 2018” is unclear.

**GEC Interrogatory #029**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

At what LUEC estimate would OPG consider the Darlington refurbishment uneconomical?

**Response**

OPG would consider the Darlington refurbishment “uneconomical” where the Levelized Unit Energy Cost (“LUEC”) consistently exceeds the LUEC for other baseload options with similar load meeting characteristics for a full range of input variables.

**GEC Interrogatory #030**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

What was the cost criteria (including LUEC) used by OPG to determine that the refurbishment of the Pickering B refurbishment was uneconomical?

**Response**

See the response to interrogatories Ex. L-1-070 and Ex. L-2-026.



**GEC Interrogatory #031**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Regarding the statement on page 8 of Attachment 4 to D2-2-1: "An economic feasibility assessment of the refurbishment of Darlington has indicated that this is one of the most economic generation options available to OPG to maintain a significant footprint in the Ontario Electricity Marketplace", has OPG assessed whether other non-OPG generation options could pose less of an economic risk and/or cost to the Ontario rate-payer?

**Response**

No, OPG has not assessed other non-OPG generation options.

**GEC Interrogatory #032**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Has the specific Darlington reactor design ever undergone refurbishment previously?

**Response**

No, the specific Darlington reactor design has never undergone refurbishment.

**GEC Interrogatory #034**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

In regard to this statement on post-refurbishment operations costs on page 17: "A range of \$450M to \$525M per year (2009 dollars) of post-refurbishment costs, including operations, outages and projects were considered in the feasibility assessment", did OPG consider the impact of increases in nuclear accident insurance in its annual operational cost estimates? If so, please provide a break down and rationale.

**Response**

Yes. Ex. L-1-089 discusses increases in nuclear accident insurance premiums due to a projected increase in the statutory liability cap to \$650M. These increases were included in Darlington's annual post-refurbishment operational cost estimates. The Economic Feasibility Assessment assumed an increase in these premiums from the current levels of \$0.8M per year to \$2.7M per year in 2013, which was the projected increase at the time of the analysis.

**GEC Interrogatory #035**

**Ref:** Ex.D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

The minutes of the April 1<sup>st</sup> information session regarding its rate application state “OPG was unable to confirm whether the Province had to finally approve the Darlington project for completion, although Barrett indicated that they will certainly be well informed about the project. OPG will try to determine the governance requirements around the project in reply to this question.” Will OPG contract for services or components before a final approval for the Darlington refurbishment is given by its board of directors and the Ontario government?

**Response**

On May 25, 2010, OPG provided the following response to the question from the April 1, 2010 information session and posted the response on its website at the url <http://www.opg.com/about/reg/stakeholdering/infosessions/>:

Does OPG have any governance requirements that would entail seeking approval from the shareholder before the full release for the Darlington refurbishment project could go ahead?

There is no requirement to get approval of the shareholder. OPG seeks shareholder concurrence of its business plans, and the Darlington refurbishment project is included in the 2010-2014 business plan. On February 4, 2010, the Province provided its concurrence with the decision of OPG’s Board of Directors to proceed with the Darlington refurbishment project.

OPG has released funding for the Project Definition phase of the Nuclear Refurbishment project, which consists of two sub-phases: Preliminary Planning and Engineering and Detailed Planning (Ex. D2-T2-S1, Attachment 2, pages 21 and 22).

OPG anticipates entering into some limited number of contracts during the Preliminary Planning phase to meet the deliverables for that phase, i.e., contracts to design and construct the Training and Mock-up Building. OPG may also enter into contracts with key vendors for major component work programs such as Retube and Feeder Replacement, Fuel Handling, Turbines and Generators.

- 1 It is anticipated that during the Engineering and Detailed Planning phase, certain contracts
- 2 will be partially or fully released in recognition of the long lead time required for certain
- 3 aspects of the work.



**GEC Interrogatory #037**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Has OPG estimated the operational and maintenance costs of operating the Darlington reactors until their nominal end-of-life date between 2018 and 2020 instead of refurbishing the station in the 2015 to 2016 period.

**Response**

Yes. As part of the Economic Feasibility Assessment (Ex. D2-T2-S1, Attachment 4), the option of not refurbishing Darlington includes an assessment of the operational and maintenance costs required to achieve the nominal end-of-life dates indicated above.

**GEC Interrogatory #040**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please provide the fuel cost assumption used in calculating the LUEC price for the Darlington refurbishment project.

**Response**

The median fuel cost included in OPG's calculation of the Levelized Unit Energy Cost ("LUEC") for Darlington Refurbishment is \$4/MWh (2009 dollars). A range of plus 30 per cent and minus 30 per cent was used in developing the sensitivity analysis for the LUEC as shown in Ex. D2-T2-S1, Attachment 4, page 34, Figure 3. Note that the fuel cost shown in Figure 3 also includes used fuel management cost (see Ex. L-7-038).

