Board Staff Interrogatory #24

Issue Number: 4.1
Issue: Do the costs associated with the nuclear projects that are subject to section 6(2)4 of O. Reg. 53/05 and proposed for recovery meet the requirements of that section?

Interrogatory

Reference:
Ref: Exh A1-6-1 Attachment 1

O. Reg. 53/05 requires that the OEB ensure that OPG recovers costs to increase the output of, refurbish or add operating capacity to a generation facility if the costs were prudently incurred. In EB-2007-0905, OPG Payment Amounts April 1, 2008 to December 31, 2009, the OEB established the Capacity Refurbishment Variance Account (CRVA) to be used for this purpose.

Please identify which projects under OPG's Nuclear Operations capital forecast for 2016 to 2021 qualify for treatment under O. Reg. 53/05 and therefore for which the CRVA would be used.

Response

There are currently no projects under OPG's Nuclear Operations **capital** forecast for 2016 to 2021 which OPG believes qualify for treatment under O. Reg. 53/05 and therefore to which the Capacity Refurbishment Variance Account (CRVA) would apply.

OPG believes that Pickering Extended Operations enabling **non-capital** costs, including the Fuel Channel Life Assurance (FCLA) Project, qualify for CRVA treatment. Pickering Extended Operations are discussed in Ex. F2-2-3 and the FCLA business case is summarized at Ex. F2-3-3 Table 2b line 34. OPG also believes that the non-capital Fuel Channel Life Extension (FCLE) Project, including ongoing costs (see Full Release BCS attached to Ex. L-6.1-1 Staff-93), as well as the Fuel Channel Life Management (FCLM) Project continue to qualify for CRVA treatment.

The following table sets out the 2016-2021 forecasts for the above non-capital costs reflected in the evidence as well as the life-to-date actual amounts of these costs to the end of 2015:

OM&A Costs Subject to CRVA Treatment

in millions	2015	2016	2017	2018	2019	2020	2021	Total
Project OM&A								
FCLM Project	$ 2.3	$ 0.4						
FCLE Project***	$ 14.9	$ 15.4	$ 13.6	$ 14.4	$ 9.3	$ 1.7	$ -	$ 69.3
Ongoing	$ 1.0	$ 0.3	$ 8.0	$ 31.6	$ 57.6	$ 14.4	$ 7.5	$ 120.3
Less SFCR *					$ (24.0)			$ (24.0)
	$ 18.2	$ 16.1	$ 21.6	$ 46.0	$ 42.9	$ 16.1	$ 7.5	$ 168.3
PECO OM&A								
Enabling Costs **	$ -	$ 15.0	$ 25.6	$ 55.3	$ 107.1	$ 104.2	$ -	$ 307.1
	$ 18.2	$ 31.1	$ 47.2	$ 101.2	$ 150.0	$ 120.3	$ 7.5	$ 475.4

* Single Fuel Channel Replacement (SFCR) included in FCLE Project BCS as contingency/not included in revenue requirement but would be subject to CRVA if incurred

** Includes FCLA Project Costs

*** 2015 For FCLE is Life to Date.

CCC Interrogatory #16

Issue Number: 4.1
Issue: Do the costs associated with the nuclear projects that are subject to section 6(2)4 of O. Reg. 53/05 and proposed for recovery meet the requirements of that section?

Interrogatory

Reference:
Reference: Ex. A1/T3/S1/p. 3

The evidence states that the basis of the application can be found in O. Reg 53/05 and Section 78.1 of the OEB Act. The regulation states that the Board shall accept the need for the Darlington Refurbishment Project in light of the 2013 Long-Term Energy Plan and the related policy of the Minister of Energy endorsing the need for nuclear refurbishment. Does OPG have an agreement with the Province regarding the Darlington Refurbishment Program? If so, please provide that agreement.

Response

OPG does not have an agreement with the Province of Ontario regarding the Darlington Refurbishment Program.

CCC Interrogatory #17

Issue Number: 4.1
Issue: Do the costs associated with the nuclear projects that are subject to section 6(2)4 of O. Reg. 53/05 and proposed for recovery meet the requirements of that section?

Interrogatory

Reference:
Reference: Ex. A1/T3/S1/p. 3

Does OPG have the discretion to stop the DRP in its entirety or at any stage of its completion? If so, under what conditions might OPG consider exercising that discretion? Does OPG have the discretion to change the scope or timing of the DRP at any stage? If so, under what conditions might OPG consider exercising that discretion?

Response

OPG's plan is to complete the refurbishment of all four units at Darlington and the project planning, project infrastructure and contracts have been put in place to achieve this goal. The Ministry of Energy has endorsed OPG's plan to refurbish all four units.

OPG does not have full discretion to stop the DRP in its entirety at any stage or to change the scope and timing of the DRP at any stage without consulting its Board of Directors and the Ministry of Energy.

OPG will continually exercise due diligence throughout the DRP to ensure that the economic and strategic benefits of continuing with the DRP remain robust. Given the strategic importance of the DRP to the Province of Ontario, OPG's Board of Directors, the Province of Ontario, the IESO and other stakeholders will exercise a continuing high degree of oversight (see Ex. D2-2-9, p. 8 for a description internal to OPG as well as external oversight). Because of the multi-unit nature of the DRP among other factors, OPG would expect the strategic and economic benefits of the DRP to be reconfirmed at least as frequently as after the completion of each unit's refurbishment, i.e., that there continues to be a strong business case to proceed with the remaining units. Please see also L-4.3-1 Staff-44.

Board Staff Interrogatory #25

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 1

The referenced evidence is a request for approval of $9.7M (over the approved execution-full Business Case Summary (BCS)) for the Darlington Operations Support Building Refurbishment. The original project cost was forecasted to be $46.7M[5]. The Engineering, Procurement, Construction (EPC) contract is identified as being $14.4M over the original budget.

[5] EB-2013-0321, Exh. D2-2-1, Attachment 8-4

a) Please explain the root causes for the cost variance and what actions OPG has taken to better manage projects in future to prevent such over-variances.

b) What was the final project cost?

c) Please confirm whether the OPG Project Management cost for project oversight was $3.7M. If not, what was the final OPG Project Management cost?

d) Please summarize the role of OPG Project Management in project oversight for the Darlington Operation Support Building Refurbishment.

e) What is the typical cost as per cent and/or dollars for OPG Project Management?

Response

a) The root causes of the cost variance are as follows:

   i) The estimate at the time of the full release approval was inadequate. The full release for the project was approved prior to the completion of detailed engineering, which was not in accordance with established practices. OPG has updated the project approval process to ensure that the required deliverables for each approval gate are completed and that the project has an appropriate class of estimate for the approval gate.

ii) Engineering assumptions were not validated prior to the full BCS approval. The main assumption was that the building rehabilitation would be executed to commercial standards. However, due to the building being inside the nuclear power plant, that was not entirely feasible. There was insufficient contingency allocated for invalidated design assumptions. Collaborative front-end planning and the Gated process as described in Ex. L-4.4-15 SEC-43 will address the validation inadequacy and engineering assumptions on future projects.

iii) Changes from the preliminary engineering requirements were identified during detailed engineering to meet code requirement and reduce future maintenance costs for the heating, ventilation, and air condition systems.

iv) The amount of power available from the station was limited without costly upgrades to the power supplies, which necessitated modifications to use lower power consumption LED lighting. While this increased project costs, it will result in lower OM&A costs in the future.

v) There were some required scope additions to address discovery issues such as mold and asbestos.

b) The project, which is still completing close-out activities, is currently projected to cost $62.0M by the project team.

c) A final OPG project management cost is not available until all close-out activities have occurred.

d) OPG Project Management conducted project oversight for the Darlington Operation Support Building Refurbishment in accordance with N-STD-AS-0030 Project Oversight Standard. Oversight activities include:

i) Regular progress meetings to review risks as well as schedule and cost performance
ii) Monitoring of project metrics (safety, quality, schedule and cost)
iii) Meets with vendor
iv) Perform observations, and review documentation
v) Regular walk downs of the jobsite for safety compliance to the applicable safety management program, workmanship and to assess progress.

e) The typical OPG Project Management cost is 10% of the total cost.

Board Staff Interrogatory #26

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 18

The BCS for the Darlington Restore Emergency Service Water and Fire Water Margins project estimates the project cost to be $20.9M higher than the previous estimate and cost is identified as a high risk.

a) Please provide a detailed explanation for the significant increase in estimated project cost.

b) Please provide an update on the status of this project with respect to cost and schedule including meeting the pre-requisite of installation completion prior to the start of Darlington Refurbishment in 2016.

Response

a) As indicated in Ex. D2-1-3, Attachment 1, Tab 18, p. 3, the increase is due to the significant increase in project scope. The initial definition phase partial release identified a risk to the station's emergency water supply and recommended installation of a new diesel driven fire water supply system. This initial project cost estimate was conceptual. The subsequent project definition phase identified a need to enhance the reliability of the associated emergency cooling water as well as address Beyond Design Basis Events. In the second partial release BCS (Ex. D2-1-3, Attachment 1, Tab 18) the conceptual cost estimate from the initial definition phase was increased primarily as a result of new project requirements and additional costs to expedite the project schedule.

b) A subsequent review of the project resulted in a less complex project scope being implemented. This removed the requirement for this project to be completed prior to the start of refurbishment, which significantly reduced project cost and schedule risks. Work is currently in progress to complete the design and estimate the project costs in support of the next BCS release planned for 2017. Project completion is now targeted for September 2019.

Board Staff Interrogatory #27

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 19
The BCS for the Darlington Station Roofs Replacement Project is a partial-release BCS for $0.8M approved in November 2012. The estimated total project cost including contingency is estimated to be $36.3M with a 2018 target project completion date. The BCS also identifies a preliminary design completion target date of September 9, 2013.

Please provide an update on the status of the project with respect to both schedule and cost and the reasons for variances, if any, and their impact.

Response

The project was placed in deferred status in October 2014, following completion of preliminary design work in August 2014, to allow other higher priority capital work to proceed at Darlington.

The project was taken out of deferred status in February 2016. The project is evaluating repair and replacement options and planning the overall project strategy. An updated schedule and cost estimate will be completed to support the first Execution Phase business case and is targeted for approval by Q2 2017.

Board Staff Interrogatory #28

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 20

The BCS for the Darlington Powerhouse Water Air Cooler Units Replacements project states that a full release BCS is expected to be approved with a target date of April 2016, following completion of detailed engineering for all units and procurement of all materials under the current BCS. The BCS also states that OPG Project Management and Engineering costs will be significantly higher than previously estimated.

a) Please provide an update on the project schedule and cost including whether the full release BCS has been approved as planned.

b) Please explain the underlying basis for the higher OPG Project Management and Engineering costs relative to the EPC contractor's work scope and responsibilities.

Response

a) A partial execution BCS was approved in September 2016 (see Attachment 1 which contains confidential information as marked). The updated total project cost is $26.6M. The increase is mainly due to equipment, engineering and construction cost increases. The cost of Air Cooling Units (ACUs), based on costs obtained from competitive bids, is higher than the original estimate. Engineering and construction costs are higher, due to the addition of mist eliminators and required relocation of some ACUs and interfering services. The target in-service date has changed from December 2019 to January 2023, as a result of the delay encountered in issuing the equipment purchase order, and delays in completing detailed engineering. The project schedule was re-evaluated and associated dates have been reflected in the latest BCS.

b) Based on experience from similar projects, OPG project oversight and cost has increased to support the resolution of construction issues. In the latest BCS, OPG Project Management and Engineering costs were reviewed and adjusted to reflect actual experience to-date on this project.

Type 3 Business Case Summary

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

Executive Summary and Recommendations

Project Information			
Project #:	16-31532	**Document #:**	D-BCS-73200-10002
Project Title:	Powerhouse Water ACU Replacements		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	**Investment Type:**	Sustaining
Phase:	Execution	**Release:**	Partial
Facility:	Darlington	**Target In-Service or Completion Date:**	JAN-2023

Project Overview

We recommend an additional release of $9,816 k, including [redacted] of contingency.

This will bring the total-to-date release to $21,153k, including [redacted] of contingency, compared to the previous release of $11,337k, including [redacted] of contingency. The estimated total project cost is $26,595k, including [redacted] of contingency.

The quality of the estimate for this release is Class 3, and for the total project is Class 4.

The total project cost has increased by $6,547k mainly due to the following changes in Engineering, Procurement, and Construction (EPC) vendor costs:

Item	Change [k$]	Details
Detailed Engineering	842	Additional Detailed Engineering work is required to: 1) Relocate 16 Air Cooler Units (ACUs), due to the addition of a mist eliminator on each ACU. 2) Relocate services (ie. lights and Public Announcement (PA) systems) at 18 affected locations. 3) Perform a technical evaluation to confirm that the reduced flow rate to each ACU, due to the addition of a mist eliminator, meets the cooling capacity requirements for each affected room.
Material Costs	2,052	The initial budgeted values received during the Collaborative Front End Planning (CFEP) phase of this project were lower than the actual costs. An increase in costs required to purchase the ACUs, was realized following the implementation of a competitive bid, using approved technical specifications.
[redacted]		
Total	6,547	

The funding from the previous release was used to complete the following deliverables:

1) Completion of extrusive flow measurements on 12 ACUs.
2) Preparation of 50% Engineering Change (EC) packages for Unit 1 Outage and Unit 2 Online.
3) Preparation of nine procurement technical specifications for Units 0, 1, 2, 3, and 4.

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

Type 3 Business Case Summary

Project #: 16-31532 Document #: D-BCS-73200-10002
Project Title: Powerhouse Water ACU Replacements, <Partial> <Execution> Release

Project Overview

4) Completion of the competitive bidding process for the procurement of the ACUs.

Since the last Business Case Summary (BCS), the following risks, included in the last BCS, have been retired:

a) Schedule risk: Approval has been received to replace the Unit 2 Outage ACUs during the Unit 2 Refurbishment project; eliminating the possibility of possible schedule delays.
b) Schedule risk: The Unit 2 Online ACUs have been scheduled to be replaced prior to the completion of the Unit 2 Outage ACUs.
c) Technical Risk: The selected replacement ACUs use the same technology as the existing ACUs; therefore, minimizing the risks introduced with utilizing new technologies.

This release will fund the following scope of work:

- Completion of remaining ACU flow measurements.
- Completion of the additional Detailed Engineering work related to relocating the ACU and affected services for Units 1, 2, 3 and 4 outage EC packages.
- Procurement of remaining equipment and materials.
- Installation Planning, ACU Replacement (execution), and EC Closeout for:
  - Unit 3 Online
  - Unit 4 Online
  - Unit 3 Outage
  - Unit 1 Online

Problem Statement/Business Need:

The scope for this project includes the replacement of the following ACUs:

(a) 0-73260-ACU3-16
(b) X-73220-ACU2 to 10 (X= Unit 1, 2, 3, 4)
(c) X-73220-ACU17 to 26 (X = Unit 1, 2, 3, 4)

The ACUs listed above are approaching the end of their useful service life. Cooling coil leaks (due to inadequate condensate drainage resulting in corrosion) and loose fan blades have caused the ACUs to be unavailable on multiple occasions. Additionally, the ACUs spraying condensate during humid conditions, which have initiated false alarms in rooms where a “beetle” is present.

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

Integrated Implementation Plan (IIP) item number, IIP-CC 033, requires the replacement of the aforementioned units by the following years:

- Unit 3, 2018
- Unit 4, 2019
- Unit 1, 2020
- Unit 2, 2022
- Unit 0, 2022

Summary of Preferred Alternative:

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

History of scope and schedule changes:

The Target In-Service date has changed to January 2023, from December 2019, as a result of the delay encountered in issuing the ACU equipment purchase order. This is mainly due to a delay in replacing the Unit 2 Outage ACUs, which is now scheduled to occur in the D2221 Outage.

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Type 3 Business Case Summary

Project #: t6-3 t532
Document #: D-BCS-73200-10002
Project Title: Powerhouse Water ACU Replacements, <Partial> <Execution> Release

Project Overview

Key Assumptions and Risks:

There is a risk that project's scope may increase if the ACU isolation valves or the drain lines are found to be inadequate during the replacement of each ACU. The work plan will include instructions on testing the isolation valves and, if necessary, replacing them with a suitable valve. Additionally, a resolution for the drain lines will be incorporated into the design package for each unit. Therefore, additional costs may be incurred to the project, to resolve these potential issues.

There is a risk that delays will be encountered with acquiring the final vendor drawings, causing delays in the completion of the detailed design packages. To alleviate this risk, final vendor drawings will be included as a key deliverable in the vendors purchase order, to be delivered to OPG six weeks after the purchase order is issued. The engineering package completion dates have been scheduled, to allow for potential delays in the final vendor drawings.

Project Cash Flows, NPV, and OAR Approval Amount

k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	1,468	3,816	2,695	3,358					11,337
Requested Now	-	(2,379)	5,147	2,746	2,425	807	680	390	9,816
Future Required	-			1,070	2,242	1,903	72	155	5,442
Total Project Cost	1,468	1,437	7,842	7,174	4,667	2,710	752	545	26,595
Ongoing Costs	-								
Grand Total	1,468	1,437	7,842	7,147	4,667	2,710	752	545	26,595

Estimate Class:	Class 4	**Estimate at Completion:**	[redacted]
NPV:	N/A	**OAR Approval Amount:**	$26,595k

Additional Information on Project Cash Flows (optional):

Spare parts cost will be shown in the next BCS, following receipt of a spare parts list for the new ACUs.

It is estimated that the total cost of existing inventory to be scrapped is $1.7M, based on a preliminary review. A detailed list of inventory to be scrapped, including each associated quantity and cost, will be provided in the next BCS.

Approvals

	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Glenn Jager President OPG Nuclear and CNO			12 AUG 2016
I concur with the business decision as documented in this BCS.			
Finance Approval: Ken Hartwick SVP Finance, Strategy, Risk and CFO per OPG-STD-0076			Sept 2, 2016
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Jeff Lyash President and CEO per OAR 1.1			Sep 15 16

Type 3 Business Case Summary

Project #: 16-31532 Document #: D-BCS-73200-10002

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

Business Case Summary

Part A: Business Need

The scope for this project includes the replacement of the following ACUs:

(d) 0-73260-ACU3-16
(e) X-73220-ACU2 to 10 (X= Unit 1, 2, 3, 4)
(f) X-73220-ACU17 to 26 (X = Unit 1, 2, 3, 4)

The ACUs listed above are approaching the end of their useful service life. Cooling coil leaks (due to inadequate condensate drainage resulting in corrosion) and loose fan blades have caused the ACUs to be unavailable on multiple occasions, as recorded in Station Condition Records (SCRs). These issues are also documented in Component Condition Analysis for Air Cooling Units. Additionally, another issue with the ACUs is the condensation spraying during humid conditions, which have initiated false alarms in rooms where a "beetle" is present.

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

IIP item number, IIP-CC 033, requires the replacement of the aforementioned units by the following years:

- Unit 3, 2018
- Unit 4, 2019
- Unit 1, 2020
- Unit 2, 2022
- Unit 0, 2022

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

Description of Preferred Alternative

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

Master EC package [2] and Modification Design Requirements [3] have been prepared and issued, to provide design and functional requirements for the replacement ACUs. Since ACUs 1/2/3/4-73220-ACU2-10 are located in critical rooms with sensitive equipment, installations will be performed during planned unit outages (D1831, D1941, D2011, D2221) to minimize risk to unit operation. All remaining ACUs will be replaced online.