**GEC Interrogatory #041**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

At the March 29th information session held by OPG it states that "The LUEC at \$0.08/kWh has no risk transfer to AECL." Other refurbishment projects, such as Bruce A and Point Lepreau have all used AECL as the principal contractor and project manager due to its expertise in CANDU design and refurbishment. The economics of these projects (from the operator perspective) have been enhanced by fixed-price contracts, which transfer risk for cost over-runs, delays and future performance to AECL, which is currently backstopped by the federal tax-payer. This has lowered the upfront costs to nuclear operators pursuing CANDU refurbishment.

- a) Does OPG plan on assuming the project risks for cost over-runs or delays or to transfer these risks to another entity via contractual performance guarantees?
- b) Does OPG plan on assuming the risks of future reactor performance or transfer these risks to another entity via contractual performance guarantees?

**Response**

- a) OPG as owner of the project recognizes that it ultimately owns all of the project risks. OPG plans to transfer to the contractors those risks that are within their control to mitigate via performance guarantees. OPG plans to retain those risks that it is best able to mitigate in order to minimize the inclusion of risk premiums in contractors prices.
- b) OPG's plan is to assume the risk of future reactor performance. This is a refurbishment project on units that have already been in operation for over 25 years prior to the refurbishment. The reactor design is not being modified in any significant manner. OPG does not believe that it would be practical to seek performance warranties from installation contractors, given that there are only a limited number of components being replaced and that the future performance of the units depends on the interactions of many systems, as well as human performance. However, OPG's contracting strategy will seek to obtain warranties from the contractors on the physical work performed to the extent possible. OPG is unaware of any precedent for contractors providing future performance warranties for a reactor refurbishment project.

**GEC Interrogatory #042**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Figure 5 of Attachment 4 to Exhibit D2-2-1 includes CO<sub>2</sub> costs in the estimated LUEC costs for Combined Cycle Gas Turbines (CCGT) in comparison with the Darlington LUEC estimates. Please provide the rationale for include CO<sub>2</sub> costs and what assumptions were used in estimating these costs.

**Response**

CO<sub>2</sub> costs were included in the estimated costs for electricity output from Combined Cycle Gas Turbines ("CCGT"), for comparison with the costs of electricity output from Darlington Generating Station, based on OPG's expectation that there will either be a binding cap and trade regime or that a carbon tax will be implemented in the future, i.e., in the post-refurbishment timeframe.

The following CO<sub>2</sub> costs assumptions were used in developing the Levelized Unit Energy Cost ("LUEC") estimates for CCGT. These values were applied from 2020 onwards.

	Low	Medium	High
CO <sub>2</sub> Cost (2009 C\$/Mg of CO <sub>2</sub> )	15	30	50
CO <sub>2</sub> Emissions (Teragrams/TWh)	0.42		

**GEC Interrogatory #043**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

At hearings of the federal government's Natural Resources Committee in 2009 on the proposed Nuclear Liability and Compensation Act, the president of GE Hitachi's Canadian division Peter Mason, stated that his company's nuclear division is severed from the international parent in order because of concern that it could be sued in case of an accident at a Canadian facility. For this reason, the company will not sell any equipment built or designed by the U.S. parent to be used in Canadian reactors under the current Nuclear Liability Act. Does OPG cost estimates for the proposed Darlington refurbishment project assume that it will have open access to services and components from US companies? Or, does it assume that contracting for components and servicing for the Darlington refurbishment will be restricted to Canadian based companies because of the limited liability protection provided to them under Canadian law?

**Response**

There is no plan to restrict work on the Darlington Refurbishment project to Canadian-based companies.

Qualified companies will be invited to participate in competitive bid processes for work during execution of the Darlington NGS Refurbishment Program. Whether or not a company elects to participate in the Darlington Refurbishment Program will be a business decision determined solely at the discretion of each company.



**GEC Interrogatory #044**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

In 1998, Ontario Hydro stated the cost of re-tubing a reactor as follows: "The most recent estimate of reactor re-tubing costs are \$265M per unit (1997 Constant \$ Excluding Capitalized Interest). In addition, there is a one-time set-up cost ranging from \$50-\$100 MW per station."<sup>1</sup> Since that time, cost estimates for re-tubing projects have increased significantly with OPG estimating the refurbishment of Darlington to range from \$6 – 10 billion for four units. Please provide an outline of the OPG's cost estimates for re-tubing and refurbishment projects since 1997. Please discuss the reasons behind the increase in cost estimates.

**Response**

The cited estimates are outdated and for a different kind of project (replacement of pressure tubes versus refurbishment). They are in no way related to OPG's Darlington Refurbishment project and are not relevant to OPG's Application. As no useful purpose would be served in trying to explain the many factors that have changed over the intervening 12 years and the many differences between re-tubing and refurbishment, OPG declines to do so.

---

<sup>1</sup> Vince Gonsalves (Manager, Financial Business Planning and Decision Support, Ontario Hydro), to Ms. Sumita Dixit (Researcher, Campaign for Nuclear Phaseout), Letter, September 9, 1998.