Deliverables:	Associated Milestones (if any):	Target Date:
Current Release	*Current Release*	
Approve and Issue Unit 0, 1, 2, 3, and 4 EC Packages.	Unit 3 Online EC Package Issued	23JUN2017
	Unit 3 Outage EC Package Issued	23MAR2017
Complete installation and Available for Service (AFS) of 73220-ACU17-26 for Unit 1, 3 and 4 Online ACUs.	Unit 4 Online EC Package Issued	26FEB2018
	Unit 3 Online AFS Complete	02MAY2018
	Unit 4 Online AFS Complete	18DEC2018
Complete Installation and Available for Service (AFS) of 73220-ACU2-10 for 3 Outage ACUs, during the D1831 Outage.	Unit 1 Online EC Package Issued	28JUN2018
	Unit 4 Outage EC Package Issued	13MAR2018
	Unit 2 Online EC Package Issued	28JUN2018
	Unit 3 Outage AFS Complete (D1831)	21SEP2018
	Unit 0 Online EC Package Issued	25OCT2018
	Unit 2 Outage EC Package Issued	08FEB2019
	Unit 1 Outage EC Package Issued	26FEB2019
	Unit 1 Online AFS Complete	01APR2019
Future Release:	*Future Release*:	
Complete installation and Available for Service (AFS) of 73220-	Unit 4 Outage AFS Complete (D1941)	30AUG2019

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

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Type 3 Business Case Summary

Project #: 16-31532
Document #: D-BCS-73200-10002
Project Title: Powerhouse Water ACU Replacements, <Partial> <Execution> Release

Deliverables:	Associated Milestones (if any):	Target Date:
ACU17-26 for Unit 1 and 2 Online ACUs. Complete installation and Available for Service (AFS) of 0-73220-ACU3-16 for Unit 0 Online ACUs. Complete Installation and Available for Service (AFS) of 73220-ACU2-10 for Unit 1 and 4 Outage ACUs, during the D2011 and D1941 Outages. Closeout all project related ECs and complete all related Project Closeout activities.	Unit 0 Online AFS Complete Unit 1 Outage AFS Complete (D2011) Unit 2 Online AFS Complete Unit 2 Outage AFS Complete (D2221) EC Closeout Completed Project Complete	30MAR2020 29JUL2020 22DEC2020 31JAN2023 01AUG2023 21FEB2024

References	
Title	**Document Number**
1. Powerhouse Water ACU Replacement, Project Charter	D-PCH-73200-10001
2. Powerhouse Water ACU Replacement, Master EC	EC 121839
3. Powerhouse Water ACU Replacement, Modification Design Requirements	NK38-MDR-73200-10001

Part C: Other Alternatives

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

Alternative 2: Base Case – No Project

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

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

Delaying the project is not recommended as existing ACUs are failing and are a maintenance burden for the station. Additionally, it risks the project of not meeting the aforementioned IIP commitment dates, which were agreed to with the Canadian Nuclear Safety Commission (CNSC).

Alternative 4: N/A

Alternative 5: N/A

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

k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	1,468	3,816	2,695	3,358					11,337
Requested Now	-	(2,379)	5,147	2,746	2,425	807	680	390	9,816
Future Required	-			1,070	2,242	1,903	72	155	5,442
Total Project Cost	1,468	1,437	7,842	7,174	4,667	2,710	752	545	26,595
Ongoing Costs	-								
Grand Total	1,468	1,437	7,842	7,147	4,667	2,710	752	545	26,595

Estimate Class:	Class 4	**Estimate at Completion:**	[redacted]
NPV:	N/A	**OAR Approval Amount:**	$26,595k

Additional Information on Project Cash Flows (optional):

Type 3 Business Case Summary

Project #: 16-31532
Document #: D-BCS-73200-10002
Project Title: Powerhouse Water ACU Replacements, <Partial> <Execution> Release

Spare parts cost will be shown in the next BCS, following receipt of a spare parts list for the new ACUs.

It is estimated that the total cost of existing inventory to be scrapped is $1.7M, based on a preliminary review. A detailed list of inventory to be scrapped, including each associated quantity and cost, will be provided in the next BCS.

Part E: Financial Evaluation

k$	Preferred Alternative	Base Case	Delay Work	Alternative 4	Alternative 5
Project Cost	26,595		35,000		
NPV					
Other (e.g., IRR)					

Summary of Financial Model Key Assumptions or Key Findings:

As per OPG-STD-0076, a Financial Evaluation is optional for Sustaining and Regulatory projects.

Part F: Qualitative Factors

Qualitative factors that are provided by the Preferred Alternative are:

- Stakeholders Relations with the CNSC will be maintained, as OPG meets the commitments tied to IIP-CC 033.
- Technical or operational considerations, related to condensate being sprayed onto sensitive station equipment. The new ACUs will mitigate the spraying of condensate droplets, in the nearby areas.
- Reliability of the Powerhouse Water ACUs. The new ACUs will resolve the existing issues with leaking cooling coils, loose fan blades and vibration due to worn bearings and improve equipment reliability and maintainability.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that construction costs will be higher than what has been currently estimated, due to unexpected in-field conditions, causing for an increase in construction scope.	In-field walkdowns have been performed to assess the extent of construction work required. Constructability walkdowns will be performed following the completion of the corresponding design package, for each unit. Contingency funding has been allocated to address this risk within this release.	Low	Medium
Scope	There is a risk that project scope may increase if isolation valves or the drain lines are found to be inadequate during the replacement of each ACU.	The work plan will include instructions on testing the isolation valves and, if necessary, replacing them with a suitable valve. A resolution for the drain lines will be incorporated into the design package for each unit.	Medium	Medium
Schedule	There is a risk that delays will be encountered with acquiring the final vendor drawings, causing delays in the completion of the detailed design packages.	Final vendor drawings will be included as a key deliverable in the vendors purchase order, to be delivered to OPG six weeks after issuing the purchase order. The engineering package completion dates have been scheduled, to allow for potential delays in the final vendor drawings.	Low	Low
Resources	There is a risk that due to competing priorities, contractor and OPG design resources may not be fully available to prepare, review and approve design ECs	Projects will conduct regular stakeholder meetings to monitor progress. There is sufficient float included in the schedule in case of lack of resources or discovery	Low	Low

Part G: Risk Assessment				
Risk Class	**Description of Risk**	**Risk Management Strategy**	**Post-Mitigation**	
	as per project schedule.	issues.		
Quality/ Performance	There are no quality/performance risks identified.		Low	Low
Technical	There is a risk that the available water flow rate will be insufficient for the new ACUs. Note: There is no risk that the air flow rate produced by the replacement ACU will be insufficient since it is specified as a design parameter.	Work orders have been initiated to support the EPC contractor in taking flow measurements of an adequate sample size of ACUs. Intrusive measurements will be taken to resolve the uncertainties experienced when performing the extrusive measurements.	Medium	Medium

Part H: Post Implementation Review (PIR) Plan		
Type of PIR Report	**Target In-Service or Completion Date**	**Target PIR Completion Date**
Simplified PIR	JAN-2023	JAN-2024

Measurable Parameter	**Current Baseline**	**Target Result**	**How will it be measured?**	**Who will measure it? (person/group)**
Reliability of new ACU Units	ACU unit coil leaks, vibration, and fan blade failures	No leaks, vibration out of specification, or fan blade failures	Number of Work Orders, SCRs and vibration monitoring results	Performance Engineering
Incidents of condensation spraying in ACU rooms	Condensation spray in ACU rooms	No condensation spraying	System Performance Monitoring Plan and weekly walk downs	Performance Engineering

Part I: Definitions and Acronyms

ACU – Air Cooler Unit
AFS – Available for Service
BCS – Business Case Summary
CFEP – Collaborative Front End Planning
EC – Engineering Change
EPC – Engineering, Procurement, Construction
IIP – Integrated Implementation Plan
PA – Public Announcement
SCR – Station Condition Record

Type 3 Business Case Summary

Project #: 16-31532
Document #: D-BCS-73200-10002
Project Title: Powerhouse Water ACU Replacements, <Partial> <Execution> Release

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Type 3 Business Case Summary

Project #: 16-31532
Document #: D-BCS-73200-10002
Project Title: Powerhouse Water ACU Replacements, <Partial> <Execution> Release

For Internal Project Cost Control

Type 3 Business Case Summary

Project #: 16-31532
Document #: D-BCS-73200-10002
Project Title: Powerhouse Water ACU Replacements, <Partial> <Execution> Release

Appendix A: Summary of Estimate										
Project Number:	16-31532									
Project Title:	Powerhouse Water ACU Replacements									
k$	**LTD**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Future**	**Total**	**%**
OPG Project Management	359	95	119	149	118	63	40	3	946	3
OPG Engineering (including Design)	235	42	347	375	239	71	39		1,348	5
OPG Procured Materials									0	0
OPG Station Support	1	0	19	158	116	148	41		483	2
Design Contract(s)	[redacted]									
Construction Contract(s)										
EPC Contract(s)										
Consultants										
Other Contracts/Costs										
Interest										
Subtotal										
Contingency										
Total	**1,468**	**1,437**	**7,842**	**7,174**	**4,667**	**2,710**	**752**	**545**	**26,595**	**100**
Removal Costs			86	237	248	248	236		1,055	

Notes			
Project Start Date	OCT2012	**Total Definition cost** (excludes unspent contingency for Nuclear)	[redacted]
Target In-Service (or AFS) Date	JAN2023	**Contingency included in this BCS** (Nuclear only)	
Target Completion Date	FEB2024	**Total contingency released plus contingency in this BCS** (Nuclear only)	
Escalation Rate	4%	**Total released plus this BCS without contingency** (Nuclear only)	
Interest Rate	5.26%	**Total released plus this BCS with contingency** (Nuclear only)	$21,153k
Removal Costs	$1,055k	**Estimate at Completion** (includes only spent contingency for Nuclear)	[redacted]

Prepared by:		Approved by:	
Matthew Tannous Project Manager Projects and Modifications	2016-08-18 Date YYYY-MM-DD	Brian Graham Section Manager Projects and Modifications	2016-08-18 Date YYYY-MM-DD

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Type 3 Business Case Summary

Project #: 16-31532
Document #: D-BCS-73200-10002
Project Title: Powerhouse Water ACU Replacements, <Partial> <Execution> Release

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

Comparison of Total Project Estimates

Phase	Release	Approval Date	Total Project Estimate in k$ (by year including contingency)						Future	Total Project Estimate
			2012	2013	2014	2015	2016	2017		
Definition	Full	OCT2012	3	590	4,010	2,720	996	972	401	9,693
Definition & Execution	Partial	JAN2015		226	150	3,154	5,529	5,719	5,258	20,045
Execution	Partial	APR2016		226	150	1,092	1,437	7,842	15,848	26,595

Project Variance Analysis

k$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	359	1,601	946	(655)	OPG Project Management costs adjusted according to burn rates experienced to date, in the project.
OPG Engineering (including Design)	235	1,012	1,348	336	Additional engineering oversight is required, due to the increase in engineering work being performed by the EPC contractor.
OPG Procured Materials					
OPG Other	1	30	483	453	Station support costs increased to account for the support required during the installation of all 90 ACUs.
[redacted]					
Total	**1,468**	**20,045**	**26,595**	**6,550**	
Removal Costs		**282**	**1,055**	**773**	Increase due to relocation of ACUs and interfering services (ie. lights and PA systems).

Board Staff Interrogatory #29

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 21

The BCS for the Darlington Water Treatment Plant (WTP) Replacement Project is a partial-release BCS approved in October 2012 for $5.2M, intended to complete Phase 1, the Full Definition Phase (consisting of Preliminary and Detailed Design), of the project. The BCS estimates the total project cost including contingency at $57.8M with a target in-service date of November 25, 2016 for the new WTP.

Interrogatory

a) Please provide an update on the status of the project with respect to both schedule and cost including any subsequent BCS(s) approved since October 2012.

b) Please advise if there are any implications on station operation if the stated target in-service date of November 25, 2016 is not met.

c) Please advise if OPG has made a decision yet whether or not to outsource the operation of the new WTP. If yes, does OPG project there to be any associated future Operating and Maintenance cost savings relative to those for the existing WTP? If yes, what are they?

Response

a) Work on the project was halted in 2013 to allow for higher priority work to be advanced at Darlington. Work on the project is still on hold awaiting a decision on whether or not to outsource the operation of the new Water Treatment Plant (WTP).

b) The implication of not meeting the in-service target stated in the BCS is the potential reduction in reliability of the current WTP and, with that, potential risk of multi-unit/station shutdown. An improvement plan to increase reliability of the current WTP with an accompanying bridging strategy was completed in 2015 to mitigate this risk.

c) No decision has been made to date on whether or not to outsource operation of the new WTP.

Witness Panel: Nuclear Operations and Projects

Board Staff Interrogatory #30

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 22

The BCS for the Darlington "Install Multi-Gas Analyzers on the Main Output Transformers (MOT), the System Service Transformers (SST) and the Unit Service Transformers (UST)" project identifies the project scope to include the installation of on- line Multi-Gas Analyzers on the station's twelve MOT, four SST, and four UST.

a) In line with present industry standards and the World Association of Nuclear Operators, on-line Multi-Gas Analyzers are recommended on power transformers. Has OPG conducted any benchmarking comparisons or studies of similar multi-gas analyzer installations at other utilities? If yes, how does OPG's project unit costs compare to these other installations?

b) The BCS indicates that the replacement of the High Voltage Bushing Monitoring (HVBM) was removed from the project scope, largely the result of an increase in the HVBM cost estimate from $4M to $7.2M. OPG intends instead to replace the HVBM during the Darlington Refurbishment outages. Why does OPG consider this to be a cost-effective decision and what are the estimated future costs of the HVBM replacement?

c) Will the cost for this work now be included as part of the DRP costs?

Response

a) OPG has not performed benchmarking studies with respect to Multi-Gas Analyzer installation costs.

b) The BCS did state that the replacement of the High Voltage Bushing Monitoring (HVBM) was removed from project scope. However, the BCS did not state that HVBM would be included in DRP scope.

The removal of HVBMs from scope was considered cost-effective, at the recommendation of the transformer OEM, as OPG is and will be replacing the High Voltage Bushings at regular intervals based on engineering recommendations.

Darlington Refurbishment scope includes the replacement of High Voltage Bushings on Unit 2 only, and its cost is included as part of DRP.

New High Voltage Bushings on the Unit 1, 3, and 4 will be installed during routine unit outages.

c) The cost of installing HVBM is not included in DRP.

Board Staff Interrogatory #31

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 23
The BCS for the Darlington Radiation Detection Equipment Obsolescence project is a partial-release BCS, approved in January 2014, for $1.15M and intended to complete the scope definition. The BCS estimates the total project cost at $46.875M including contingency and identifies a target date of October 30, 2015 for the preparation of the BCS for the next phase.

a) Has the scope definition work been completed as planned? Please provide an update on the status of the project with respect to cost and schedule.

b) It would appear that many, if not all, of the seven radiation detection and monitoring systems are critical to station and unit operation. Will the replacement of these systems require close integration with the Darlington Refurbishment Program? If yes, which of these systems are on the critical path as part of the Unit 2 refurbishment outage?

Response

a) Initial scope definition has been completed, and the planning for the next phase of the project is ongoing. The funding from the January 2014 Business Case Summary (Ex. D2-1-3, Attachment 1, Tab 23) was used to complete preliminary engineering for all seven of the radiation detection systems, and procurement technical specifications for four of the systems. Following the completion of preliminary engineering, an updated total project cost estimate is being developed as part of the planning for the next phase of this project.

   The next phase is planned to include completion of the remaining three technical specifications; partial detailed engineering; and, procurement of engineered equipment for five of the seven systems. A Business Case Summary (BCS) for this phase is targeted to be approved in early 2017.

b) The replacement of the affected radiation detection systems located in Unit 2 will occur after the refurbishment is complete and therefore will not require coordination with the Darlington Refurbishment Program (DRP). Equipment replacements on the remaining units will need to be coordinated with the DRP but will not impact the DRP critical path.

Witness Panel: Nuclear Operations and Projects

Board Staff Interrogatory #32

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 24

The BCS for the Darlington Condenser Cooling Water and Low Pressure Service Water Travelling Screen Replacement project estimates the total project cost to be significantly higher, $37.6M including contingency, compared to the estimated total project cost of $24.4M identified in the previous partial-release BCS. While the BCS identifies the contributing factors for the $13.3M variance, the BCS also states that actuals from the first screen installations have been used to estimate future installation costs of all units.

a) Did OPG factor in the experience from these installations in arriving at new estimates, i.e. incorporated lessons learned to prevent recurrence, instead of just using the actual cost data?
b) Please explain the relatively high OPG Project Management costs (10% of the total project estimate) on this project.

Response

a) Yes, lessons learned from the Condenser Cooling Water (CCW) travelling screen replacements were incorporated into the revised project estimate for the CCW work. OPG had completed the installation of two CCW travelling screens at the time the June 2015 BCS was prepared.

   OPG had not yet completed any Low Pressure Service Water (LPSW) travelling screen replacements. However, transferable lessons learned from the CCW travelling screen replacements were also applied to the LPSW travelling screen replacement scope and cost estimate.

b) OPG would not characterize its project management cost as being “relatively high”, as the interrogatory suggests. The project management cost for this project is consistent with the typical percentage of 10% used in other OPG projects, as discussed in Ex. L-4.2-1 Staff-25 part (e).

Board Staff Interrogatory #33

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 25
This BCS for the Darlington Shutdown Cooling Heat Exchanger (HX) Replacement project is a Phase 2 Partial Definition & Execution BCS and is subsequent to a previous Phase 1 Partial Definition BCS. The BCS states that a Phase 3 Full Execution BCS is planned in the future.

a) The BCS discusses a phased approach to awarding EPC contracts. Please explain whether the phased approach applies to the same vendor in each phase or whether each phase is open to multiple vendors:
   i. If the former, please clarify how project cost risks are mitigated unless the successful vendor has already committed to a preliminary cost for each contract phase;
   ii. If the latter, please clarify how this approach minimizes overall project costs including the management of resource risks.

b) The BCS states that estimated OPG resource costs have increased from $3.4M to $10.6M as a result of increased resource requirements resulting from a longer HX replacement duration. In particular, the BCS states that the previous HX replacement duration was based on a 2-week installation period working 24/7, and a 6-week installation period working 40 hours/week. The new HX replacement duration is based on 30-day installation period working 24/7, and a 6-week installation period working 40 hours/week. Please clarify how these changes result in the magnitude of the increased variance as stated.

Response

a) All three phases of the Engineering, Procurement, and Construction (EPC) contract were awarded to one vendor following a competitive bidding process. The preferred vendor was chosen based on pricing details submitted, including a comprehensive Class 3 cost estimate. Project cost risks are mitigated in a number of ways, including: i) the contract between OPG and the preferred vendor specifies the committed pricing for all three phases; and ii) OPG is not obligated to award subsequent phases of the contract to the preferred vendor. The award of subsequent phases of the contract to the preferred vendor is contingent on acceptable quality, cost and schedule performance. OPG has the option to open subsequent phases of the contract to alternate vendors.

Witness Panel: Nuclear Operations and Projects

b) The change in the estimated cost is driven by the increased duration of the 24/7 installation period and an increase in the number of OPG staff required to support the installation.

The increased duration of an additional 16 days of 24/7 work per unit results in an increase of $1.4M.

An increase in the number of OPG staff results in additional expenditures of $5.8M. Additional Operations, Engineering and Radiation Protection staffing has been added to the field execution to provide additional oversight, faster resolution of issues and improved safety support. Additionally, full-time project management and project engineering support is being provided until the completion of the project in 2018.

Board Staff Interrogatory #34

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 26
This BCS is with respect to the Darlington Neutron Overpower & Ion Chamber Amplifier Replacement (Reactor Regulating System, Shutdown System 1 & Shutdown System 2) project.

a) The BCS covers the replacement of In-Core Flux Detector (ICFD) and Ion-Chamber (IC) amplifiers only. Please confirm whether the neutron detectors and ion chambers will also need to be replaced or not. If yes, please explain when.

b) Please clarify why the purchase of off-the-shelf amplifiers is not a viable option given the widespread use of such equipment in the nuclear industry. Alternatively, was the option of replacing the existing ICFD and IC including the associated amplifiers with integral units considered?

Response

a) The in-core flux detectors are all planned to be replaced at Darlington during each unit's refurbishment outage. Replacement of in-core flux detectors must be done during a reactor outage. The Ion Chambers will also need to be replaced and the plan is to replace them when signs of degradation are identified during condition-based maintenance.

b) These amplifiers are used exclusively in CANDU reactor shutdown systems. The technical specifications are specific for each of the CANDU stations and are manufactured to high quality and reliability standards. Such amplifiers are not readily available in the market. Therefore, an "off-the-shelf" approach is not viable.

Replacement using integral units was not considered since it is not technically feasible.

Board Staff Interrogatory #35

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 27
This BCS is for the Darlington Zebra Mussel Mitigation Improvements project and identifies a target project in-service date of July 25, 2016.

a) Please provide an update on the status of the project (cost and schedule) given the stated target in-service or completion date of July 25, 2016.

b) The BCS states that OPG has taken into account the Pickering experience with regards to the implementation of de-chlorination systems and their operations. To the extent that OPG's hydroelectric stations are also susceptible to zebra mussel fouling, has OPG also considered the hydroelectric experience in dealing with zebra mussel fouling in the Darlington project? If so, please explain.

Response

The project cost and schedule have been revised and are awaiting final approval consistent with OPG's approval process.

a) The revised total project cost is now $29.3M, based on an estimate reviewed by the Asset Investment Steering Committee and the target in-service date is September 2017. The cost increase is due to unforeseen field changes discovered during installation, including material and labour costs required to complete the modifications, and additional scope initiated after the installation commenced. Additional project scope includes: adding a permanent sampling station to the de-chlorination system, and a permanent aeration system for the Inactive Drainage Lagoon.

b) Yes, OPG has also considered the hydroelectric experience in dealing with zebra mussel fouling in the Darlington project. For example, the use of Zequanox (a naturally occurring bacterium found on strawberry roots that has been proved to be lethal to zebra and quagga mussels) has been tested on a small scale at hydroelectric plants. The most common methods of mitigation used by industries along the Great Lakes are a system of chlorination and strainers combined with anti foul or foul release coatings. They are preferred due to their comparatively low cost, high level of effectiveness, and reasonably simple use for the operator.

Witness Panel: Nuclear Operations and Projects

Board Staff Interrogatory #36

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 28
The BCS for the Darlington Highway 401 and Holt Road Interchange project relates to OPG's funding of a portion of the total project cost. The work is to be executed by the Ontario Ministry of Transportation.

a) Please provide an update on the status of the project (cost and schedule) given the stated target date of December 2015 for construction completion.

b) Is OPG liable for any future maintenance costs following the project completion?

c) The BCS states that in order to maximize the productivity at the refurbishment worksites, OPG would be negotiating with the trades unions to have the trades report for work at the jobsite, rather than at the entrance to the site. The outcome of these negotiations has significant impacts on productivity and therefore cost and schedule of the refurbishment project. What is the status of these negotiations and what are the associated impacts, if any?

Response

a) The project was 95% complete as of December 2015 with the following work outstanding:
- Final asphalt on entire Holt Road and roundabouts
- Final asphalt on Highway 401 Westbound and Eastbound on and off-ramps
- Paving Waterfront Trail through soil mound (Park Rd-Solina Rd)
- Landscaping
- Removal, cleanup, top soiling and seeding

This work was completed in August 2016 at a total cost of $24.6M.

b) OPG is not liable for any future maintenance costs.

c) OPG confirms that negotiations were completed with the trades unions and that agreements are in place for the trades to report to their designated work locations at the start of their shifts. This process is now in effect. The impact of implementing this process

is an expected increase in productivity as the trades will report and clock-in at their designated work locations, rather than at the security gate at the entrance to the site. This impact has already been included in OPG's productivity assumptions for the Release Quality Estimate.

Board Staff Interrogatory #37

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 29

The BCS for the Darlington OH180 Programmable Logic Control Aging Management Hardware Installation project identifies a planned future partial-execution BCS release in March 2016.

a) What is the status of the partial-execution BCS targeted for approval by 31 March, 2016? If approved, please provide a copy.

b) Has a decision been made with respect to proceeding with either re-engineered Input and Output boards or their refurbishment? What are the associated implications, if any?

c) From a project schedule standpoint, are there any criticality issues relative to the Darlington Refurbishment outages? If yes, what are the associated impacts?

Response

a) The Partial Execution Business Case Summary (BCS) is currently targeted for approval by the Board of Directors in early 2017.

b) It has been decided that re-engineered Input/Output boards will be used. The cost of refurbishing the existing boards is higher than the cost of re-engineering. Furthermore, the re-engineered boards would be more reliable.

c) This project will have no impact on Darlington Refurbishment outages from a project schedule standpoint.

Witness Panel: Nuclear Operations and Projects

Board Staff Interrogatory #38

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 30
This BCS is a partial-definition release for the Darlington Digital Control, Common Process and Sequence of Events Monitoring Computer Aging Management project intended for preliminary engineering and procurement of engineering services.

From a project schedule standpoint, are there any criticality issues relative to the Darlington Refurbishment outages? If yes, what are the associated impacts?

Response

There are no criticality issues for this project from the schedule standpoint relative to the start date or duration of the Darlington Refurbishment outages.

Board Staff Interrogatory #39

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 31
This BCS for the Darlington Generator Stator Core Spare project covers the procurement of the spare generator core and discusses its application in the replacement of the Unit 3 and Unit 4 stator cores only.

a) Please clarify what the corresponding situation and associated risks are with the Units 1 and 2 stator cores and windings; as these do not seem to be covered by the current project.

b) How will their integrity be managed to provide continued service to the end-of-life of the refurbished Units 1 and 2?

Response

a) The tightness of Unit 1 stator wedges has been confirmed as stable. On-line Partial Discharge ("PD") Monitoring indicates no PD concerns.

In 2010, all Unit 2 stator end wedges and some adjacent wedges were replaced. Off-line vendor PD indicated the stator was in good condition.

As a result, Units 1 and 2 were assessed as being in good condition.

b) At present, it is expected that Units 1 and 2 stators may last until end of life, assuming the risk of significant failure for Units 1 and 2 can be mitigated by:

- Performing a minimum scope of inspections and maintenance during unit refurbishment,
- Performing expanded on/off line monitoring, and
- Accomplishing diagnostics without removing the rotor.

It is expected that these actions will give advanced warning of degradation and will allow for advanced planning for remediation, if required.

Witness Panel: Nuclear Operations and Projects

Board Staff Interrogatory #40

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 32

The BCS for the Darlington Vault Cooling Coil Replacement project states that the project is not currently in the Operations Business Plan and that it was originally planned for during the DRP outages. The BCS also states that while replacement of some vault cooling coils has been advanced, the remaining coils will be replaced during respective unit refurbishment outages.

Please clarify what project scope and costs will be included in Nuclear Operations and reclassified from the Refurbishment Program scope and what remains within the DRP envelope.

Response

A business case summary (BCS) for the Darlington Cooling Coil Replacement project was approved in September 2016 (see Attachment 1 which has confidential content as marked). The total project estimate is now $18.8M, reduced from the previous total project estimate of $26.3M.

The nuclear operations' project scope and associated costs are to replace individual leaking or low flow coils in advance of each unit's refurbishment.

The Darlington Refurbishment Program scope (TS0280-01 and TS1570-1) and associated costs are to replace the fan, fan motor and all cooling coils in all unit coolers during each of the refurbishment outages.

ONTARIO POWER GENERATION

Records File Information:
Records SCI/USI Retention
- See Guidance Section

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Type 3 Business Case Summary

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

Executive Summary and Recommendations

Project Information			
Project #:	Project # 82816	Document #:	D-BCS-73720-10001-R001
Project Title:	DN Vault Cooling Coil Replacement		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	Investment Type:	Regulatory
Phase:	Execution	Release:	Partial
Facility:	Darlington	Target In-Service or Completion Date:	Sept 2020

Project Overview

We recommend the release of an additional $ 3,817 k, including contingency of [redacted]
The estimated total project cost is $ 18,753 k, including [redacted] of contingency.

The quality of the estimate for this release is Class 2, and for the total project is Class 3.
Specific contingency has been included to account for scope uncertainty.

The business objective of this project is to reduce the risk to Darlington operations from leaking or reduced flow vault cooling coils. Selected coils will be replaced to allow the units to operate with low risk until their respective unit refurbishment outages.

This release, with remaining unspent funds from the previous release will fund the following scope of work:

- Replace leaking and degraded vault cooling coils in outages D1632, D1711, D1831
- Prepare for contingent forced outage(s) for coil replacement
- Prepare a subsequent release BCS to address remaining replacements require before the respective refurbishment outages.

Tube plugging or repair of installed coils is not part of this project scope.

Vault cooling coils provide cooling to the reactor vault under operating conditions. Under Loss of Coolant Accident (LOCA) conditions they remove heat from the steam ladened atmosphere and maintain vault negative pressures.

Many vault cooling coils are leaking which requires the coils to be valved out. Nineteen coils have been replaced since D1512 to D1641. There are currently 6 leaking coils across the station; Unit 1 (2 coils), Unit 2 (2 coils), Unit 3 (2 coils) and 9 repaired coils that are at risk of leaking; Unit 1 (3 coils), Unit 2 (3 coils), Unit 3 (3 coils). Vault temperatures can approach shut down limits of 61°C associated with Negative Pressure Containment System (NPCS) Level 2 impairment due to high summer lake water temperatures. Reduced cooling capacity from high service water temperature, leaking coils isolated and degraded flow from coil fouling, have contributed to lowered cooling margins. In addition, Environmental Qualification (EQ) margins are being reduced due to the elevated temperatures experience by EQ equipment.

Project scope has been added to D1632 and D1711. Four coils are planned for replacement during D1632, with no additional funding required due to a reduction in project costs. The four coil replacements planned for D2011 have been brought forward to D1711, requiring some additional funding.

Coil replacement was planned scope for refurbishment outages (DSR-TS0280-1), and is a IIP committment. A portion of this regulatory work is being advanced to outages preceeding refurbishment as leaking coils and coils with degraded flow need to be replaced now to increase margins to avoid impairments due to vault temperatures.

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

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Type 3 Business Case Summary

Project #: Project # 82816 Document #: D-BCS-73720-10001-R001
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

Project Overview

Summary of Preferred Alternative:

Replace only coils with leak(s) and coils with significant degradation in available planned outage(s) leading into each unit's refurbishment outage. Remaining coils will be replaced during the refurbishment outage under DSR-TS028-1.

Valving in leaking coils to maintain vault temperatures may be used as temporary mitigation provided leak rates are manageable. Repairing of leaking coils can be attempted during outages, with the repair strategy dependent on leak size and location. Repairing leaking coils increases cooling capacity after returning the coil to service, but may not provide adequate temperature margin to avoid NPCS impairments. Tube plugging reduces coil cooling capacity and leak repair does not reduce the probability of other tube leaks in the coil. Cooling coil replacement is preferred over plugging or repair. Costs associated with plugging or repair are not included in this project.

Material and installation costs are known with high confidence, as nineteen have been replaced to date.

Key Assumptions and Risks:

Scope of work for each planned outage will target leaking coils and coils with degraded flow. Initiation of leaks in in-service coils in not predictable. Some coils due to known interferences will require 2 piece replacement coils increasing project costs. As such the project scope for each outage up to 2020 may vary. Significant specific contingency is included in the project estimate to address the uncertain number of coil replacements.

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Type 3 Business Case Summary

Project #: Project # 82816
Document #: D-BCS-73720-10001-R001
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

Project Cash Flows, NPV, and OAR Approval Amount

k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	4552	5109	2275						11,936
Requested Now	-		1470	2347					3,817
Future Required	-				3000				3,000
Total Project Cost	4552	5109	3745	2347	3000				18,753
Ongoing Costs	-								
Grand Total	4552	5109	3745	2347	3000				18,753

Estimate Class:	Class 3	**Estimate at Completion:**	[redacted]
NPV:		**OAR Approval Amount:**	$18,753k

Additional Information on Project Cash Flows (optional):

The Requested Now amount of $3,817k incorporates cost experience from the successful installation of 19 coils to date. Cash flows for the remainder of 2016 through 2018 includes specific scope contingency of [redacted] for potential replacement of an additional 2 coils in D1831 as well as general contingency commensurate with risk of scope growth proportionate to the remaining coils on a unit for a total contingency of [redacted] through remaining project life.
Refer to table in Part B of this BCS.

Approvals

	Signature	Comments	Date
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Brian Duncan SVP Darlington	Brian Duncan	None	Sept 8/2016
I concur with the business decision as documented in this BCS.			
Finance Approval: Carla Carmichael VP, Nuclear Finance per OPG-STD-0076	C Carmichael	-	Sept 19/16
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Glenn Jager President OPG Nuclear, and Chief Nuclear Officer per OAR 1.1	Glenn Jager		20 Sept 2016

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Records File Information:
Records SCI/USI Retention
- See Guidance Section

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Type 3 Business Case Summary

Project #: Project # 82816
Document #: D-BCS-73720-10001-R001
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

Business Case Summary

Part A: Business Need

Vault cooling coils provide cooling to the reactor vault under operating conditions. Under Loss of Coolant Accident (LOCA) conditions they remove heat from the steam ladened atmosphere and maintain vault negative air pressures. Vault Evnrivonmental Qualified (EQ) equipment in the vault is also protected from elevated temperature thermal degradation. They are Nuclear Class 3 Components.

There is a total of 64 coils across the station (4 units x 4 Air Cooling Units [ACU]/unit x 4 coils/ACU). The coil material is 5/8"OD x 0.049 wall ASME SB-75 UNS C12200 tubes with 0.009" thick ASTM B-152 UNS C11000 fins. The Design life is 25 years. A component condition assessment at 15 years inservice (2006) indicated a maximum wall loss of ~ 27% at the coil u-bend due to flow erosion corrosion. An additional assessment performed in 2013 recorded a measured wall loss of ~ 42% at the coil u-bend with a maximum of 52%. Coil replacement was planned in nuclear refurbishment (DSR-TS0280-1), and is an IIP committment. There are known interferences such that selected coils would need a split coil design for replacement if it occurred before refurbishment.

Darlington has experienced vault cooling coil leaks. The failure mechanism are attributed to errosion corrosion and pitting corrosion. Heat transfer capability has also decreased due to coil fouling from zebra mussels, silt and other debris . Early in 2016 there was 9 leaking coils across the station: Unit 1 (2 coils), Unit 2 (2 coils), Unit 3 (2 coils) and Unit 4 (3 coils). As coils are found to be leaking they are valved out of service. As coils are valved out of service vault temperatures increase.

Vault cooling coils form part of the Negative Pressure Containment System (NPCS). System normal operation and impairments are:

- Design Vault temperature: 37.8 °C
- Level 3 Impairment: Alarm set-point 55.0 °C
- Level 2 Impairment: Shut down limit 61.0 °C

Placing leaking vault coolers back in service to control vault temperatures, introduces normal water into the vault atmosphere and downgrades heavy water vapour recovery. The Tritium Removal Facility (TRF) Upgrader/ Heavy Water Management (HWM) capacity can be challenged by the downgraded inventory received by the vapour recovery system and the Primary Heat Transport (PHT) D_2O recovery trench. Operating long term with vault leaks increases upgrader operating costs. Coil replacements address this risk, and increase margins on EQ equipment thermal degradation.

Delay in addressing vault cooling coil leaks is a significant risk to Darlington operations.

Part B: Preferred Alternative: Replace Selected Vault Cooling Coils ahead of Refurbishment

Description of Preferred Alternative

Replace only coils with leak(s) and coils with significant degradation in available planned outage(s) leading into each unit's refurbishment outage. Remaining coils will be replaced during the refurbishment outage under DSR-TS028-1.

A two piece replacement coil is required for selected installations as accessibility issues are known.

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

Type 3 Business Case Summary

Project #: Project # 82816 Document #: D-BCS-73720-10001-R001
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

Part B: Preferred Alternative: Replace Selected Vault Cooling Coils ahead of Refurbishment

Description of Preferred Alternative

This strategy will mitigate the risk of:

- Unplanned outages associated with high vault temperatures (NPCS Impairment)
- Accelerated EQ equipment aging due to elevated vault temperatures
- Challenging TRF Upgrader operations and costs
- Extensions to planned outages to complete all vault cooler work which is currently planned in refurbishment.

This project is not in the current Operations Business Plan. Partial scope is being advanced from Refurbishment scope to mitigate existing operational risks. Replacement coils have been procured for inventory, and 19 coils have been replaced to date. Material and installation costs are well known.

The project scope from the previous revision of the BCS is the following:

Scope (Forecast Coils Replaced)	2015 D1512, D1511 D1521, D1531 D1541	2016 D1641	2017 D1711	2018 D1831	2019 D1941	2020 D2011	Total
Planned	12	6	4	2	6	4	34
Contingent[1]		2		2	2		6
Total	12	8	4	4	8	4	40

The proposed project scope for the current revision of the BCS is the following:

Scope (Forecast Coils Replaced)	2015 D1512, D1511 D1521, D1531 D1541	2016 D1641 D1632	2017 D1711	2018 D1831	2019 D1941	2020 D2011	Total
Planned	12	7+4	8	2	6	0	37
Contingent[1]				2	2		6
Total	12	11	8	4	8	0	43

1) Specific contingency applied to account for the contingent scope. Contingent scope impact on critical path would be assessed for D1941.

Deliverables:	Associated Milestones (if any):	Target Date:
Replace 6 coils in D1512 (complete)		30 June 2015
Replace high risk coils in D1611, D1521, D1531 & D1541	AFS	20 Dec 2015
Replace high risk coils in D1641	AFS	29 July 2016
Refine future scope for 2017 to 2018 outages	This BCS	15 Sept 2016
Refine future scope for 2019 to 2020 outages	Future Release BCS	15 Sept 2018

Part C: Other Alternatives

Alternative 2: Base Case – No Project

Without action, vault temperatures may not be maintained within the operating margins for NPCS and degradation

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Type 3 Business Case Summary

Project #: Project # 82816 Document #: D-BCS-73720-10001-R001
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Alternative 2: Base Case – No Project

of EQ equipment will be accelerated due to elevated temperatures. An unplanned outage is likely. Placing leaking coils back in service carries significant risk of exceeding TRF Upgrader capability and potential impacting the VBO HWM strategy, and future upgrader operating costs.