**GEC Interrogatory #045**

**Ref:** Ex. D2-T2-S1

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Has OPG carried out condition assessments on Darlington's calandria vaults? When and how will calandria vaults be inspected before, during or after the refurbishment?

**Response**

Darlington Generating Station calandria vaults have been inspected and assessed as part of the station's Life Cycle Management program. However, a detailed internal calandria inspection has not been done and this is scheduled to be completed during the refurbishment outage. This inspection requires very specialized tooling and it can only be undertaken when all the calandria internal tubes have been removed.

**Pollution Probe Interrogatory #002**

**Ref:** Ex. D2-T2-S1, pages 4-5  
Minutes of Stakeholder Information Session 1, page 18

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

OPG estimates that the Darlington refurbishment project will have a LUEC of between 6 and 8 cents per kWh (2009\$) excluding capitalized interest.

With respect to these LUEC estimates, please state OPG's assumptions with respect to the refurbishment project's:

- a) pre-tax weighted average cost of capital;
- b) after-tax weighted average cost of capital;
- c) average annual capacity factor;
- d) present value of the short-term, medium-term and long-term costs associated with the management of used nuclear fuel.

**Response**

OPG estimates that the Darlington Refurbishment project will have a Levelized Unit Energy Cost ("LUEC") of between \$0.06/kWh and \$0.08/kWh (2009\$), however, the evaluation of LUEC includes capitalized interest.

The following are the assumptions used in calculating the LUEC for the Darlington Refurbishment project:

- a) OPG does not use a Pre-tax Weighted Average Cost of Capital.
- b) After-tax Weighted Average Cost of Capital = 7 per cent.
- c) Average Annual Capacity Factor: a range of 82 per cent to 92 per cent was used.
- d) OPG does not separate out its estimate of the costs of used fuel management into short-term, medium-term and long-term components. The cost of used fuel management used in the development of the LUEC estimates was \$0.4/MWh (2009\$), which is equivalent to the 0.04¢/kWh shown in Ex. L-7-038. A range of +/-30 per cent was used for sensitivity analysis.

**Pollution Probe Interrogatory #003**

**Ref:** Ex. D2-T2-S1, pages. 4 and 5  
Minutes of Stakeholder Information Session 1, page 18

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

OPG estimates that the Darlington refurbishment project will have a LUEC of between 6 and 8 cents per kWh (2009 dollars) excluding capitalized interest.

Please provide a break-out of OPG's LUEC estimates according to at least the following categories:

- a) capital costs;
- b) fixed operating, maintenance & administration;
- c) fuel cost;
- d) variable operating, maintenance & administration;
- e) short-term, medium-term and long-term costs associated with the management of used fuel.

**Response**

The question is incorrect in stating that OPG's estimates of the Levelized Unit Energy Cost ("LUEC") range exclude capitalized interest. The evaluation of LUEC includes capitalized interest.

The range of \$0.06/kWh – \$0.08/kWh for the LUEC of Darlington Generating Station (Ex. D2-T2-S1, page 8, Figure 1) is based on a Monte Carlo analysis where a significant degree of variability is introduced into the different inputs to the LUEC calculation (e.g., refurbishment costs, post-refurbishment costs and performance and post-refurbishment station life). The LUEC range of \$0.06/kWh – \$0.08/kWh has a medium to very high confidence range.

Because OPG's range estimate is based on a Monte Carlo analysis, it is not possible for OPG to provide the breakdown of the capital costs, operating costs and fuel costs which make up the upper and lower bound of the range or of any points in-between. However, OPG can provide the following, based on its preliminary high confidence estimates:

**Expected “Typical” Refurbishment Costs, Operations Maintenance & Administration  
and Fuel Cost Ratios in the LUEC for Darlington Refurbishment**

<b>Component of LUEC</b>	<b>% of LUEC</b>
Refurbishment Costs	35
OM&A Costs	55
Fuel (including used fuel management)	10
Total	100

OPG does not separate out its estimate of the costs of used fuel management into short-term, medium-term and long-term components.



**Pollution Probe Interrogatory #006**

**Ref:** Ex. D2-T2-S1, pages 4 and 5 and Attachment 4, page 9  
Minutes of Stakeholder Information Session 1, page 18  
Ex. E2-T1-S2, Table 1b

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

OPG estimates that the Darlington refurbishment project will have a LUEC of between 6 and 8 cents per kWh (2009\$) excluding capitalized interest.

Please re-calculate your low and high LUEC estimates with the following revised assumptions:

- a) All costs associated with construction work in progress are included in the LUEC. In other words, the Board does not allow OPG to include its capital costs in rate base before the project is completed and in-service;
- b) The project is financed 30% by debt and 70% by equity; and
- c) The project's required after-tax rate of return on equity is 18%.

Please also provide your re-calculated LUEC estimates under the following scenarios with respect to the project's average annual capacity utilizations rates:

- a) 64.2%;
- b) 70%;
- c) 82%; and
- d) 87%.