Alternative 3: Do More – Replace All Coils in Units 1 & 4 and Half Coils in Unit 3

Given the long duration of operation of Unit 1 and Unit 4 to their respective refurbishment outages and the uncertain rate of coil degradation, plan to replace all the coils in these units. Half the coils in Unit 3 to ensure sufficient operating margin remains to refurbishment.

Alternative 4: Plug Leaking Coils

Plugging the tubes and then placing the coil back in increases cooler capacity but decreases cooler efficiency and may not provide sufficient margin on NPCS and EQ. Plugging does not reduce the probability of future leaks on that coil and is therefore not an effective mitigation on its own. Not all leak locations are repairable due to accessibility within the coil. This alternative is not recommend, although may be used as a bridging strategy to eventual replacement.

Alternative 5:

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

k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	4552	5109	2276						11,936
Requested Now	-		1470	2347					3,817
Future Required	-				3000				3,000
Total Project Cost	4552	5109	3745	2347	3000				18,753
Ongoing Costs	-								
Grand Total	4552	5109	3745	2347	3000				18,753

Estimate Class:	Class 3	Estimate at Completion:	[redacted]
NPV:		OAR Approval Amount:	$18,753k

Additional Information on Project Cash Flows (optional):

The Requested Now amount of $3,817k incorporates cost experience from the successful installation of 19 coils to date. Cash flows for the remainder of 2016 through 2018 includes specific scope contingency of [redacted] for potential replacement of an additional 2 coils in D1831 as well as general contingency commensurate with risk of scope growth proportionate to the remaining coils on a unit for a total contingency of [redacted] through remaining project life.
Refer to table in Part B of this BCS.

Part E: Financial Evaluation

k$	Preferred Alternative	Base Case	Do More	Plug	
Project Cost	18,753	N/A	N/A	N/A	
NPV					
Other (e.g., IRR)					

Summary of Financial Model Key Assumptions or Key Findings:

Part F: Qualitative Factors

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Type 3 Business Case Summary

Project #: Project # 82816 Document #: D-BCS-73720-10001-R001
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

Part F: Qualitative Factors

As the rate of degradation is not fully understood advancing needed coil replacements would eliminate risk of;

- challenging TRF upgrader capacity which could impact VBO and Refurbishment strategies
- pushes to planned outages to complete all vault cooler work which is currently scoped in refurbishment
- uncertainty associated with patching and/or plugging leaking coils as bridging only should coil fail in a different location or the repair fail prior to refurbishment

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that cost could increase due to the need for emergent coil replacement and/or physical accessibility challenge the replacement.	Specific contingency allotted for emergent coil replacement where anticipated and additional general contingency proportionate to the remaining coils on a given unit for a total of [redacted] contingency dollars for the remaining scope of the project. A two piece coil is being pursued where accessibility issues are known.	Medium	Low
Scope	There is a risk that scope could increase due to the need for emergent coil replacement.	Target leaking coils in upcoming outages. Include contingency for emergent replacement. Remaining scope to be completed under Refurbishment scope.	Medium	Low
Schedule	Target coil replacements exceeds planned outage duration	Target leaking coils and at most risk coils. Additional replacements under subsequent planned outages or during refurbishment outage.	Medium	Low
Resources	There is a risk that resources may not be available to execute the required scope planned for a given outage.	Work will be contracted.	Low	Low
Quality/ Performance	2 piece coil gasket life may lead to periodic replacement	Selection of gasket material to optimize service life.	Low	Medium
Technical	Risk of unknown interference or accessibility issues arising during coil replacement.	A two piece coil is being pursued where accessibility issues are known. Repair and/or plugging could be used if the option permitted.	Medium	Low

Additional Risk Analysis:

Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Simplified PIR	July 2020	Dec 2020

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Coil Leakage	Many coils have significant leaks requiring isolation	Replaced coils have zero leaks and are valved in for service	Visual inspection following replacement and flows established.	Maintenance
Coil Isolation	Leaking coils valved in	No leaking coils	Visual inspection	Maintenance

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Project #: Project # 82816
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
	to control vault temperatures	required to be in-service to control vault temperature	following replacement and flows established.	
Negative Pressure Containment System Impairment	Vault temperature approaching alarm set point of 55°C (Level 3 impairment). Summer vault temperature is expected to reach shut-down limit of 61°C (level 2 impairment)	Margin exists on Level 3 impairment of NPCS	Operations monitoring	Operations
Leakage to containment	Challenging TRF Upgrader capacity Increased upgrader costs	Leakage well within upgrader capacity with sufficient margin to accommodate planned outages	Collection & input to upgrader	TRF Technical

Part I: Definitions and Acronyms
NPCS – Negative Pressure Containment System
VBO – Vacuum Building Outage
TRF – Tritium Removal Facility
EQ – Environmental Qualification
HWMB – Heavy Water Management Building

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Type 3 Business Case Summary

Project #: Project # 82816
Document #: D-BCS-73720-10001-R001
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

For Internal Project Cost Control

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Type 3 Business Case Summary

Project #: Project # 82816
Document #: D-BCS-73720-10001-R001
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

Appendix A: Summary of Estimate									
Project Number:	Project # 82816								
Project Title:	DN Vault Cooling Coil Replacement								
k$	LTD	2016	2017	2018	2019	2020	Future	Total	%
OPG Project Management	31	30	22	6	18			106	1%
OPG Engineering (including Design)	119	75	56	14	44			308	2%
OPG Procured Materials	1,068	1168	936	216	601			3,989	28%
OPG Other	250							250	2%
Design Contract(s)	[redacted]								
Construction Contract(s)									
EPC Contract(s)									
Consultants									
Other Contracts/Costs									
Interest									
Subtotal									
Contingency									
Total	4,552	5,109	3,745	2,347	3,000			18,753	

Notes			
Project Start Date	June 2015	Total Definition cost (excludes unspent contingency for Nuclear)	0
Target In-Service (or AFS) Date	Jul 2020	Contingency Included in this BCS (Nuclear only)	[redacted]
Target Completion Date	Jul 2020	Total contingency released plus contingency in this BCS (Nuclear only)	
Escalation Rate	3%	Total released plus this BCS without contingency (Nuclear only)	
Interest Rate	5%	Total released plus this BCS with contingency (Nuclear only)	$15,753k
Removal Costs	$2,967k	Estimate at Completion (includes only spent contingency for Nuclear)	[redacted]

Prepared by:		Approved by:	
Eric Kool Performance Engineering	Date 2016-07-25	Dave Burger Manager, Performance Engineering	Date 2016-07-25

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Type 3 Business Case Summary

Project #: Project # 82816
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release
Document #: D-BCS-73720-10001-R001

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

Comparison of Total Project Estimates

Phase	Release	Approval Date	Total Project Estimate in k$ (by year including contingency)						Future	Total Project Estimate
			2015	2016	2017	2018	2019	2020		
Execution	Partial	Nov 2015	7000	4935	2810	2719	5573	3284		26,322
Execution	Partial	Aug 2016	4552	5109	3745	2347	3000			18,753

Project Variance Analysis

k$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management		805	106	-699	Efficiencies gained in execution requires less operations and contract support.
OPG Engineering (Including Design)		401	308	-93	Less effort for subsequent design packages realized.
OPG Procured Materials		4871	3989	-882	Actual cost of split coils approx $47k lower than initial quotation, offset slightly by $3k higher actual cost of standard coil. New scope includes 3 additional coils.
OPG Other		250	250	0	
Design Contract(s)	[redacted]				
Construction Contract(s)					
EPC Contract(s)					
Consultants					
Other Contracts/Costs					
Interest					
Subtotal					
Contingency					
Total		26322	18753	-7569	

Type 3 Business Case Summary

Project #: Project # 82816 Document #: D-BCS-73720-10001-R001
Project Title: DN Vault Cooling Coil Replacement, <Partial> <Execution> Release

Appendix C: Financial Evaluation Assumptions
Key assumptions used in the financial model of the Project are (complete relevant assumptions only):
N/A

Appendix D: References
NK38-REP-73720-100005-R002
NK38-REP-73720-0473755
NK38-REP-73720-0485570

Appendix E: Photo - Leaking Coil at U-bend

Board Staff Interrogatory #41

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 33

This BCS relates to the Darlington Primary Heat Transport (PHT) Pump Motor Replacement/Overhaul project. The BCS states that the alternative of buying new PHT pump motors is not recommended based on higher cost and duration. The BCS also states that this alternative would be re-evaluated if overhaul motor cost reaches $5M per motor. The BCS further states that operational experience shows that PHT pump motors manufactured by the same Original Equipment Manufacturer have similar problems at U.S stations and that another Canadian CANDU operator is also refurbishing their PHT pump motors.

a) Based on the project schedule information in the BCS, overhaul costs for one or, possibly two PHT pump motors should be available in the meantime.
Please confirm whether this information is available and, if so, does OPG still plan to proceed with the preferred alternative of overhauling all PHT pump motors?

b) Has OPG conducted any benchmarking cost comparisons with other nuclear utilities that have undertaken similar PHT pump motor refurbishment and replacement projects? If yes, how do OPG project costs for PHT pump motor refurbishment and replacement compare to these external projects?

Response

a) The actual cost for a fully refurbished PHT pump motor is not available at this time.
In order to accelerate the replacement program as a result of losses sustained due to a PHT Pump Motor failure in 2015, OPG decided in May 2016 (See Attachment 1 which has confidential content as marked) to purchase four new motors and reduce the number of motors to be refurbished accordingly.

b) OPG has reviewed the motor replacement strategies with other utilities. OPG has also engaged industry motor experts to assist with the evaluation and review of both refurbished and new PHT motors.

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Type 3 Business Case Summary

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

Executive Summary and Recommendations

Project Information			
Project #:	10-73566, 16-80144, 16-36001	**Document #:**	D-BCS-33130-10005 R000
Project Title:	DN PHT Pump Motor Replacement, Overhaul and Capital Spares		
Class:	☐ OM&A ☒ Capital ☒ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	**Investment Type:**	Sustaining
Phase:	Execution	**Release:**	Partial
Facility:	Darlington	**Target In-Service or Completion Date:**	Dec 2019

Project Overview

We recommend the release of an additional $32.2M, including [redacted] of contingency. Including this release the total to date released is $116.0M including [redacted] contingency.

The estimated total project cost is $ 151.8M including [redacted] of contingency.

The class of estimate for this release is Class 3. The class of estimate for the entire project is Class 3.

Darlington Primary Heat Transport (PHT) pump motors have experienced in-service degradation. Ozone is present in the motors and indicates partial discharge, which is a precursor of stator winding shorts to ground. Failure of a rotor retaining ring in an in-service motor in December 2015 (D1341) has identified an additional degradation mechanism. The current condition of the motors is identified as High Risk in the Enterprise Risk Management system. Retirement of this risk requires replacement or refurbishment of all original operational motors and spares.

Recognition of the additional failure mode (retaining ring failure) has changed the strategy for replacement/refurbishment from the previous release. The purchase of four (4) additional new motors is recommended in this release, and the replacement/refurbishment schedule has been accelerated. Project completion is advanced from June 2022 in the previous release to December 2019.

Overall Project Scope

Objective of the this Project is to provide nineteen (19) new or refurbished PHT Pump motors to replace all sixteen (16) operating PHT Pump Motors and provide three (3) permanent spares all with a 30 year design life. It is expected that four (4) existing in-service motors will not be refurbished upon removal. No assumption on salvage value of these four (4) motors has been made in this release.

Scope completed under previous releases:

- Purchase four (4) new motors under project 36001.
- Install and commission four (4) new motors in D1512, D1513 and D1531 under project 73566.
- Ship for refurbishment three (3) motors under project 80144.

This Release:

- Procure an additional four (4) new motors under project 73566 (Total is now 8 new motors).
- Ship eight (8) motors out for refurbishment under project 80144.
- Refurbishment of five (5) motors under project 80144.
- Install two (2) motors during D1711 under project 73566.
- Remove six (6) motors from units under project 73566.

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Type 3 Business Case Summary

Project #: 36001/73566/80144
Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Project Overview

- Refurbish on site old spare (PM17) under project 73566.
- Procure new PHT pump motor trailer under project 80144.

Future Release:

- Refurbishment of six (6) motors under project 80144.
- Ship two (2) motors out for refurbishment under project 80144
- Install ten (10) motors in units under project 73566.
- Remove six (6) motors from units under project 73566

A Full Release BCS to complete total project scope is scheduled for November 2017.

History of scope and schedule changes:

The total project cost has decreased from $160.3M to $151.8M as a result of:

- Procurement of four (4) new motors has been added (73566).
- Replacement of motors increased (73566)
- Overhaul reduced to eleven (11) motors from seventeen (17) (80144)

Schedule has been expedited to complete all replacements by end of 2019 instead of 2022.

The Target In-Service dates are as follows:

Four (4) motors installed and in service in 2015. COMPLETE

Two (2) motors to be installed in D1711.

Two (2) motors to be installed in D1831.

Four (4) motors to be installed in DNRU2 (2018)

Four (4) motors to be installed in D1941.

Key Assumptions and Risks:

Current assumptions are:

- One (1) motor can be overhauled within 8 months.
- Vendor can support refurbishment of two (2) motors in parallel in 2016 and three (3) in parallel in 2017 and beyond.
- Due to discovery issues during condition assessment for any motor it may be realized the motor is not recoverable or refurbishment costs escalate to a point where a new motor is more viable and cost effective.
- Initial first two new motors can be delivered within 11 months of Purchase Order issuance.

Contingency plan is in place in the event any motors do not meet their delivery milestone and the effect on downstream motor replacements and available spares.

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Type 3 Business Case Summary

Project #: 36001/73566/80144
Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Project Cash Flows, NPV, and OAR Approval Amount									
M$	LTD	2016	2017	2018	2019				Total
Currently Released	39.3	14.3	31						84.6
Requested Now		17.9	10.6	3.7					32.2
Future Required				20.0	15.0				35.0
Total Project Cost	39.3	32.2	41.6	23.7	15				151.8
Ongoing Costs									
Grand Total	39.3	32.2	41.6	23.7	15				151.8

Estimate Class:	Class 3	**Estimate at Completion:**	[redacted]
NPV:		**OAR Approval Amount:**	$151.8M

Additional Information on Project Cash Flows (optional):
NPV is not required for a cost benefit as this is a sustaining project.

Approvals			
	Signature	**Comments**	**Date**
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Glenn Jager Chief Nuclear Officer			4 MAY 2016
I concur with the business decision as documented in this BCS.			
Finance Approval: Ken Hartwick Chief Financial Officer per OPG-STD-0076			May 11, 2016
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Jeff Lyash President & CEO per OAR 1.1			May 12/16

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Type 3 Business Case Summary

Project #: 36001/73566/80144
Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Business Case Summary

Part A: Business Need

There are sixteen (16) operating Primary Heat Transport (PHT) pump motors operating on DNGS site – four (4) per unit. Additionally, there is one (1) spare motor (PM17). PHT pump motors are 100% duty with no installed redundancy. Failure of any one of the operating motors will result in an unplanned outage and could result in an extended outage depending on availability of spare motors.

Four (4) new PHT motors have been installed: one in D1512 (unplanned outage as a result of 1-33130-PM3 deteriorating condition), one in D1513 (forced outage caused by retaining ring failure in 1-33130-PM1) and two in D1531 (planned outage).

The current condition assessments of old PHT pump motors all identify medium, high, or very high risk and are expected to have an increasing probability of failure until replaced by new or refurbished motors. There are indications of winding deterioration in the PHT pump motors. The presence of ozone is a sign of partial discharge in the stator windings and/or electrical connections. Partial discharge is the precursor of a short to ground for the stator windings. If the motor fails due to short to ground, the motor will more than likely be unrecoverable. The extent of condition, i.e. the risk to the motors associated with high ozone levels and the deterioration rate will not be fully understood until detailed Condition Assessment and subsequent testing of the first motor being refurbished is complete. Failure of the retaining ring in one of the old motors in December 2015 (D1513) has introduced a new significant risk of retaining ring failure due to stress corrosion in any of the old motors operating on site.

Based on documented operational experience, the expected service life for a motor of this size is 25 to 30 years There is operational experience showing motors manufactured by the same Original Equipment Manufacturer (OEM) have similar problems at other U.S. stations. The failure rate is one per 24 years and deteriorating, based on a study for the U.S. Nuclear Regulatory Commission "Aging Assessment of Large Electric Motors in Nuclear Power Plants (NUREG/CR-6336). With this deteriorating failure rate, the existing motors cannot be expected to run reliably without being replaced with new or fully refurbished. Currently, another Canadian CANDU operator is refurbishing their motors.

The business risk arising from the current condition of the pump motors is documented in the Enterprise Risk Management system as "High". Retirement of the risk requires the replacement of all operational motors. OPG's strategic decision to manage this risk and restore system capability is a combination strategy of refurbishment and procurement of new PHT pump motors to replace the existing operating motors and provide permanent spare motors.

The failure of the retaining ring in 1-33130-PM1 in December 2015 identified a new significant risk. In response, OPG has expedited the schedule for replacement of all PHT Pump motors to be complete by end of 2019. Currently, the credited spares available are a used PHT pump motor removed from Unit 3 and old spare PM17 which is being partially overhauled on site to return it to a running condition. To mitigate this risk four (4) new PHT motors are immediately being procured in parallel with two (2) motors being refurbished. This will ensure that four (4) new or refurbished motors are on site on or around the end of 2016 to support replacement of two (2) PHT pump motors in D1711 and provide two (2) new or refurbished viable spares.

Part B: Preferred Alternative: Overhaul of PHT Pump Motors combined with purchase of new

Description of Preferred Alternative

OPG has put into place a combination strategy of refurbishment and purchase of new PHT pump motors to meet the accelerated replacement schedule while maintaining a minimum number of viable spares at any one time. To support this strategy procurement of four (4) additional new motors from the Original Equipment Manufacturer (OEM) is required.

Procurement of four (4) new motors from OEM will ensure viable spares are available at any time, while refurbishment of remaining eleven (11) motors progresses. This aligns with stakeholder strategy to keep three (3) spares available at any time. This also reduces unreasonable schedule pressure on the refurbishment vendor with regards to refurbishment duration and shop capacity.

Replacement of existing PHT motors will be completed in all units by end of 2019. Risk is to be further reduced by completing the replacement/refurbishment of the identified highest priority motors by end of 2018.

The preferred alternative is recommended against other alternatives due to cost and duration.

Pros:

- The motors need to be overhauled in order to extend their life expectancy for another 30 years. Similar motors were overhauled at power plants in Canada and US with good results.

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

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Part B: Preferred Alternative: Overhaul of PHT Pump Motors combined with purchase of new

Description of Preferred Alternative

- Immediate procurement of four (4) additional new PHT motors (total 8 new) will provide required new and refurbished spares in shortest time frame to mitigate current condition of only having old used spares available, and is required to support the accelerated schedule.