Please also break out your re-calculated LUEC estimates according to at least the following categories:

- a) capital costs;
- b) fixed operating, maintenance & administration costs;
- c) fuel cost;
- d) variable operating, maintenance & administration costs; and
- e) short-term, medium-term and long-term costs associated with the management of used fuel.

Please also state your low and high total capital cost estimate for the project with respect to the above-noted assumptions.

**Response**

The question is incorrect in stating that OPG's estimates of the Levelized Unit Energy Cost ("LUEC") range exclude capitalized interest. The evaluation of LUEC includes capitalized interest.

a) See Ex. L-10-004 part a).

b) See Ex. L-10-004 part b).

OPG has re-run the Monte Carlo analysis, with the changes to assumptions on weighted average cost of capital (i.e., 70 per cent Equity at ROE of 18 per cent; 30 per cent Debt at 6 per cent cost of debt = 14 per cent WACC after-tax) and at the capacity factors requested. The impact of these changed assumptions on the LUEC range in cents per kWh is summarized in the table below.

<b>Darlington Refurbishment "High Confidence" LUEC Range Estimates at 14% WACC</b> <i>(Assuming 70% Equity, 30% Debt and 18% ROE)</i>				
<b>Capacity Factor</b>	<b>64.2%</b>	<b>70%</b>	<b>82%</b>	<b>87%</b>
LUEC High Confidence Range (¢/kWh)	12 to 18	11 to 16	10 to 14	9 to 13

Because OPG's range estimate is based on a Monte Carlo analysis, it is not possible for OPG to provide the breakdown of the capital costs, operating costs and fuel costs which make up the upper and lower bound of the range or of any points in-between. Please refer to the response in Ex. L-10-003 for the typical percentage breakdown of the LUEC into refurbishment costs, operations, maintenance & administration ("OM&A") costs and fuel costs.

**Pollution Probe Interrogatory #009**

**Ref:** Ex. D2-T2-S1 page 4  
Ex. D2-T2-S1, Attachment 3

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

OPG is seeking Board approval to recover, from all of Ontario electricity ratepayers, its costs associated with assessing the feasibility of and planning one of OPG's potential future electricity generation projects.

Does OPG believe it would also be appropriate for investor-owned generation companies (such as Brookfield Power) to be also allowed to recover, from all Ontario electricity ratepayers, their costs associated with assessing and planning its potential future electricity generation projects in Ontario? If so, please fully describe under what circumstances. If not, please explain why not.

**Response**

OPG believes that all Ontario investor-owned and publicly-owned entities under OEB rate-regulation, like OPG, should recover from ratepayers their prudently incurred costs associated with feasibility assessment and planning of regulated projects.

OPG has no view on the appropriate methodology for cost recovery by investor-owned generation companies (such as Brookfield Power) that are not rate-regulated.

**Pollution Probe Interrogatory #011**  
**(NON-CONFIDENTIAL VERSION)**

**Ref:** Ex. D2-T2-S1, Attachment 4

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

According to OPG's prefiled evidence: "Based on publicly available information, the economics of Darlington Refurbishment are more attractive than alternative generation options including New Nuclear and Combined Cycle Gas Turbines (CCGT)."

Please provide OPG's best estimates of the LUECs for both new nuclear and combined-cycle gas turbines.

Please also provide a break-out of your LUEC estimates according to at least the following categories:

- a) capital costs;
- b) fixed operating, maintenance & administration;
- c) fuel cost;
- d) variable operating, maintenance & administration; and
- e) short-term, medium-term and long-term costs associated with the management of used fuel.

Please also state the key input assumptions for your LUEC calculations, including: capital costs per MW; capital structure; costs of equity and debt; heat rates, commodity cost of gas; annual capacity utilization rates.

**Response**

OPG does not have a definitive range estimate for the Levelized Unit Energy Cost ("LUEC") for new nuclear. OPG's statement referenced above is based on its high-level assessment of the range estimates of the capital costs of new nuclear (see response to the interrogatory in Ex. L-7-027).

Based on these publicly available sources, OPG used a range for the overnight costs of new nuclear of approximately \$3,800/kW (low) to \$6,100/kW (high). When this range of capital costs is combined with a reasonable range of estimated operating and fuel costs, based on OPG's experience for the ranges for these costs, this indicates that the LUEC for new nuclear would be higher than the LUEC for Darlington Refurbishment.

With respect to Combined Cycle Gas, please also refer to Ex. L-7-027 where OPG provided a range of estimates for the overnight cost in \$/kW of Combined Cycle Gas Plant.

OPG's confidential filing (Ex. D2-T2-S1, Attachment 4, page 34), shows a range of LUECs for Combined Cycle Gas. The total LUECs shown on that chart and the breakdown of the LUECs for Combined Cycle Gas are as follows:

	Combined Cycle Gas Plant LUECs (¢/kWh)		
	Low Estimate	Median Estimate	High Estimate
Capital Cost			
OM&A			
Fuel			
CO <sub>2</sub>			
Total <sup>1</sup>			

The range of estimates OPG used as inputs to this analysis are as follows:

- Capital Costs: Approximately \$800/kW to approximately \$1550/kW.
- OM&A Costs: Approximately \$15/kW/yr to approximately \$30/kW/yr.
- Fuel Costs: The range of natural gas prices assumed were approximately U.S. \$4/MMBtu (low) to U.S. \$9/MMBtu (high).
- Capacity Factor: A range of 75 per cent (low) to 85 per cent (high) was assumed.
- Heat Rates: 7000 Btu/kWh for low, medium and high.
- Capital Structure: 55 per cent Debt, Cost of Debt 6.2 per cent; 45 per cent Equity, ROE (after-tax) 10 per cent.

Please also refer to the answer to interrogatory Ex. L-1-069, part a) which provides details of the median gas price forecast between 2010 and 2020, and the response to interrogatory Ex. L-7-027 which provides additional information on the publicly available estimates that OPG used to develop its range of capital costs for combined cycle gas.

<sup>1</sup> Numbers may not add due to rounding.



## Pollution Probe Interrogatory #014

**Ref:** Ex. D2-T2-S1, Table 3

### **Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

### Interrogatory

Please extend the time horizon of this Table to show the forecasted capital expenditures for Nuclear Generation Development Projects in 2013 and 2014.

### Response

The time horizon of Ex. D2-T2-S1, Table 3 is extended to 2013 and 2014 as shown below:

Table 3									
Capital Expenditures Summary - Nuclear Generation Development Projects (\$M)									
Line No.	Description	2007 Actual	2008 Actual	2009 Actual	2010 Budget	2011 Plan	2012 Plan	2013 Plan	2014 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
	<b>Darlington Refurbishment</b>								
1	Darlington Refurbishment Project - Definition Phase	0.0	0.0	0.0	44.4	42.2	149.2	266.2	395.5
2	Darlington Campus Master Plan	0.0	0.0	1.0	28.6	63.0	106.6	76.7	48.5
3	<b>Total Darlington Refurbishment</b>	0.0	0.0	1.0	72.9	105.2	255.8	342.9	444.0
4	<b>Darlington New Nuclear Project</b>	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	<b>Total Generation Development Capital</b>	0.0	0.0	1.0	72.9	105.2	255.8	342.9	444.0

The Darlington Refurbishment shown here are lower than those shown in the Nuclear Refurbishment Business Plan (Ex. D2-T2-S1, Attachment 1, page 6) because the Business Plan numbers include capitalized interest.

As noted in Ex. D2-T2-S1, page 16, OPG has not included any capital costs for new nuclear in its test period revenue requirement because the Province has not yet determined the cost recovery mechanism for that project. For the same reason, the 2013 and 2014 capital expenditures are shown as zero in the table above.

**PWU Interrogatory #007**

**Ref:** Ex. D2-T2-S1, page 4 of 17 states:

The Darlington Refurbishment project is a major undertaking that will require several years of planning and preparation prior to the first outage in 2016. To mitigate risk, the project is being managed in phases, requiring that certain milestones be achieved before proceeding to a subsequent phase and before OPG Board authorization of the expenditure of funds associated with activities in that phase.

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) Please provide further details on the phases that this project is divided into, the work to be performed during each phase, the deliverables, and the acceptance criteria that must be met at the end of each phase before proceeding to the next phase. In particular, please indicate how this project management approach reduces the risk of cost overruns and failures of the rehabilitated plant to perform to expectations.
- b) Is this approach one that allows OPG to capitalize on experience gained from other major projects? If so, how was experience gained incorporated into this approach?

**Response**

- a) The Darlington Refurbishment project is divided into phases as outlined in the Darlington Refurbishment – Preliminary Release Business Case (Ex. D2-T2-S1, Attachment 4), on pages 16-18. The Project Execution Plan (Ex. D2-T2-S1, Attachment 2) provides additional details of the project objectives, work scope and schedule, performance measurement and evaluation, and risk management and contingency plan. The Project Execution Plan provides a list of deliverables required in each phase. This project management approach reduces project risk by mandating a gated process of ‘check-points’ at each major project phase in order to ensure the project is on track in its development regarding scope, cost, quality and schedule.
- b) As noted in Ex. D2-T2-S1 (page 6, lines 20-23), OPG’s approach to refurbishing Darlington Generating Station is based on industry best practices, experience gained internally, and comparisons with other nuclear entities undergoing major refurbishment projects. Each of these elements allows OPG to capitalize on experience gained from other major projects.

1       The experience gained from this approach was incorporated into the project's risk  
2       management as described in Ex. D2-T2-S1, Attachment 2, pages 27-28. The project  
3       release strategy described in a), above also reflects the industry experience on other  
4       major projects.