Cons:

- Overhaul cost is estimated based on a base scope of work as described in the technical specification. Each motor situation is different and the overhaul cost for each motor could increase based on the results of each motor inspection at the overhaul company. Inspection report for each motor will be reviewed and accepted by OPG and could result in increase of base scope of work as originally estimated.
- This could create issues with regards to operating and maintaining motors of a slightly different design. The new and overhauled motors are from the same OEM and there are differences with regards to the type of bearing and some other parts used.
- Staged release supports re-assessment/measure of costs associated with motor refurbishment.

Deliverables:	Associated Milestones (if any):	Target Date:
Ship three (3) used PHT pump motors for overhaul (batch # 1)	N/A	Complete
Issue PO to purchase four (4) new PHT pump motors.	Major Contract PO Issued	Apr 2016
Receive three (3) overhaul motors from vendor. (batch # 1)	N/A	Nov 2016
Ship two (2) used PHT pump motors for overhaul (batch # 2).	N/A	Oct 2016
Receive four (4) new PHT motors	LLM received	Dec 2016 to Jun 2017
Ship three (3) used PHT pump motors for overhaul (batch # 3).	N/A	Jun 2017
Receive two (2) overhaul motors from vendor. (batch # 2)	N/A	Jul 2017
Ship three (3) used PHT pump motors for overhaul (batch # 4) **(Future BCS)**	N/A	Oct 2018
Receive four (4) overhaul motors (batch # 3 & 4) from vendor. **(Future BCS)**	N/A	Sep 2018
Receive two (2) overhaul motors (batch #4) from vendor. **(Future BCS)**	N/A	Apr 2019

Part C: Other Alternatives

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

Alternative 1: Base Case – Do Nothing

This is not recommended. Motor replacement is required based on Partial discharge and ozone indications. The business risk is documented under Enterprise Risk management (ERM) risk # ER19731 - DN - Darlington Primary Heat Transport Pump Motor Failures Impacting Station Operations'

Alternative 2: Buying New Motors

Buying fifteen (15) new PHT pump motors is not cost effective. New vs refurbishment is about twice as expensive

Alternative 3: Refurbishment of all Motors

Refurbishment of all fifteen (15) motors will result in extension of schedule past 2019 and also impact availability of spares when required in units. OPG has put into place a combination strategy of refurbishment and purchase of new PHT pump

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Alternative 3: Refurbishment of all Motors

motors that both meets the replacement schedule while maintaining a minimum number of viable spares at any one time.

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

M$	LTD	2016	2017	2018	2019				Total
Currently Released	39.3	14.3	31						84.6
Requested Now		17.9	10.6	3.7					32.2
Future Required				20	15				35
Total Project Cost	39.3	32.2	41.6	23.7	15.0				151.8
Contingency									
Grand Total	39.3	32.2	41.6	23.7	15				151.8

Estimate Class:	Class 3	**Estimate at Completion:**	[redacted]
NPV:		**OAR Approval Amount:**	$151.8M

Additional Information on Project Cash Flows (optional):

NPV calculations are not applicable.

Part E: Financial Evaluation

M$	Preferred Alternative	Base Case	Delay Work	Alternative 4	Alternative 5
Project Cost	151.8				
NPV	NA				
Other (e.g., IRR)					

Summary of Financial Model Key Assumptions or Key Findings:

NPV is not required for a sustaining project.

Part F: Qualitative Factors

Project is to address a station risk which will demonstrate to the public that OPG is managing risk to support the long term viability of DNGS.

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that the cost of refurbishment will increase based of inspection of each motor and additional repairs not included in our technical specification. Cost increase could vary between motors. Transportation cost exceeded estimate during first motor trip between OPG and Vendor. Cost for procurement of new motors could increase.	Mitigation: Review with overhaul vendor results of the incoming inspection for each motor to determine required repairs/design changes that are optional work as per our technical specification. OPG is to concur with the replacement recommendations, if any. If the cost for overhaul exceeds New motors to be purchased are identical with the last four (4) purchased under project # 16-36001 and negotiations process with vendor to ensure no cost increase.	High	Medium

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Project #: 36001/73566/80144 Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
Scope	Possibility of discovery issues, not anticipated, during the assessments.	Mitigation: Review condition assessment report for each motor to determine if replacements are required for major motor parts part of the optional work. Consider value for the money for refurbishment vs new motors.	High	Medium
Schedule	There is a risk that the overhauled motors will not be ready in time for the planned sequence of PHT motor swaps due to schedule push due to discovery work.	Mitigate. Contingency money to be included. Contract includes financial penalties if 8 months overhaul window for each motor is exceeded.	High	Medium
Resources	There is a risk that the overhaul supplier shop floor may not be able to support an increased volume of motor overhauls to ensure motor availability for the scope. There is a risk that the supplier Design and Analysis department does not have good capability to reverse engineering capabilities and seek third party expertise as they have no previous experience in overhaul of similar size motors. There is a risk that vendor has no capabilities in the decontamination of these motors.	Mitigate: Contingency money to be included to support additional new motors purchase to ensure motor overhaul and replacement schedules are met. Mitigate: Vendor to be monitored to ensure it has all required resources in place to overhaul these motors on time and provide required technical support during motors operation. Mitigate: Vendor facility to be monitored to ensure selected vendor has decontamination capabilities and experience. OPG to clean motors and ship as UTP.	High	Medium
Quality/ Performance	There is a risk that the quality of the overhaul will result in reduced efficiency of the motor as opposed to the OEM efficiency of 96.90% and have a financial impact.	Mitigate: Review proposed overhaul process to ensure efficiency of the motor requirement is met. OPG to take design responsibility and prepare a process to approve vendor documentation.	High	Medium
Technical	There is a risk that some parts are obsolete and replacement may require design modifications. This will increase the overhaul cost for each motor. There is a risk of old motors failure in unit due to PD damage, retaining ring failure, etc.	Mitigate: Use like-for-like replacements as much as possible to reduce reverse engineering or design modifications on each motor. Procure at least four new motors to have available spares and reduce the risk of not having spares available due to delays in overhaul or motor failure.	High	Medium

Additional Risk Analysis:

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Part H: Post Implementation Review (PIR) Plan

Type of PIR Report	Target In-Service or Completion Date	Target PIR Completion Date
Comprehensive PIR	DEC - 2019	DEC - 2020

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Motor condition presents high risk to operations	Of 16 motors; 2 have been identified as having a very high risk of failure, 7 at high risk, and 6 motors at medium risk.	All 16 motors have low risk of failure	Partial discharge monitoring and ozone testing	Components Engineering
Motor efficiency	The existing motor design efficiency is 96.90%	The existing motor design efficiency is 96.90%	Acceptance testing	Components Engineering

Part I: Definitions and Acronyms

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For Internal Project Cost Control

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Appendix A: Summary of Estimate										
Project Number:	10-73566									
Project Title:	DN PHT Pump Motor Replacement, Overhaul and Capital Spares									
M$	**LTD**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Future**	**Total**	**%**
OPG Project Management	0.6	0.1	0.3	0.2	0.4				1.6	3
OPG Engineering (including Design)	0.4	0.1	0.1	0.1	0.1				0.8	1
OPG Procured Materials	0.3	0.1	0.1	0.2	0.1				0.8	1
OPG Procured Materials (New Motors)	0	12.9	17.1	0	0				30	45
OPG Travel	[redacted]									1
OEM technical Support										1
OPG Other (Field Engineering, CMO, PCC)										5
OPG Control Maintenance										5
OPG Rad Protection										5
Replacement Contract/Cost										34
Interest										9
Subtotal										100
Contingency										
Total	**8.9**	**18.4**	**28.6**	**7.7**	**7.1**				**72.7**	

Type 3 Business Case Summary

Project #: 36001/73566/80144
Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Appendix A: Summary of Estimate										
Project Number:	16-80144									
Project Title:	DN PHT Pump Motor Replacement, Overhaul and Capital Spares									
M$	**LTD**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Future**	**Total**	**%**
OPG Project Management	0	0.4	0.2	0.2	0.2				1	2.5
OPG Engineering (including Design)	0	0.1	0.1	0.1	0.1				0.4	1
OPG Travel Expenses	0	0.1	0.1	0.1	0.1				0.4	1
OPG Other (Field Engineering, CMO, PCC)	0	0.1	0.1	0.1	0.1				0.4	1
OPG Rad Protection	0	0.1	0.1	0.1	0.1				0.4	1
Overhaul Contract	[redacted]									79
Trailer Cost										0.5
Consultants										4
Shipment Preparation Contract										6
Interest										4
Subtotal										**100**
Contingency										
Total	1.4	12.8	13.5	16.0	7.6				51.3	

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Type 3 Business Case Summary

Project #: 36001/73566/80144
Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Appendix A: Summary of Estimate										
Project Number:	16-36001									
Project Title:	DN PHT Pump Motor Capital Spares									
M$	**LTD**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Future**	**Total**	**%**
OPG Procured Materials	28.9	0	0	0	0				28.9	100
Subtotal	**28.9**	**0**	**0**	**0**	**0**				**28.9**	100
Contingency										
Total	**28.9**	**0**	**0**	**0**	**0**				**28.9**	

Notes			
Project Start Date	JUN-2013	**Total Definition cost** (excludes unspent contingency for Nuclear)	[redacted]
Target In-Service (or AFS) Date	JUN-2019	**Contingency included in this BCS** (Nuclear only)	
Target Completion Date	DEC-2019	**Total contingency released plus contingency in this BCS** (Nuclear only)	
Escalation Rate	2.0%	**Total released plus this BCS without contingency** (Nuclear only)	
Interest Rate	5.0%	**Total released plus this BCS with contingency** (Nuclear only)	$151.7M
Removal Costs		**Estimate at Completion** (includes only spent contingency for Nuclear)	[redacted]

Prepared by:		Approved by:	
Simion Deju Project Manager Projects and Modifications	Date 2016-04-04	Mike Name Section Manager Projects and Modifications	Date 2016-04-04

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Type 3 Business Case Summary

Project #: 36001/73566/80144
Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

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

Comparison of Total Project Estimates

Phase	Release	Approval Date	Total Project Estimate in M$ (by year including contingency)						Future	Total Project Estimate
			LTD	2016	2017	2018	2019	2020		
Execution*	Partial	MAY 2015	41.0	12.6	31.0	15.0	12	14	34.7	160.3
Execution	Partial	Q1 2016	39.3	32.2	41.6	23.7	15.0			151.8
*Composed of two releases:										
36001	30.8	2013-05-31								
73566/80144	129.5	2015-07-15								
	160.3									

Project Variance Analysis - 36001

M$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management					
OPG Engineering (including Design)					
OPG Other (Field Engineering, CMO, PCC)					
Procurement of New Motors	28.9	30.8		-1.9	All motors have been procured. Variance is due to final costs being lower than originally estimated.
OPG Travel					
OEM Technical Support					
Interest					
Subtotal	28.9	30.8		-1.9	
Contingency					
Total	28.9	30.8		-1.9	

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Type 3 Business Case Summary

Project #: 36001/73566/80144
Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Project Variance Analysis - 73566					
M$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	0.6	3.1	1.6	-1.5	Shorter duration of project results in lower project management costs
OPG Engineering (including Design)	0.4	1.1	0.8	-0.3	Shorter duration of project results in lower engineering costs
OPG Procured Materials	0.3	1.1	0.8	-0.3	Shorter duration of project results in lower procured materials costs
OPG Procured Materials (New Motors)	0.0	0.0	30.0	30.0	Increase due to procurement of four (4) new motors.
OPG Travel	0.0	0.0	0.6	+0.6	Increase due to procurement of new motors.
OEM Technical Support	[redacted]				
OPG Other (Field Engineering, CMO, PCC)					
OPG Control Maintenance					
Replacement Contract(s)					
Trailer Cost					
OPG RAD Protection Costs					
Interest					
Subtotal					
Contingency					
Total	8.9	26.7	72.7	+46.0	

Type 3 Business Case Summary

Project #: 36001/73566/80144 Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Project Variance Analysis - 80144					
M$	LTD	Total Project		Variance	Comments
		Last BCS	This BCS		
OPG Project Management	0.0	1.7	1	-0.7	Reduction of scope to eleven (11) motors.
OPG Engineering (including Design)	0.0	1.1	0.4	-0.7	Reduction of scope to eleven (11) motors.
OPG Procured Materials	0.0	1.1	0.0	-1.1	
OPG Travel Expenses	0.0	0.0	0.4	+0.4	Added for OPG visits to refurbishment facility.
OPG RAD Protection	0.0	0.0	0.4	+0.4	Increase due to extensive surveys required before shipping out motors for refurbishment.
Shipment Preparation Contract	0.0	0.0	2.5	+2.5	Increase due to extensive surveys required (shroud removal and decontamination) before shipping out motors for refurbishment.
OPG Other (Field Engineering, CMO, PCC)	0.0	2.8	0.4	-2.4	Reduction of scope to eleven (11) motors.
Overhaul Contract	[redacted]				
Consultant (Third Party Oversight)					
Trailer Contract					
Interest					
Subtotal					
Contingency					
Total		102.8	51.3	-51.5	

Type 3 Business Case Summary

Project #: 36001/73566/80144
Document #: D-BCS-33130-10005 R000
Project Title: DN PHT Pump Motor Replacement, Overhaul and Capital Spares, <Partial> <Execution> Release

Appendix C: Financial Evaluation Assumptions
Key assumptions used in the financial model of the Project are (complete relevant assumptions only):
Project Cost: 1. Cost of a new motor is $7.7M CAD and two motors are to be delivered within 11 months. Motors to be identical with the last four motors delivered to OPG in 2015. 2. Overhaul cost is estimated at as $2.2M per motor. 3. Transportation cost is estimated from $160,000 (in 2015) to $195,000 (in 2019) per trip.

Appendix D: References

Board Staff Interrogatory #42

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 35
This BCS is for the Fukushima Phase II Beyond Design Basis Event Emergency Mitigation Equipment project. The total project capital ($46.3M) and Minor Fixed Assets (MFA) ($13.8M) costs attributed to Pickering (6 operating units) appear to be proportionally much higher than those attributed to Darlington ($28M capital and $2.1M MFA).

Please explain what the main factors are that contribute to these cost differences.

Response

The main factors contributing to the capital cost differences between Pickering and Darlington station include:

1) Greater number of unit specific installations at Pickering (six units) compared to at Darlington (four units).

2) Station design differences that contribute to the following additional scope at Pickering:
   a) Two additional sets of switchgear in each of Pickering Units 1 and 4, with extensive underground cable runs.
   b) Cabling and switchgear for repowering the Vacuum Building Main Volume Vacuum Pumps, which is only required at Pickering.
   c) Extensive seismically qualified cable runs to repower Reactor Building Hydrogen Igniters, which is only required at Pickering.
   d) Installation of 59 seismic racks at Pickering for storage of emergency air bottles, plus the cost of the air bottles to maintain airlock seal integrity. The Darlington airlock design permits use of portable diesel compressors and air lines with no permanent modification to the plant required.

3) Installation of a large storage pad at Pickering to store the five 1.4 MW portable generators to be used by both stations.

4) Functionality assessment cost is greater at Pickering, due to the complexity of Pickering station's design, and more systems/equipment to be reviewed.

Pickering station's MFA cost includes the following additional items:

1) Five 1.4 MW Generators (to be used, if required, at Darlington).

2) Transport Trucks to move the 1.4 MW generators onsite at Pickering or, if required, to Darlington.

3) One Generator Load Bank (1.4 MW) to test the portable 1.4 MW generators.

4) Fueling trucks at Pickering to meet fuelling timelines, due to the larger number of emergency mitigation equipment.

5) One 350 kW Generator to power the Pickering Main Volume Vacuum Pumps.

Board Staff Interrogatory #43

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: Exh D2-1-3, Attachment 1, Tab 36
This BCS is for the (Pickering) Machine Delivered Scrape project.

a) Please provide an update on the project status, particularly with respect to any information that OPG has with respect to the on-reactor deployment of the Circumferential Wet Scrape Tool by a non-OPG CANDU operator in 2015.

b) Based on this and any other information, please confirm whether OPG plans to continue with the project as discussed in the BCS and/or whether these plans have materially changed relative to the planned life-extension date of the Pickering B units to 2024.

Response

a) The Project is proceeding and is currently in Execution phase with a full release BCS approved in February 2016 (see Attachment 1 which has confidential content as marked). Current project activities are focused on integration and commissioning in preparation for first on-reactor use at Pickering in 2017.

The Circumferential Wet Scrape tool had a successful deployment by a non-OPG CANDU operator in 2015. OPG was allowed to directly observe a portion of their scrape execution. The tool vendor and the non-OPG CANDU operator have shared lessons learned with OPG. This operating experience is being incorporated into OPG plans.

b) OPG is continuing with the project. The number of scrape campaigns and the total number of pressure tubes on which machine delivered scrape is expected to be deployed has increased as a result of the Pickering planned life extension to 2022/2024.

ONTARIO POWER GENERATION

Records File Information:
Records SCI/USI Retention
- See Guidance Section

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Type 3 Business Case Summary

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

Executive Summary and Recommendations

Project Information			
Project #:	66600	**Document #:**	N-BCS-30740-10003
Project Title:	Machine Delivered Scrape		
Class:	☐ OM&A ☒ Capital ☐ Capital Spare ☐ MFA ☐ CMFA ☐ Provision ☐ Others:	**Investment Type:**	Value Enhancing
Phase:	Execution	**Release:**	Full
Facility:	IMS	**Target In-Service or Completion Date:**	Spring 2017, P1751

Project Overview

We recommend the release of $11,965k, including [redacted] of contingency. This will bring the total release to $26,091k including [redacted] contingency. The estimated total project cost is $26,091 k, including [redacted] of contingency.

The quality of the estimate for this release is Class 2, and for the total project is Class 2.

We plan to purchase from a vendor a Circumferential WEt Scrape Tool (CWEST) to execute pressure tube scrapes. We will deploy the tool with the Universal Delivery Machine (UDM) for Pickering 5-8. This single system; Machine Delivered Scrape (MDS) will replace manual Damp Circumferential Scrape (DCS) for pressure tube rolled joints (RJ), and fueling machine delivered Wet Axial Scrape (WAS) for body of tube (BOT) scrapes.

In-service pressure tube equivalent hydrogen concentration data requires scrape sampling. The data establishes fitness for service for pressure tubes under CSA N285.4-05, Periodic Inspection of CANDU Nuclear Power Plant Components, and CSA N286.8-05, Management System Requirements for Nuclear Power Plants.

The business objective of this value enhancing project is to reduce the cost and effort of acquiring this scrape data for Pickering 5-8 by:

- Reducing critical path outage durations
- Reduce outage execution costs
- Reduce personnel dose
- Eliminate high hazard open fuel channel work
- Eliminate feeder ice plugging
- Eliminate non standard fueling machine deployment

This is the third and final release for the project. To date, $14,126 k (including contingency) has been released for:

- Procurement and initial payment for CWEST
- Detailed engineering for UDM software modifications, UDM umbilical, and mock-ups
- Delivery of the first CWEST tool head by year end 2015
- Procurement of additional CWEST support equipment

This final release funding is required to support the remaining procurement of CWEST support equipment, mock-ups and testing activities.

Dual MDS and DCS/WAS will occur in P1671 to perform commissioning and inspection results equivalency testing (inclusion into P1671 scope still pending and inspection costs not project funded). The first solo use of MDS will occur in P1751 (i.e. The BCS only assumes economics savings from P1751 forward).

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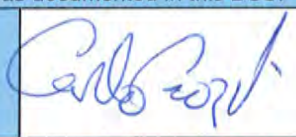
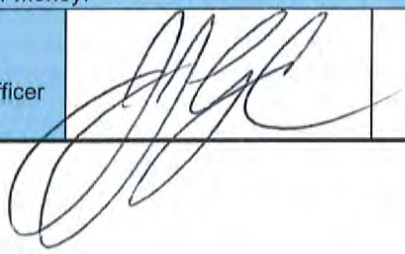
Type 3 Business Case Summary

Project #: 66600
Project Title: Machine Delivered Scrape, <Full> <Execution> Release
Document #: N-BCS-30740-10003

Project Cash Flows, NPV, and OAR Approval Amount									
k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	13,515	611	-	-	-	-	-	-	14,126
Requested Now	-	10,610	1,355	-	-	-	-	-	11,965
Future Required	-	-	-	-	-	-	-	-	-
Total Project Cost	13,515	11,221	1,355	-	-	-	-	-	26,091
Ongoing Costs	-	0	0	-	-	-	-	-	0
Grand Total	13,515	11,221	1,355	-	-	-	-	-	26,091

Estimate Class:	Class 2	**Estimate at Completion:**	[redacted]
NPV:	$18,188k	**OAR Approval Amount:**	$26,091k

Additional Information on Project Cash Flows (optional):
Currently Released 2016 cash flows represent remaining 2016 cash flows from PCRAF002 (Dec 2015) as of 04Jan2016.

Approvals			
	Signature	**Comments**	**Date**
The recommended alternative, including the identified ongoing costs, if any, represents the best option to meet the validated business need.			
Recommended by (Project Sponsor): Glenn Jager President, OPG Nuclear and Chief Nuclear Officer			22FEB2016
I concur with the business decision as documented in this BCS.			
Finance Approval: Carlo Crozzoli (acting) SVP & Chief Financial Officer per OPG-STD-0076			Feb 25/16
I confirm that this project, including the identified ongoing costs, if any, will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: Jeffrey Lyash President & Chief Executive Officer per OAR 1.1			2/26/16

Type 3 Business Case Summary

Project #: 66600
Project Title: Machine Delivered Scrape, <Full> <Execution> Release

Document #: N-BCS-30740-10003

Part B: Preferred Alternative: OPG Purchase and Deployment of CWEST Tooling System

Description of Preferred Alternative

The preferred alternative will see OPG negotiate and purchase a multi-positional, circumferential wet scrape tool (CWEST), delivered by the Pickering UDM. Campaign execution and responsibility for tool maintenance would rest with OPG.

The CWEST tool is able to collect eight (8) scrapes from a wet CANDU pressure tube in a single deployment. Delivered to a specific axial position and verified by UT, the tool acquires both the oxide scrape and sample cut. The chips are stored in an eight (8) position sample tray, which is internally indexed axially with each subsequent scrape.

Tooling is designed to CSA N286.2, Design Quality Assurance for Nuclear Power Plants and built to Z299.3, Guide for Selecting and Implementing the CAN3-Z299-85 Quality Assurance Program Standards.

This preferred alternative will completely eliminate:

- High Hazard Open Channel Work
- Ice Plugging for channel isolation
- Vented Closure Plugs and Channel Isolation Plus (VCPs & CIPs) requirements
- Channel defueling and associated storage and new fuel costs
- Multi-cycle deployments of tooling to collect required scrape samples on any given channel
- Platform installation and configuration for scrape
- Fuelling machine modifications for WAS (which currently requires non-routine operation)
- Post outage fuel flux imbalance at reactor start-up due to new fuel
- DCS tooling leases – MDS would be all OPG owned equipment
- Radiation Shipments of OPG owned contaminated tooling (Still required for scrape sample transport)

This preferred alternative will significantly reduce:

- Personnel Dose (Reactor face work significantly reduced)
- Outage critical path duration for scrape activities
- Labour intensive manual scrape activities
- FM Usage (Still required for fuel push operations, but no special needs or configurations required)
- Additional (External) resource requirements for campaigns
- Inspection/Channel cycle time to collect required scrape samples
- Reactor face shielding requirements
- Risk of development and deployment of new tooling – CWEST has been previously deployed

This alternative eliminates or significantly reduces OPG's reliance on vendor supplied tooling, schedule, maintenance, spare parts, tool rebuilds or other similar beyond-OPG control events. OPEX from the D1321 outage suggests a solid understanding and familiarity with the tooling and process is critical for a successful CANDU scrape campaign. OPG owned tooling means being responsible for maintenance, rebuilds, and spare parts but also that knowledge and experience are built and retained by OPG technical staff.

This final release BCS will fund the remaining procurement and testing activities to make the CWEST system available for service.

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Type 3 Business Case Summary

Project #: 66600
Project Title: Machine Delivered Scrape, <Full> <Execution> Release
Document #: N-BCS-30740-10003

Deliverables:	Associated Milestones (if any):	Target Date:
Last Partial BCS Release		
1. MDS Gate #3 – Next CWEST usage on non-OPG reactor.	1 OPG evaluation of CWEST tool performance post next on reactor usage.	Complete
2. Assembly, Testing, and Delivery of CWEST Tool Head #1 to OPG.	2 Delivery of Tool #1 to PNGS	Complete[1]
3. Fabrication, Testing and Delivery of CWEST equipment required to provide minimum fully operational CWEST system to OPG. (i.e. cutters, manual tools, chip retrieval and transfer system)	3 Delivery of equipment to PNGS	Complete[1]
4. UDM Software Modifications for CWEST, Developmental Release	4 Developmental Release to OPG, Production/Final Release to OPG	Complete
This BCS Release		
5. Delivery of mock-ups and auxiliary equipment	5 Delivery of Mock-ups to OPG	June 15, 2016
6. Assembly, Testing, and Delivery of CWEST Tool Head #2 to OPG	6 Delivery of Tool#2 to to OPG	May 27, 2016
7. Delivery of UDM Umbilical cable	7 Delivery of Umbilical cable to OPG	August 19, 2016
8. Partial AFS prior to P1671	8 MDS Partial AFS for P1671	Sep 16, 2016
9. Final AFS post P1751	9 MDS Final AFS post P1751	Sep 2017, post P1751.

Notes
1) CWEST Tool #1 and manual tools were assembled and demonstrated at Vendor facility. OPG has chosen to keep equipment at vendor facility to facilitate completion of other tasks.

Part C: Other Alternatives

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

Alternative 2: Base Case – Abandon MDS Project

The benefits of MDS are substantial. Cancellation of the project at this time would provide none of the planned benefits of MDS. Current sunk costs of approximately $13.5 M would have to be written off against OM&A.

Abandonment of MDS would mean continuation of current scrape practices, which involve significantly greater critical path times, higher personnel dose updates and higher execution costs. It also would mean continuation of ice plugging, open channel work, and use of CIPs/VCPs.

Cancellation is less financially attractive than the preferred alternative, resulting in financial write offs as well as having a lower NPV than the preferred alternative.

Alternative 3: Delay Work – Delay MDS Project by One (1) Year / Two (2) Pickering 5-8 Outages

With the approval of the first partial BCS in February 2014, and subsequent placement of several purchase orders, the option to delay remains. However, since the last partial BCS, many purchase orders for equipment deliverables have been placed. Thus, the projected cash flows for 2016 would not differ significantly from the preferred alternative.

Delaying MDS by one calendar year would push the commissioning and equivalency testing into P1761 and would delay the realization of MDS savings to P1881 and beyond. **[Note:** Due to the small window between P1671 and P1751, IMS' preference for a delay option would be one calendar year which is equivalency to two PNGS-058 outages]

In the previous partial BCS, the Delay Work alternative was challenged as there were a limited number of outages which would reap MDS savings. However, with the inclusion of PN Life Extension, the delay alternative would still bare a positive NPV.

The cash flow impact and reduced payback period results in a reduced NPV to the project and is therefore less attractive than the preferred alternative.

Alternative 4: Procure 3rd Party CWEST Scrape Services (Deployment and Tooling) At Pickering 5-8

This alternative would see a third party provider prepare and provide the CWEST scrape tools, deployed using OPG supporting resources and equipment, while providing technical support and operations oversight. Similar to current OPG scrape practices

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Type 3 Business Case Summary

Project #: 66600
Project Title: Machine Delivered Scrape, <Full> <Execution> Release
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Part D: Project Cash Flows, NPV, and OAR Approval Amount

k$	LTD	2016	2017	2018	2019	2020	2021	Future	Total
Currently Released	13,515	611	-	-	-	-	-	-	14,126
Requested Now	-	10,610	1,355	-	-	-	-	-	11,965
Future Required	-	-	-	-	-	-	-	-	-
Total Project Cost	13,515	11,221	1,355	-	-	-	-	-	26,091
Ongoing Costs	-	0	0	-	-	-	-	-	0
Grand Total	13,515	11,221	1,355	-	-	-	-	-	26,091

Estimate Class:	Class 2	**Estimate at Completion:**	[redacted]
NPV:	$18, 188k	**OAR Approval Amount:**	$26,091k

-Additional Information on Project Cash Flows (optional):
Currently Released 2016 cash flows represent remaining 2016 cash flows from PCRAF002 (Dec 2015) as of 04Jan2016.

Part E: Financial Evaluation

M$	Preferred Alternative	Base Case	Delay Work	Alternative 4	Alternative 5
Project Cost	[redacted]	$ 4, 597	[redacted]	$ 44, 742 k[1]	
NPV	$ 18, 188 k	($ 10, 707 k)	$ 10, 884	($ 12, 476 k)[1]	

Note:
1) The NPV and project cost for 'Alternative 4' has not been recalculated for this BCS. The NPV shown above is from the last partial BCS.

Summary of Financial Model Key Assumptions or Key Findings:

** NPV is calculated based on PN Life Extension. The scope of PN Life Extension Outages has been provided by Generation Planning and is consistent with information posted on Generation Planning intranet webpage.

The Preferred and Delay alternatives are reported less LTD sunk costs, as of month end December 2015

Abandon MDS alternative shows LTD sunk costs, as of month end December 2015

The delay MDS alternative would see the commissioning run in 2017, with full savings realized in outages starting in 2018.

For preferred alternative, first usage is planned for P1751 and is the first outage for which benefits are considered. P1671 is considered a commissioning run only, and will have mandatory scrape scope performed using existing scrape tools. No benefits to OPG are considered for P1671. Inclusion in P1671 outage scope is still pending CNO concurrence

The P1671 commissioning run is required to support the establishment of scrape "equivalency", the direct comparison between manual DCS and MDS data models. Said data models trend [Heq] uptake and are used in establishing fitness for service and unit end of life calculations.

Type 3 Business Case Summary

Project #: 66600
Project Title: Machine Delivered Scrape, <Full> <Execution> Release

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Part G: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	There is a risk that costs will increase due to risks identified below. As described previously in this BCS, some of the technical risks have been realized and have resulted in a cost increase. Some technical risks remain and continue to be tracked.	Per specific technical identified risks identified below.	Medium	Medium
Scope	There is a risk that scope will increase due to risks identified below. As described previously in this BCS, some of the technical risks have been realized and have resulted in scope increase. Some technical risks remain and continue to be tracked.	Per specific technical identified risks identified below.	Medium	Medium
Schedule	1. There is a risk that operators will take longer than anticipated to become familiar with the tool. 2. There is a risk that the time required to build an OPG toolset, with the currently realized and still outstanding technical risks, is longer than quoted.	1. Multiple training opportunities have been established, from including OPG "observers" at the vendor's facility during manufacturing and testing, to formal classroom and hands on training with CWEST. 2. OPG has worked closely with the vendor to establish realistic timeframes for delivery. A staged approach to delivery has been arranged. "Pain and gain" type clause to be negotiated into tool head procurement PO of scope increase to reinforce delivery on commitments.	Medium	Low
Resources	There is a risk that the MDS schedule will continue to slip due to a lack of qualified resources to progress the work to completion.	There is a resource agreement between Projects and the various IMS Operations groups. Role responsibilities have been identified. Work continues on implementing the appropriate training program.	Low	Medium
Quality/ Performance	There is a risk that CWEST will suffer additional setbacks during next non-OPG on channel use. Since CWEST use at a non-OPG NGS was successful twice in 2015, this risk is now considered low probability.	OPG maintains consistent communication with vendor and non-OPG NGS tracking performance of tool. OPG is kept informed of issues and ensures OPEX is incorporated into OPG tooling set.	Low	Medium
Technical	1. There is a risk that traceability of the collected chips will be lost.	1. The current mitigation plan to address traceability deficiencies is: i) Initiate Kepner Tregoe (KT) method root cause analysis. ii) Increase understanding of issue with internal stakeholders (via OPEX sharing).	High	Medium

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Project #: 66600
Project Title: Machine Delivered Scrape, <Full> <Execution> Release

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Part H: Post Implementation Review (PIR) Plan		
Type of PIR Report	**Target In-Service or Completion Date**	**Target PIR Completion Date**
Simplified PIR	Spring 2017, P1751	November 2017

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Dose Uptake	10.0 rem (6 DCS & 10 BOT)	5.5 rem (6 DCS & 10 BOT)	Campaign Dosimetry	DAMS, SME
Execution Cost	$3500k/campaign (6 DCS & 10 BOT)	$1600k/campaign (6 DCS & 10 BOT)	Campaign Budget/Actual Costs + Fuel costs saved	DAMS, SME
Outage Critical Path	400hrs (6 DCS & 10 BOT)	150hrs (6 DCS & 10 BOT)	Campaign Schedule	DAMS, SME
Ice Plugging	Yes	No	Campaign Execution	DAMS, SME
Open Channel Work	Yes	No	Campaign Execution	DAMS, SME
Use of Fuelling Machine in non-standard configuration	Yes	No	Campaign Execution	DAMS, SME

** - all parameters measured comparing current manual scrape practices to MDS scrape activities.

Part I: Definitions and Acronyms

ADL - Affected Documents List
AEL - Affected Equipment List
AFS - Available for Service
AISC - Asset Investment Screening Committee
ANDE - Advanced Non Destructive Examination
BCS - Business Case Summary
BOE - Basis of Estimate
BOT - Body of Tube
CANDU - CANadian Deuterium Uranium
CGSB - Canadian General Standards Board
CIP - Channel Isolation Protocol
COG - Candu Owner's Group
COMS - Constructability, Operability, Maintainability, Safety
CQTS - Cutter Qualification Tool Station
CSA - Canadian Standards Association
CWEST - Circumferential Wet Axial Scrape Tool
CWEST - Circumferential Wet Scrape Tool
DAIA - Design Agency Interface Agreement
DAMS - Delivery and Reactor Maintenance Systems
DCS - Damp Circumferential Scrape
DTL - Design Team Leader
EC - Engineering Change
ECC - Engineering Change Control
EOL - End of Life
ESA - Electrical Safety Authority
ET - Eddy Current Testing
FH - Fuel Handling
FM - Fuelling Machine
FMSR - Fuelling Machine Service Room

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Type 3 Business Case Summary

Project #: 66600
Project Title: Machine Delivered Scrape, <Full> <Execution> Release
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Appendix A: Summary of Estimate										
Project Number:	66600									
Project Title:	Machine Delivered Scrape									
Choose an item.	**LTD**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**Future**	**Total**	**%**
OPG Project Management	525	563	432						1,520	6.3
OPG Engineering (including Design)	790	1,328	207						2,325	9.6
OPG Procured Materials	11,414	6,077	245						17,736	73.1
OPG Other	[redacted]									5.8
Design Contract(s)										
Construction Contract(s)										
EPC Contract(s)										
Consultants										
Other Contracts/Costs										1.1
Interest										4.2
Subtotal										**100**
Contingency										
Total	**13,515**	**11,221**	**1,355**						**26,091**	

Notes			
Project Start Date	2014-02-01	**Total Definition cost** (excludes unspent contingency for Nuclear)	$ 0
Target In-Service (or AFS) Date	P1671 "Commissioning Run" with no OPG benefits P1751 1st use with OPG benefits	**Contingency included in this BCS** (Nuclear only)	[redacted]
Target Completion Date	18Nov2017	**Total contingency released plus contingency in this BCS** (Nuclear only)	[redacted]
Escalation Rate	2.0 %	**Total released plus this BCS without contingency** (Nuclear only)	[redacted]
Interest Rate	5.5 %	**Total released plus this BCS with contingency** (Nuclear only)	$ 26,091 k
Removal Costs	N/A	**Estimate at Completion** (includes only spent contingency for Nuclear)	[redacted]

Prepared by:	Approved by:
Ranald McKay MDS Project Manager Feb 16/2016 Date	Ryan Howard, NDE Projects Department Manager 16 FEB 2016 Date

AMPCO Interrogatory #17

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Attachment 1 Page 2 Nuclear Business Case Summary Index

Please complete the attached excel spreadsheet prepared by AMPCO.

Response

In the attached spreadsheet (Attachment 1), the values for Original Total Project Estimate, except where noted, reflect the estimates in the first Execution Phase Business Case Summary ("BCS"). Per OPG-STD-0076 Developing and Documenting Business Cases, OPG does not commit to the full estimated cost of a project until the first Execution Phase BCS at which stage most of the detailed engineering and planning is complete and procurement of engineered equipment is underway.

For reference purposes, Chart 1 lists BCS' that have been filed as attachments in response to interrogatories.