**PWU Interrogatory #017**

**Ref:** (a) Ex. F1-T1-S1, page 3, line 12 to page 14, line 5 states:

**Portfolio Approach to Investment Management**

Hydroelectric uses a structured portfolio approach to identify and prioritize projects for its investment program. Annual engineering reviews and plant condition assessments (conducted on a cycle of approximately seven to ten years) are performed to determine short-term and long-term expenditure requirements to sustain or improve each facility, and ensure continued safe operation. These may be followed by the preparation of a facility life cycle plan, which is performed on an as-needed basis for marginal assets or assets requiring significant expenditures relative to the value of the facility. This planning approach is designed to identify necessary capital, operating and maintenance expenditures for each facility, and direct limited corporate funds at the facilities that can best maintain or enhance the value of the hydroelectric business and OPG. The cornerstone of this approach is that safety, environmental, and other regulatory programs are of the highest priority compared to production and reliability initiatives.

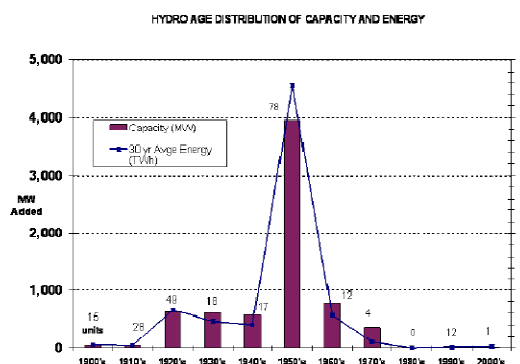
**Streamlined Reliability Centred Maintenance Process**

Hydroelectric uses a process known as streamlined reliability centred maintenance process to optimize the preventive maintenance program at its facilities. The streamlined reliability centred maintenance process provides a consistent method of identifying, scheduling and executing maintenance activities. The concept of streamlined reliability centred maintenance dictates that the type and frequency of preventive maintenance applied to an individual component is determined based on the nature and consequences of failure (i.e., balance of cost versus risk). By focusing maintenance and associated support resources appropriately, Hydroelectric has been able to accomplish more of its base work program (including additional regulatory requirements), while minimizing the need for additional resources.

1 (b) Ex. F1-T1-S1, Attachment 1, page 3

HYDRO ASSET PROFILE  
EB-2010-0008  
EXHIBIT F1-1-1  
Attachment 1  
Page 4 of 36

## The Assets: Age Profile & Re-Investment Frequencies



STATION COMPONENTS	OVERHAUL/REPLACEMENT FREQUENCY (YEARS)										Range (M's)
	10	20	30	40	50	60	70	80	90	100	
GENERATORS											
rebuild											0.5 to 4
TURBINES											
major overhaul (mechanical parts)											1 to 3
replace runners											1 to 5
PROTECTION & CONTROL											
replace											1 to 5
SERVICE WATER & AUXILIARIES											
replace											0.4 to 10
HEADGATES/SOURCE GATES											
rebuild/replace											0.2 to 4
PENSTOCKS											
rebuild/replace											7 to 15
replace steel											7 to 15
CRANES											
rebuild/replace											0.5 to 5
CIVIL STRUCTURES (BUILDINGS)											
rebuild/replace											0.2 to 100
CIVIL STRUCTURES (DAMS)											
rebuild/replace											1 to 100
AQUADUCTS & TUNNELS											
rebuild/replace											30 to 1,000

- Average age of stations is 70 years.
- 70% of Hydro capacity built during the 1950's and 1960's.
- Equipment service lives range between 30 to 50 yrs.
- Structures such as dams, penstocks, powerhouses, canals, etc. typically require repairs every 25 to 50 years. Replacement of some civil components is required every 40 to 75 years (eg, wood stave penstocks, stop-logs, etc).
- There is risk of deteriorating performance and safety without significant continued re-investment (due to demographics of portfolio, and large number and variability of stations/units/equipment).
- Re-investment levels of about 1% to 3% per yr of "replacement cost" are considered reasonable by industry experts. Hydro has invested approximately 0.5% to 1.5% per yr of "replacement cost" in the past 10 years (excludes new facilities). Determination of appropriate investment levels should consider station/fleet age and condition, type of equipment, station role (peaking vs base), past investment strategy (eg, harvesting), reliability targets, etc.
- The Business Plan addresses the need to sustain and improve the existing assets for long term per the Hydro mandate. Plant Condition Assessment/Life Cycle Plans and Portfolio Approach to Asset Management used to determine and prioritize investments (Appendix A).

ONTARIO POWER  
GENERATION

OPG Confidential

3

### Issue Number: 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

### Interrogatory

- Ref (a) provides information related to hydroelectric assets life cycle assessment and maintenance process, and Ref (b) provides information on hydroelectric asset age profile and re-investment frequencies. Please provide similar information for nuclear generation.
- Please provide detailed descriptions of OPG's nuclear engineering review and plant condition assessment processes.

Witness Panel: Nuclear Projects

Response

a) OPG Nuclear has established life cycle plans for its “major components”, including, steam generators, fuel channels, reactor components, and feeder piping. The end-of-life of any one of these “major components” defines the end-of-life of the nuclear unit. The life cycle plans for the major components identify degradation mechanisms and associated rates, inspection and maintenance requirements to mitigate degradation, and, where appropriate, expected life of the components. The life cycle plans for the major components are extensive, reflecting the technically complex nature of these components, as well as their importance towards achieving unit end-of-life. The information in these life cycle plans is used to support business planning, including investment in these assets and required outages to support the inspection and maintenance strategies outlined in these plans.

b) OPG Nuclear has established an Integrated Aging Management Program. The objective of this program is to ensure that the condition of critical nuclear power plant equipment is understood and that required activities are in place to maintain the health of these components and systems while the plant ages. This is accomplished by establishing an integrated set of programs and activities that ensure performance requirements of all critical station equipment are met on an ongoing basis (critical station equipment refers to equipment that is important to safe and reliable operation). The program also requires preparation of condition assessments for critical plant equipment.

The condition assessment process has the same objectives and fundamental steps as the life cycle plans for major components, discussed earlier:

- i. Identifying and understanding component degradation mechanisms.
- ii. Collecting data or conducting analyses, research or other activities to evaluate the degree of degradation experienced.
- iii. Evaluating component condition by comparing experienced degradation against established limits.
- iv. Establishing actions required to maintain acceptable component condition. Actions can be in the form of material condition improvements or modification of program activities, such as, adjusting a chemistry program parameter.

The actions identified through this process are documented in system and component health reports. These actions are integrated into the station equipment reliability plan, which is an input into business planning. Condition assessment of equipment is performed on an ongoing basis by defined system surveillance activities. System health reports summarize the results of component condition assessments and identify action plans required to resolve aging related issues. An aggregate assessment of system deficiencies (including component aging issues) is completed in the determination of the overall system health rating.



**SEC Interrogatory #009**

**Ref:** Ex. D2-T2-S1

**Issue Number:** 4.5

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) What incentive mechanisms have been implemented to help ensure the Darlington Refurbishment is completed on time and within the established budget?
- b) At Exhibit D2-2-1 Attachment 1; slide 6 it indicates that the full time equivalent (FTE) related to the Darlington Refurbishment is 98 FTEs in 2009 rising to 148 in 2012. Are these FTE incremental to OPG's current staff or re-assignments from other parts of OPG?
- c) What is the total cost related to the incremental FTEs for the Darlington Refurbishment project?

**Response**

- a) The Darlington Refurbishment contract strategy is being developed during preliminary planning of the definition phase. In developing this strategy, OPG will assess various contractual incentive mechanisms to help ensure the completion of the refurbishment on time and within the established budget.
- b) As indicated at Ex. D2-T2-S1, Attachment 1, slide 6, the full time equivalent ("FTE") related to the Darlington Refurbishment is 98 FTEs in 2009 and is projected to increase to 148 in 2012. OPG will first seek to re-assign OPG's current staff, however, where this is not possible, OPG will hire externally.
- c) OPG does not know in advance whether staff will be re-assigned from other parts of OPG, or hired externally and, thus, cannot provide the total costs related to the incremental FTEs for the Darlington Refurbishment project.

**SEC Interrogatory #010**

**Ref:** Ex. D2-T2-S1, Attachment 1, Nuclear Refurbishment Business Plan, page 6  
Ex. D2-T2-S1, pages 12 and 16, Chart 2 and Table 3, Darlington Costs

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please reconcile the Darlington Refurbishment cost tables referenced above.

**Response**

Exhibit D2-T2-S1, Attachment 1, Nuclear Refurbishment Business Plan, page 6 includes capitalized interest in years 2011 (\$6.1M), and 2012 (\$15.8M).

Ex. D2-T2-S1, page 12, Chart 2 and Ex. D2-T2-S1, Table 3 exclude capitalized interest consistent with the inclusion of Construction Work In Progress ("CWIP") in rate base.

**SEC Interrogatory #011**

**Ref:** Ex. D2-T2- S1, page 5, Darlington Refurbishment

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please provide the calculation for the Levelized Unit Energy Cost ("LUEC") of between 6 and 8 cents. In showing this calculation, please provide details as to the assumptions made which cause the variance in this estimate.

**Response**

The range estimate for the Darlington Refurbishment project Levelized Unit Energy Cost ("LUEC") is based on OPG's evidence (Ex. D2-T2-S1, page 8, Figure 1). The LUEC range of \$0.06/kWh to \$0.08/kWh presents a very high confidence level. These results are based on a Monte Carlo analysis where a significant degree of variability is introduced into the different inputs to the LUEC calculation (e.g., refurbishment costs, post-refurbishment costs and performance and post-refurbishment station life). As a result, there is no single calculation that produces a LUEC of between 6 and 8 cents.

The assumptions which went into the calculation of the LUEC are provided in OPG's evidence Ex. D2-T2-S1, Attachment 4 ("Economic Feasibility Assessment of Darlington Refurbishment"). These include capital costs, operating, maintenance and administration costs and fuel costs. The schedule and duration of the outages used to derive the LUEC is shown on page 29 of Ex. D2-T2-S1, Attachment 4, and the capability factor ranges are shown on page 32. The range of assumptions used, which cause variability in the estimate are summarized in Figure 3, on page 34 of Ex. D2-T2-S1, Attachment 4.