Chart 1

Project No.	BCS Title	Interrogatory
25619	Operations Support Building Refurbishment	Ex. L-4.4-15 SEC-48 Attachment 1
33955	Shutdown System Computer Aging Management	Ex. L-4.4-15 SEC-46 Attachment 1
34000	Auxiliary Heating System	Ex. L-4.4-15 SEC-46 Attachment 2
31532	Powerhouse Water Air Conditioning Units Replacement	Ex. L-4.2-1 Staff-28 Attachment 1
82816	Vault Cooling Coil Replacement	Ex. L-4.2-1 Staff-40 Attachment 1
73566 80144	Primary Heat Transport Pump Motor Replacement/ Overhaul	Ex. L-4.2-1 Staff-41 Attachment 1
66600	Machine Delivered Scrape	Ex. L-4.2-1 Staff-43 Attachment 1

4.2-AMPCO-17
Ref: D2-1-3 Attachment 1 Page 2 Nuclear Operations Facility Tier 1 Projects (>$20 million)

Tab No.	Project No.	Business Case Summary (BCS) Title	Original In-service Date[4]	Updated In-service Date[5]	Original Total Project Estimate[4]	Total Project Estimate Last BCS	Total Project Estimate Current BCS[5]	Original OPG Project Management Estimate[4]	Updated OPG Project Management Estimate[5]	Original OPG Engineering Estimate[4]	Updated OPG Engineering Estimate[5]	Original OPG Procured Material Estimate[4]	Updated OPG Procured Material Estimate[5]	Original Contractor Estimate[4]	Updated Contractor Estimate[5]	Original Contingency[4]	Updated Contingency[5]
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	(q)	(r)
1	25619	Operations Support Building Refurbishment	Oct-15	Oct-15	53.0	53.0	62.7	4.3	3.6	0.7	1.2	0.7	1.0	37.7	51.8	5.3	1.5
2	31412	DN Class II Uninterruptible Power Supply Replacement	Jun-19	Jun-25	38.4	55.1	55.1	3.9	4.0	0.9	1.9	13.3	0.0				
3	31508 49158 49299	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	Aug-16	Dec-17	70.0	111.0	115.6	6.2	8.9	5.0	9.4	2.9	0.1				
4	31717	Improve Maintenance Facilities at Darlington[2]	May-13	Oct-13	49.8	49.8	35.6	4.0	3.9	1.0	4.1	2.4	0.3	25.5	25.2	11.0	0.0
5	33621	Secondary Control Area Air Conditioning Unit Replacement[1]	Oct-14	Apr-17	12.3	19.1	28.3	2.5	6.3	3.2	1.7	2.1	2.6				
6	33631	Chiller Replacement to Reduce CFC Emissions	Jun-09	Dec-17	14.9	14.9	30.0	1.1	5.2	0.9	2.9	4.5	4.4	5.2	10.5	1.6	2.1
7	33819	Major Pump-sets Vibration Monitoring System Upgrades	Apr-17	Jul-21	12.8	12.8	23.0	3.9	2.0	0.0	1.1	0.1	0.1				
8	33955	Shutdown System Computer Aging Management[1]	Nov-16	Nov-15	17.2	20.3	20.4	3.1	3.0	7.1	5.0	1.9	1.8	1.3	7.5	1.8	0.0
9	33973	Standby Generator Controls Replacement[1]	Oct-13	May-17	21.8	39.6	43.5	4.5	8.3	2.8	3.2	8.0	7.7				
10	33977	Digital Control Computer Replacement / Refurbishment / Upgrades	Dec-10	Dec-18	22.1	22.1	24.9	1.2	2.0	4.6	7.1	3.2	1.9				
11	34000	Auxiliary Heating System	Dec-15	Oct-17	45.6	99.5	107.1	3.7	7.7	1.1	4.1	10.2	0.1				
12	36001	Primary Heat Transport Pump Motor Capital Spares	Apr-12	May-15	12.0	30.8	28.9	0.0	0.0	0.0	0.0	12.0	28.9	0.0	0.0	0.0	0.0
13	41023 49247	Unit 1 & 4 Fuel Channel East Pressure Tube Shift/Reconfigure	Jan-16	Mar-16	29.3	28.8	38.6	2.4	5.5	1.5	2.9	8.2	9.2	7.3	11.4	5.6	6.2
14	46634	Pickering A Fuel Handling Single Point of Vulnerability Equipment Reliability Improvement	Dec-12	Jun-18	27.0	27.0	27.3	2.4	3.6	1.0	2.1	6.0	4.7				
15	49109	PB Standby Generator Governor Upgrade[2]	Apr-08	Jan-15	22.1	23.3	22.8	0.9	0.9	2.0	2.0	5.9	6.6	9.7	10.4	1.7	0.0
16	49285	Modify/Replace Fiber Reinforced Plastic Components During 2010 Vacuum Buiding Outage[2]	Jun-10	Jun-10	12.8	24.5	17.7	1.8	1.0	1.3	0.5	1.6	2.3	5.5	13.7	1.9	1.8
17	62568	Feeder Repair by Weld Overlay	Jul-11	Deferred	53.2	53.2	0.0	0.8	0.8	0.3	0.3	3.3	3.3				
18	31518	Restore Emergency Service Water and Firewater Margins	Sep-16	TBD	47.1	47.1	47.1	5.0	5.0	1.5	1.5	7.3	7.3				
19	31524	Station Roofs Replacement		TBD	36.3	36.3	36.3	1.2	1.2	0.0	0.0	0.0	0.0				
20	31532	Powerhouse Water Air Conditioning Units Replacement[1]	Jan-23	Jan-23	26.6	26.6	26.6	0.9	0.9	1.3	1.3	0.0	0.0				
21	31535	Water Treatment Plant Replacement	Nov-16	Deferred	57.8	57.8	57.8	2.2	2.2	1.0	1.0	13.5	13.5				
22	31542	Transformer Multi-Gas Analyzer Installation	Dec-17	Mar-18	15.2	26.7	22.7	1.4	1.3	0.3	1.0	1.6	0.0				
23	31544	Radiation Detection Equipment Obsolescence[3]	Dec-21	Dec-22	46.9	46.9	46.9	1.1	1.1	0.6	0.6	23.8	23.8				
24	31552	Condenser Circulating Water and Low Pressure Service Water Travelling Screens Replacement	Nov-19	Jun-18	24.4	24.4	37.6	1.1	3.4	0.3	0.2	8.8	9.8				
25	31710	Shutdown Cooling Heat Exchanger Replacement	May-19	Sep-18	56.1	56.1	56.1	4.5	4.5	0.6	0.6	0.0	0.0				
26	31716	Neutron Over-Power & Ion Chamber Amplifier Replacement (Reactor Regulating System, Shutdown System 1 & Shutdown System 2)[3]	Jul-22	Jul-22	17.7	17.7	17.7	1.1	1.1	1.3	1.3	9.5	9.5				
27	38948	Zebra Mussel Mitigation Improvements	Jul-16	Aug-17	21.5	21.5	29.3	1.8	1.8	1.5	1.5	0.0	0.0				
28	73706	Holt Road Interchange Upgrade	Dec-15	Aug-16	31.0	31.0	24.6	0.0	0.0	0.0	0.0	0.0	0.0				
29	80022	OH180 Aging Management Hardware Installation[3]	Dec-22	Oct-22	47.2	47.2	47.2	2.3	2.3	5.7	5.7	22.3	22.3				
30	80078	Digital Control, Common Process and Sequence of Events Monitoring Computer Aging Management[3]	Jun-25	Jun-25	47.3	47.3	47.3	1.4	1.4	4.4	4.4	11.8	11.8				
31	80111	Generator Stator Core Spare	Jul-19	Jul-19	35.0	35.0	35.0	0.0	0.0	0.0	0.0	32.0	32.0				
32	82816	Vault Cooling Coil Replacement[1]	Jul-20	Sep-20	26.3	26.3	18.8	0.8	0.1	0.4	0.3	4.9	4.0				
33	73566 80144	Primary Heat Transport Pump Motor Replacement/Overhaul	Jun-22	Dec-19	129.5	129.5	124.0	9.9	6.9	2.2	1.2	3.4	31.0				
34	40976	Pickering B Fuel Handling Reliability Modifications[1]	Dec-15	Dec-18	29.0	37.3	43.0	1.2	2.4	0.9	0.8	9.1	8.7				
35	41027 32202	Fukushima Phase 2 Beyond Design Basis Event Emergency Mitigation Equipment	Dec-17	Dec-17	74.3	74.3	75.5	3.1	3.9	4.4	4.0	0.0	0.0				
36	66600	Machine Delivered Scrape	Jun-17	Jun-17	24.9	24.9	26.1	1.6	1.5	1.6	2.3	14.2	17.7				

Notes:
1. Current values reflect the amounts in the BCS approved subsequent to the filing.
2. Current values reflect the amouns in the Project Closure Report
3. Original and Current values reflect amounts in the Defintion Phase BCS and do not reflect committed values.
4. Original values reflect the amounts in the First Execution Phase BCS, except where noted.
5. Updated values reflect the current BCS, except where noted.

AMPCO Interrogatory #18

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Table 1

a) Of the sixteen ongoing projects listed as Tier 1 projects in Table 1 from EB-2013-0321, please identify which projects were not classified as Tier 1 projects in EB-2013-0321 and indicate the Tier they were allocated to at that time.

Response

The ongoing Tier 1 projects that were not listed as Tier 1 in EB-2013-0321 are as follows (with the line number from Ex. D2-1-3 Table 1 for reference):

Line No	Facility	Project Name	Project Number	Tier in EB-2013-0321
2	DN	Class II Uninterruptible Power Supply Replacement	31412	2
3	DN	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	31508	2
5	DN	Secondary Control Area Air Conditioning Unit Replacement	33621	2
7	DN	Major Pump-sets Vibration Monitoring System Upgrades	33819	2
8	DN	Shutdown System Computer Aging Management	33955	2
12	DN	Primary Heat Transport Pump Motor Capital Spares	36001	2
13	PN	Unit 1 & 4 Fuel Channel East Pressure Tube Shift/Reconfigure	41023 49247	2
15	PN	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	49158 49299	2

The Operations Support Building Refurbishment and Auxiliary Heating System projects were reclassified from the Darlington Refurbishment Program and were listed as Tier 1 projects in the Darlington Refurbishment Program evidence Ex. D2-2-1 Table 3 in EB-2013-0321.

Witness Panel: Nuclear Operations and Projects

AMPCO Interrogatory #19

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Table 1

a) For each of the projects in Table 1, please identify any projects where OPG did not utilize an Engineering, Procurement and Construction (EPC) contracting strategy.

Response

Please see Ex. L-4.2-2 AMPCO-19 Attachment 1, Table 1 for a list of projects that did not use an EPC contracting strategy.

Please see Ex. L-4.2-2 AMPCO-19 Attachment 2, Table 1 for a list of projects that did not use an EPC contracting strategy for a portion of the project scope.

Numbers may not add due to rounding.
Privileged and confidential. Prepared in contemplation of litigation.

Filed: 2016-10-26
EB-2016-0152
Exhibit L
Tab 4.2
Schedule 2 AMPCO-019
Attachment 1

Table 1
Capital Project Listing - Nuclear Operations Facility Projects NOT Using EPC Contracting Strategy
Projects ≥ $20M Total Project Cost

Line No.	Facility	Project Name	Project Number	Category	Start Date	Final In-Service Date	Total Project Cost[2] (M$)	Partial/Devmt Release ($M)	Initial Full Release ($M)	Superceding Full Release ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
		ONGOING PROJECTS FROM EB-2013-0321														
6	DN	Chiller Replacement to Reduce CFC Emissions	33631	Regulatory	Jan-04	Jan-13	30.0		30.0		0.0	1.2	0.0	0.0	0.0	0.0
8	DN	Shutdown System Computer Aging Management	33955	Sustaining	Nov-06	May-16	20.3		20.3		2.0	0.0	0.0	0.0	0.0	0.0
10	DN	Digital Control Computer Replacement / Refurbishment / Upgrades	33977	Sustaining	Sep-03	Dec-18	24.9		22.1	24.9	0.0	2.0	1.8	0.0	0.0	0.0
12	DN	Primary Heat Transport Pump Motor Capital Spares	36001	Sustaining	Sep-11	May-15	30.8		12.0	30.8	0.0	0.0	0.0	0.0	0.0	0.0
13	PN	Unit 1 & 4 Fuel Channel East Pressure Tube Shift/Reconfigure	41023 49247	Sustaining	Nov-09	Mar-16	38.6		28.8	38.6	17.0	0.0	0.0	0.0	0.0	0.0
16	SEC	Physical Barrier System	25609	Regulatory	Nov-05	Dec-13	67.2		49.5	67.2	0.5	0.0	0.0	0.0	0.0	0.0
		COMPLETED/DEFERRED/CANCELLED FROM EB-2013-0321														
18	PN	PB Standby Generator Governor Upgrade	49109	Sustaining	Oct-05	Jan-15	22.8		23.3		0.0	0.0	0.0	0.0	0.0	0.0
19	PN	Modify/Replace Fiber Reinforced Plastic Components During 2010 Vacuum Buiding Outage	49285	Sustaining	Nov-09	Jun-10	17.7		12.8	24.5	0.0	0.0	0.0	0.0	0.0	0.0
20	ENG	Feeder Repair by Weld Overlay	62568	Value Enhancing	May-09	Deferred	0.0		53.2		0.0	0.0	0.0	0.0	0.0	0.0
		PROJECTS NOT IN EB-2013-0321														
28	DN	Condenser Circulating Water and Low Pressure Service Water Travelling Screens Replacement	31552	Sustaining	May-13	Jun-18	37.6	27.5			10.6	8.4	7.2	0.1	0.0	0.0
30	DN	Neutron Over-Power & Ion Chamber Amplifier Replacement (Reactor Regulating System, Shutdown System 1 & Shutdown System 2)	31716	Sustaining	Jul-13	Jul-22	17.7	5.5			0.0	0.0	0.0	1.0	2.3	0.0
33	DN	OH180 Aging Management Hardware Installation	80022	Sustaining	Dec-14	Dec-22	47.2	1.4			0.0	0.0	7.9	5.7	5.5	5.6
34	DN	Digital Control, Common Process and Sequence of Events Monitoring Computer Aging Management	80078	Regulatory	Nov-15	Jun-25	47.3	1.7			0.0	0.0	0.0	0.0	1.6	6.0
35	DN	Generator Stator Core Spare	80111	Sustaining	Sep-15	Jul-19	35.0		35.0		0.0	0.0	0.0	32.0	0.0	0.0
37	DN	Primary Heat Transport Pump Motor Replacement/Overhaul	73566 80144	Sustaining	May-15	Dec-22	129.5	53.8			14.8	11.0	13.0	17.0	19.2	0.0
38	PN	Pickering B Fuel Handling Reliability Modifications	40976	Sustaining	Aug-12	Jul-17	37.3	30.9			11.5	7.9	4.2	0.0	0.0	0.0
40	PN	Machine Delivered Scrape	66600	Value Enhancing	Feb-14	May-17	24.9	14.1	0.0	0.0	18.9	1.5	0.0	0.0	0.0	0.0

Numbers may not add due to rounding.
Privileged and confidential. Prepared in contemplation of litigation.

Filed: 2016-10-26
EB-2016-0152
Exhibit L
Tab 4.2
Schedule 2 AMPCO-019
Attachment 2

Table 1
Capital Project Listing - Nuclear Operations Facility Projects Not Using EPC Contracting Strategy for a Portion of the Project Scope
Projects ≥ $20M Total Project Cost

Line No.	Facility	Project Name	Project Number	Category	Start Date	Final In-Service Date	Total Project Cost[2] (M$)	Partial/Devmt Release ($M)	Initial Full Release ($M)	Superceding Full Release ($M)	In-Service 2016 ($M)	In-Service 2017 ($M)	In-Service 2018 ($M)	In-Service 2019 ($M)	In-Service 2020 ($M)	In-Service 2021 ($M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
		ONGOING PROJECTS FROM EB-2013-0321														
3	DN	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	31508	Regulatory	Sep-11	Sep-17	52.9	51.9			17.0	13.8	0.0	0.0	0.0	0.0
9	DN	Standby Generator Controls Replacement	33973	Sustaining	Dec-06	May-17	39.6	32.4			17.9	8.7	0.0	0.0	0.0	0.0
14	PN	Pickering A Fuel Handling Single Point of Vulnerability Equipment Reliability Improvement	46634	Sustaining	Feb-11	Mar-16	27.3		27.3		3.8	2.5	0.0	0.0	0.0	0.0
15	PN	Fukushima Phase 1 Beyond Design Basis Event Emergency Mitigation Equipment	49158 49299	Regulatory	Sep-11	Aug-16	58.0	47.2			21.0	10.5	0.5	0.0	0.0	0.0
39	PN	Fukushima Phase 2 Beyond Design Basis Event Emergency Mitigation Equipment	41027	Regulatory	Oct-12	Jun-17	46.3	5.8			7.3	22.5	0.0	0.0	0.0	0.0

AMPCO Interrogatory #20

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Table 1

a) Of the nineteen Tier 1 projects listed in Table 1 as new Tier 1 projects that have been approved for execution since EB-2013-0321, please provide a listing of all of the projects that have a total project estimate that has increased in this Business Case Summary (BCS) compared to the last BCS and include the variance. For example, for the Powerhouse Water ACU Replacements project (#31532, BCS Tab 18), the last BCS total project estimate was $9.693 million, whereas this BSC indicates a total project estimate of $20.045 million.

b) For some of the projects on Table 1, the Final In-service Date is shown as 2016 or earlier but in-service additions are shown in 2016 and beyond. Please explain by project. For example, for Project #31317, the in-service date is October 2013 and $0.8 million is recorded as an in-service addition in 2016.

c) For each of the projects that have been deferred, please provide the total project estimate, the total amount spent to date and the total amount to be deferred.

d) Line 19 Project #49285: For this completed project, please explain why the Total Project Cost reflects BCS amounts and not actual amounts.

e) Column (f) Final In-service date – please provide an update to the in-service dates.

Response

a) See Ex. L-4.2-2 AMPCO-17 for the basis of comparison used in this response.

The new Tier 1 projects whose total project estimate has increased compared to the first Execution Phase BCS are shown in Chart 1.

Chart 1

Project No.	Project Name	Total Project Estimate - Last BCS (M$)	Total Project Estimate - Current BCS (M$)	Variance (M$)
31552	Condenser Circulating Water and Low Pressure Service Water Travelling Screens Replacement	24.4	37.6	13.3
40976	Pickering B Fuel Handling Reliability Modifications	37.3	43.0	5.7
66600	Machine Delivered Scrape	24.9	26.1	1.2

b) The reasons for the in-service amounts that are shown after the final in-service dates are common for all projects. The final in-service date quoted in Ex. D2-1-3 Table 1 represents the date at which the project is installed, commissioned and accepted by the operating authority at the final Available For Service Meeting. At that point, the project enters the close-out phase where the project team completes the following activities:

i) Revision of engineering drawings to reflect new configuration;
ii) Revision of design and operating manuals;
iii) Preparation of lessons-learned reports;
iv) Completion of actions identified at the Available For Service meeting;
v) Procurement and placement of spare parts in inventory;
vi) Transfer of quality records to storage;
vii) Close-out of purchase orders, and,
viii) Preparation and approval of project closure documentation.

Completion of this work typically takes about a year from the in-service date. Upon completion and approval of the project closure documentation, the cost incurred completing the above activities is transferred from construction-in-progress to fixed assets, i.e., placed in service.

c) The total project estimate, life-to-date spending and total amount deferred for the deferred projects are shown in Chart 2.

Chart 2

Project No.	Project Name	Total Project Estimate (M$)	Total Amount Life-to-Date (M$)	Total Amount Deferred (M$)
62568	Feeder Repair by Weld Overlay	53.2	0.0	53.2
31524	Station Roofs Replacement	36.3	0.8	35.4
31535	Water Treatment Plant Replacement	57.8	0.5	57.3

d) The Total Project Cost of $17.7M for project # 49285 in Ex. D2-1-3 Table 1 column (g) was the actual amount, not the BCS amount (see footnote 2 of Ex. D2-1-3 Table 1).

e) See column (e) in Ex. L-4.2-2 AMPCO-17 Attachment 1 for all projects except project # 25609 Physical Barrier. Project # 25609 was declared in-service in December 2013.

AMPCO Interrogatory #21

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Page 3

Preamble: The evidence indicates some projects have been deferred to address capital budget constraints. Specifically, the 2016 capital project portfolio budget is currently oversubscribed (i.e. the number of approved projects exceeds available funding). As a result, some projects have been deferred and a revised in-service date has not yet been determined.

a) Given the cost pressures resulting from the Darlington Refurbishment Program and Pickering Extended Operations, please discuss if any capital budget constraints or top-down targets were set for Nuclear Operations Capital.

Response

Top down targets were set for the Nuclear Operations Project Portfolio (Capital and Project OM&A) based on a number of inputs, including benchmarked levels of spending with industry peers, project backlogs and an assessment of the project organizations' capacity to execute work.