OPG's LUEC methodology is summarized below.

**Brief Explanation of LUEC Calculation Methodology:**

- LUEC is an economic measure, often used as a screening tool to facilitate consistent cost comparison across generation options with different lives and cost characteristics.
- LUEC is generally expressed in today's dollars, and is a constant number that changes over time at the rate of inflation.
- LUEC is the electricity price (in ¢/kWh or \$/MWh) that is required for an option to achieve the target rate of return (Weighted Average Cost of Capital) given the assumed option service life, operating pattern and incremental cost profile.

- 1 • For the purposes of economic comparisons, “Going Forward” (excluding sunk costs)
- 2 LUECs are typically used.

**SEC Interrogatory #012**

**Ref:** Ex. D2-T2-S2, Attachment 4, page 32, Darlington Refurbishment

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please provide the cost and reliability assumptions which underpin the high, medium and low confidence levels for the Darlington post project LEUC.

**Response**

The cost and reliability assumptions that underpin the Darlington Levelized Unit Energy Cost ("LUEC") are provided in OPG's evidence at Ex. D2-T2-S1, Attachment 4. The cost assumptions include capital costs, operations, maintenance and administration costs and fuel costs. The reliability assumptions include the schedule and duration of the outages and the capability factor range.

**SEC Interrogatory #013**

**Ref:** Ex. D2-T2-S2, Darlington Refurbishment.

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

What is the current LUEC for the Darlington GS?

**Response**

Levelized Unit Energy Costs ("LUEC") are used in OPG as an economic screening tool for comparing generation options with similar characteristics. OPG uses LUEC to assess the going forward economics of alternative generation options and does not calculate the LUEC for the existing facilities, such as the Darlington Generating Station.



**SEC Interrogatory #014**

**Ref:** Ex. D2-T2-S2, Darlington Refurbishment

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please construct a table which shows the capital, capitalized OM&A, and OM&A for the entire Darlington Refurbishment project up until the date the last unit is forecast to go into service.

**Response**

Please see the response to the interrogatory in Ex. L-12-003.

**SEC Interrogatory #015**

**Ref:** Ex. D2-T2-S1, page 5

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

Please provide the calculation of the Levelized Unit Energy Cost (LUEC) of between 6 and 8 cents. In this calculation show the assumptions made which make up the variance in this estimate.

**Response**

See response to Ex. L-12-011.

**SEC Interrogatory #016**

**Ref:** Darlington Refurbishment

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

- a) Has an economic feasibility study been undertaken which provides the net present value of the project? If so please provide a summary of the study which shows the major assumptions (e.g. annual capital cost, energy production, price of power, Unit Capability Factor and the FLR and the discount rate utilized).
- b) If no such study has been undertaken please provide OPG's expected return on the investment at the low, medium and high confidence levels for LUEC using the regulated prices proposed in this application.

**Response**

- a) OPG has carried out an Economic Feasibility Assessment for the Darlington Refurbishment project and it has been filed as Ex. D2-T2-S1, Attachment 4. The study is focused on the Levelized Unit Energy Cost ("LUEC") of Darlington Refurbishment, not on present value. As discussed in response to the interrogatory in Ex. L-12-013, LUECs are typically used in OPG as an economic screening tool for comparing generation options with similar characteristics. The major assumptions used in the study are documented in Ex. D2-T2-S1, Attachment 4, pages 26-32.
- b) Please refer to the answer to part a).

**SEC Interrogatory #049**  
**(NON-CONFIDENTIAL VERSION)**

**Ref:** Ex. D2-T2-S1; page 8  
Ex. D2-2-1 Attachment 4  
Ex. D2-T2-S1, page 33  
Darlington Refurbishment – page 5

**Issue Number: 4.5**

**Issue:** Are the capital budgets and/or financial commitments for 2011 and 2012 for the nuclear business appropriate and supported by business cases?

**Interrogatory**

At D2-T2-S1 attachment 4; pg 9 it states the cost of the Darlington Refurbishment are XXXXXXXX overnight or XXXXXXXX including interest and escalation. At D2-Tab2-Schedule 1; pg 8 the evidence states that the “refurbishment project is in the range of \$6B to 10B (2009 dollars) Please explain the meaning of the terms “overnight” and “escalation” and the apparent discrepancy between the two cost ranges.

**Response**

The term “overnight” means current dollars (in this case 2009 dollars) excluding interest and escalation. Overnight costs are used in cost estimating to refer to estimates which are expressed in today’s dollars, regardless of when the expenditure takes place (i.e., not adjusted for escalation/inflation). Escalated costs are “overnight” costs adjusted for inflation, i.e., factors in the time at which the expenditure is expected to take place.

The first confidential reference in the question is an overnight cost and represents the high confidence estimate in 2009 dollars excluding interest and escalation. The second confidential reference in the question is the high confidence estimate including interest and escalation.

The \$6B to \$10B, in 2009 dollars overnight, is the low to very high confidence feasibility estimate range.