AMPCO Interrogatory #22

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Page 8

Preamble: The evidence indicates that for six ongoing Tier 1 projects the total forecast project cost variances currently exceed 10%.

a) For each project, please confirm the variance is based on the Last BCS to This BCS and not an earlier estimate.

b) Please provide the total cost estimate variance for each project based on This BSC compared to the Definition Full Release Estimate.

Response

a) For 34000 Darlington Auxiliary Heating System, 25619 Darlington Operations Support Building Refurbishment, 33977 Darlington Digital Control Computer Replacement and 41023/49247 Unit 1 & 4 Fuel Channel East Pressure Tube Shift/Reconfigure, the variance is confirmed to be based on the "Last BCS to This BCS" where "Last BCS" is the previously approved BCS to the most current BCS/supplemental BCS at the time of preparation of the pre-filed evidence.

For 25609 Security Physical Barrier System, the variance was based on a supplemental release of $67.2M for an additional $17.7M over an earlier full release of $49.5M (Ex. D2-1-3, p. 10).

For 36001 Darlington Primary Heat Transport Pump Motor Capital Spares, the variance was based on a supplemental release of $30.8M (Ex. D2-1-3 Attachment 1 Tab 12) for an additional $18.8M over an earlier full release of $12.0M (Ex. D2-1-3, p. 11).

b) Any variance analysis against a Definition Full Release needs to take into account that most of the detailed engineering and planning and procurement of engineered equipment has not been completed as of the Definition Phase. Rather, OPG-STD-0076 Developing and Documenting Business Cases, OPG does not commit to the full estimated cost of a project until the first Execution Phase business case (L-4.2-2 AMPCO-17).

Witness Panel: Nuclear Operations and Projects

Chart 1 provides the comparison of "This BCS Release" and the "Definition Full Release":

Chart 1

Line No.	Project	This BCS Release (M$)	Definition Full Release (M$)	Date – Definition Full Release	Variance (M$)
	(a)	(b)	(c)	(d)	(e)
1	34000	99.5	45.6	September 2012	53.9
2	25619	62.7	45.4	October 2013	17.3
3	25609	67.2	37.0	February 2007	30.2
4	33977	24.9	14.8	September 2003	10.1
5	36001	30.8	N/A	N/A	N/A
6	41023	38.6	14.2	June 2011	24.4

For a capital spares project such as 36001, there is no Definition Phase release required.

AMPCO Interrogatory #23

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3

a) Please define removal costs.

b) Please explain how OPG estimate's removal costs? Is the methodology used consistent by project?

c) Please indicate the party responsible for removal. Does the party responsible vary by project?

Response

a) Removal costs referred to in Ex. D2-1-3 are those incurred during the repair, maintenance or retirement of an existing asset for such purposes as dismantling (including disassembling a component to gain access to a subcomponent to be repaired or replaced), crating, tearing down, shipping, and reinstallation of equipment previously in service. As indicated at Ex. D4-1-1, p. 2, line 2 and further discussed at Ex. L-6.4-1 Staff-113 part (a), these costs are charged to OM&A expenses as incurred.

b) The estimation of removal costs depends on the scope and complexity of the removal tasks. Typically, for simple removal, the cost of removing the existing equipment is estimated as a percentage of the installation cost. When the task of removing the existing equipment is more complex, the cost would be estimated separately and would be a function of the project scope.

This methodology is applied consistently to all projects.

c) Typically, the party responsible for removal is the EPC vendor doing the project installation. In some cases, where there are safety, union jurisdictional or operational issues, OPG maintenance trades would undertake the removal of the existing equipment.

AMPCO Interrogatory #24

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Attachment 1 Tab 1 Page 4

a) With respect to the variance details, please explain why there was no amount for contingency included in the current approval and why now a contingency of $1.5 million (2.4%) is added.

Response

The term "current approval" refers to the amount of previously approved funding. The project over-variance release (Ex. D2-1-3, Attachment 1, Tab 1) shows no amount for contingency in the current approval as there was no contingency remaining from the previous approved funding.

In the previously approved funding, $5.3M of contingency was included. The contingency was released to the project and used to fund increased Engineering, Procurement, and Construction costs for design packages, equipment procurement and additional contractor project management and field engineering support.

The contingency of $1.5M is for the remaining scope of work. As indicated at Ex. D2-1-3, Attachment 1, Tab 1, p. 4, the contingency "is required for estimate inaccuracy and for the possible realization of unknowns, particularly during the commissioning phase."

AMPCO Interrogatory #25

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3 Attachment 1

Preamble: Many of the Business Cases include "OPG Other" as a cost category.

a) Please provide a description of the nature of the costs captured under "OPG Other".

Response

The cost category of "OPG Other" on the BCS Summary of Estimates generally includes internal OPG resources required to execute or support the project that have not already been included under: OPG Project Management, Engineering, or Procured Materials. For nuclear projects, "OPG Other" typically includes station resources such as operators, control and mechanical maintainers, radiation protection technicians, system engineering, etc.

AMPCO Interrogatory #26

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-1

a) Please provide a summary of OPG's key project management performance metrics and discuss performance trends over the past five years and forecast for the test period.

Response

Key project management performance metrics used over the past five years relate to Safety, Project Schedule, and Project Cost.

The Safety metrics are All Injury Rate ("AIR") and High Maximum Reasonable Potential for Harm ("HMRPH").

The AIR metric is measured as total medical treatment plus lost time injuries/200,000 hours worked. The safety trend for OPG project staff, based on AIR, is excellent and consistently below corporate targets. The AIR target is expected to remain better than target through the test period.

The safety metric for contactor staff working on projects is HMRPH. This metric shows an increasing, (i.e., negative) trend. OPG and its contractor partners view HMRPH events as serious because even though no direct injury may have occurred, the potential for serious harm was present. OPG has actions to address this adverse HMRPH trend and expects over the test period to reverse the increasing trend.

The Project Schedule performance metric is an integrated project schedule performance index ("SPI"), which shows a declining (i.e., negative) trend. This is the result of some key projects taking longer to execute along with a significant increase in volume of project work being executed by Projects and Modifications in support of preparation for Darlington Refurbishment (see Ex. D2-2-10). Over the test period, SPI is expected to improve as lessons learned are applied, the addition of a third ES-MSA contractor is utilized, and improved project scheduling standards are implemented.

Project cost performance trend is measured using an integrated cost performance index ("CPI") across the portfolio of projects. This metric has remained constant, slightly above

target. However, there a few projects that exceeded the full BCS release and the number of projects requiring a superseding release has increased over the past five years. The project management improvement initiatives (see Ex. D2-1-1), while not expected to eliminate superseding releases, will reduce the number of projects requiring a superseding release and the magnitude of the additional budget required to complete the project.

AMPCO Interrogatory #27

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-3

a) Please provide the primary reasons for interest cost variances in the total project estimate.

b) Please provide the primary reasons for contingency cost variances in the total project estimate.

Response

a) Interest cost variances in total project cost estimates can arise for any of the following reasons:
- Change in project total cost.
- Change in interest rate.
- Change in annual cash flow distribution (both amount and timing). Interest is calculated until the asset is placed in service. Greater spending early in the project would result in a larger overall interest charge and vice versa.
- Change in timing of assets being placed in-service. Interest is only charged on the current Construction-In-Progress balance until asset is placed in service.

b) Contingency cost variances in total project estimates can arise for any of the following reasons:
- Change in project total cost.
- Change in project scope or duration.
- Project's stage of development. Contingency changes as the project progresses through each phase and cost estimates, scope, engineering and schedule become better defined.
- Risks are identified, change or are retired as the project progresses.

Witness Panel: Nuclear Operations and Projects

AMPCO Interrogatory #28

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref: D2-1-2 Table 1

Please provide a breakdown of Operations Capital based on Projects $5 million to $20 million, Projects < $5 million, and Projects Unallocated showing budget and actuals for the years 2013 to 2016 and forecast for 2017 to 2019.

Response

The requested breakdown of Operations Capital is shown in Chart 1 below.

Chart 1

Line No.	Category	2013 Actual	2014 Actual	2015 Actual	2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
	Operations Capital									
1	$5 Million to $20 Million	70.3	57.7	50.9	109.5	36.8	13.6	8.3	3.6	7.9
2	< $5 Million	37.2	44.1	33.7	35.9	29.9	18.8	1.0	0.0	0.3
3	Unallocated	0.0	0.0	0.0	5.5	48.8	94.6	159.4	221.6	149.8

Witness Panel: Nuclear Operations and Projects

AMPCO Interrogatory #29

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref 1: D2-1-1 Page 1

a) For the years 2013 to 2021, please provide a breakdown of the Nuclear Operations Capital Project Portfolio budget allocated to regulatory, system or unit reliability, system obsolescence or optimizing station generation.

Response

The breakdown as requested is provided in Chart 1 below.

The regulatory category has been interpreted to include projects that replace equipment required to support regulatory requirements as well as projects required by regulatory actions or changed regulation. As such, this total will be different than the total shown in D2-1-2 Table 3, which follows the OPG definition of regulatory projects (i.e., projects required by regulatory actions or regulation change).

The Other category was included for projects, such as facility construction, that do not meet any of the other categories. The Unallocated portion of the Portfolio is not included in the breakdown.

Chart 1

Line No.	Category ($M)	2013 Actual	2014 Actual	2015 Actual	2016 Budget	2017 Plan	2018 Plan	2019 Plan	2020 Plan	2021 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
1	Regulatory	55.4	107.3	85.4	96.1	54.2	32.5	15.5	15.4	8.4
2	Unit/System Reliability	59.8	69.6	95.5	132.9	79.4	55.0	42.9	6.1	3.6
3	System Obsolescence	44.3	52.1	49.1	73.3	65.1	53.0	26.3	16.0	18.2
4	Generation Optimization	2.7	5.7	9.6	8.0	3.5	1.1	2.3	0.0	0.0
5	Other	28.6	35.1	52.9	6.3	1.9	1.9	1.6	0.0	0.0
6	Unallocated	0.0	0.0	0.0	5.5	48.8	94.6	159.4	221.6	149.8
7	**Total**	**190.9**	**269.8**	**292.5**	**322.0**	**253.0**	**238.0**	**248.0**	**259.0**	**180.0**

Numbers may not add due to rounding.

Witness Panel: Nuclear Operations and Projects

GEC Interrogatory #16

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:

Please provide a detailed list of plant modifications and their cost that OPG *has completed* in response to new regulatory requirements imposed by the CNSC in response to the Fukushima disaster. Please provide a detailed list of plant modifications and their cost that OPG *expects to complete* in response to new regulatory requirements imposed by the CNSC in response to the Fukushima disaster and confirm that these costs have been captured in the current application. Has the CNSC indicated whether it has finished adding regulatory requirements flowing from the Fukushima disaster?

Response

The detailed list of completed plant modifications and costs, in response to new regulatory requirements imposed by the CNSC in response to the Fukushima disaster, is as follows:

Darlington:

1) Phase I - Initial Response Effort and Equipment: $3.1M
2) Phase II - Repower Hydrogen Igniters from Emergency Power System: $0.9M
3) Installation of Passive Auto-Catalytic Recombiners: $5.1M

Pickering:

1) Phase I - Hydraulic Analysis Test Report: $4.4M
2) Phase I - Modify the Standpipes & Cover Plates to draw water directly from the intake channels: $4.2M
3) Phase I - Emergency Mitigation Equipment (EME) Water to the Boilers: $1.3M
4) Installation of Passive Auto-Catalytic Recombiners: $12.1M

The detailed list of plant modifications and costs that OPG expects to complete, in response to new regulatory requirements imposed by the CNSC in response to the Fukushima disaster is as follows:

Darlington:

1) Phase I - EME Water to the End Shield Tank: $3.4M
2) Phase I - EME Water to Emergency Water Supply (EWS) and Forebay Standpipes - Water makeup to Steam Generators and Moderator via the EWS, as well as standpipes for EME Pumps: $14.1M
3) Phase I - EME Water to Primary Heat Transport (PHT) System: $2.3M
4) Phase I - Power To Critical Instrument Monitoring - Initial power to critical instrument loops for plant monitoring in a Beyond Design Basis Event (BDBE): $2.9M
5) Phase I - Additional EME Storage - Address additional storage needs in absence of regional response center: $3.8M
6) Phase I - De-aerator Storage Flowpath Seismic Upgrades - Upgrade flow path from De-aerator storage to Steam Generators, to extend available water prior to EME deployment: $1.9M
7) Phase I - Instrumented Steam Relief Valves BDBE Latching - Backup means to ensure ability to latch open relief valves on Steam Generators and ensure availability as heat sink in BDBE conditions: $2.5M
8) Phase I - Irradiated Fuel Bay (IFB) BDBE monitoring - Deployable temperature, level and radiological monitoring in each IFB: $2.3M
9) Phase I – Utilize Dousing Water Inventory for Moderator system - Valve Configuration and Accessibility: $1.1M
10) Phase II - Portable Monitoring - Portable backup to Critical Monitoring: $1.0M
11) Phase II - Emergency Power Restoration (4.16KV) - Deployable generation to restore power to the Emergency Power System: $9.5M
12) Phase II - Airlock Seals Air Supply in a BDBE - Deployable air supply to all airlock and transfer chamber seals: $1.0M
13) Phase II - Deployable Ventilation to the IFB Ventilation System: $1.2M
14) Modifications arising from Functional Reviews - Systematic review for robustness and functionality in BDBE conditions: $2.1M
15) Modifications arising from Fuelling Reviews - Confirm capability to sustain fuelling for deployed BDBE equipment: $0.7M
16) Emergency Telecommunications Enhancement to provide key stakeholders with a means to communicate within OPG and to external authorities after a BDBE - Equipment: $0.2M
17) Emergency Telecommunications Enhancement - Station Installations: $2.6M
18) Emergency Telecommunications Enhancement – Offsite Emergency Operations Centers Equipment Installations: $0.3M

Pickering:

1) Phase I - EME Water to PHT System: $2.1M
2) Phase I - EME Water to Moderator: $7.0M

Witness Panel: Nuclear Operations and Projects

3) Phase I - EME Water to the End Shield Tank: $2.7M
4) Phase I - Power To Critical Instrument Monitoring - Initial power to critical instrument loops for plant monitoring in a Beyond Design Basis Event (BDBE): $4.4M
5) Phase I - Deployable Ventilation to the Irradiated Fuel Bay Ventilation System: $2.7M
6) Phase I - Motorized Valve (MV) Tool Uninterruptible Power Supply (UPS): $5.1M
7) Phase I - Two EME Storage Buildings & Tie Downs: $8.0M
8) Phase I - IFB BDBE monitoring - Deployable temperature, level and radiological monitoring in each IFB: $1.3M
9) Phase I - Portable Tool for MV operation: $3.6M
10) Phase I - Modifications to ensure Seismic Robustness: $6.9M
11) Phase II - Emergency Power Restoration (4.16KV) - Deployable generation to restore power to the Emergency Power System: $22.3M
12) Phase II - Modifications arising from Fuelling Reviews - Confirm capability to sustain fuelling for deployed BDBE equipment: $0.4M
13) Phase II - Repower Hydrogen Igniters from Emergency Power System: $0.8M
14) Phase II - Airlock Seals Air Supply in a BDBE - Deployable air supply to all airlock and transfer chamber seals: $6.0M
15) Phase II - Repower Main Volume Vacuum Pumps – Portable power for pumps to support the Filtered Air Discharge System operation: $2.2M
16) Phase II - Portable Instrument Monitoring - Portable backup to Critical Monitoring: $2.2M
17) Phase II - Modifications arising from Airlocks Seismic Margin & Functionality Gap Assessments - Systematic review for robustness and functionality in BDBE conditions: $2.5M
18) Phase II - Diesel Generator Storage: $4.6M
19) Emergency Telecommunications Enhancement to provide key stakeholders with a means to communicate within OPG and to external authorities after a BDBE – Equipment: $0.2M
20) Emergency Telecommunications Enhancement - Station Installations: $2.7M
21) Emergency Telecommunications Enhancement – Emergency Operations Centers Equipment Installations: $0.3M

OPG confirms that these costs have been captured in its application.

The CNSC has indicated that it has finished adding regulatory requirements flowing from the Fukushima disaster. All Fukushima Action Items (FAIs) are complete and closed.

PWU Interrogatory #1

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:

Ref (a): Exhibit D2-1-3, Page 8 of 19, Lines 24-25:

> One Tier 1 project continues to be deferred. The Feeder Repair by Weld Overlay project (#62568) was deferred in May 2010. A business case summary is provided in Attachment 1 to this exhibit.

Ref (b): Exhibit D2-1-3, Attachment 1, Tab 17 (#62568), Page 1 of 27:

> The business objective of this project is to reduce the cost of managing life-limiting feeder thinning by developing a repair alternative to the current exclusive use of Cut and Weld tooling for replacing thinned feeders. It is estimated that using weld overlay repair technology in conjunction with Cut & Weld tooling (as necessary), will provide a financial benefit in the range of approximately $35M - $143M (NPV) with a 19% - 45% IRR.

a) Why has this project been deferred? Please provide the rationale and, if applicable, any documents to support the decision.

b) Are the stated financial benefit numbers for this project still valid or have they been updated?

Response

a) At the time this BCS was approved, degradation of feeders at Darlington by flow assisted corrosion was a significant life limiting threat. Three approaches were identified to address this risk:

   i. Cut and Weld (Replace)
   ii. Weld Overlay (Maintenance)
   iii. Stress Analysis (Fitness for Service Assessment)

   The stress analysis approach has been successful in demonstrating fitness for service for a large portion of feeder replacement scope, thereby reducing the urgency and

economic benefit for this project. On this basis, the project was deferred, and no decision has been made to resume or cancel the project. See Attachment 1.

b) The stated financial benefits numbers are no longer valid and would need to be updated to reflect new alternatives.

ONTARIO POWER GENERATION

Recommendation for Submission to the Board of Directors

May 20, 2010

Deferral of the Feeder Repair by Weld Overlay Project

Executive Summary

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

Another approach to feeder repair is to use an arc welding process to build up the feeder wall thickness by depositing a layer of metal on the exterior of the tube. Advantages of this method include elimination of the need to defuel and drain the channel as well as a reduction in worker radiation dose and the amount of loose contamination and radioactive waste produced.

Weld overlay technology was demonstrated in a proof of concept study and residual technical risks identified. Tooling specifications were developed and, following an open Request for Proposal process, two vendors were selected to work independently on the preliminary engineering phase to maximize the probability of success.

In parallel with the weld overlay repair technique development, use of a novel stress analysis approach was successful in demonstrating the acceptability of operation with feeders below the previously accepted thickness limit. Regulatory acceptance of this approach significantly reduces the total number of feeders that have to be replaced prior to Darlington refurbishment, thereby reducing the economic benefit for Feeder Repair by Weld Overlay Project.

An engineering decision-making meeting was held to review the results of the preliminary engineering, the status of the technical and regulatory risks and the economic analysis revised with the updated number of feeders to be repaired, costs and application times from the vendor proposals.

It was subsequently recommended to defer the weld overlay repair tooling acquisition for two to three years. Restart of the project would be considered if regulatory acceptance of the reduced thickness limit was at risk, if the number of feeders to be repaired were to increase (for example by a delay in the Darlington Refurbishment dates), or if the economic benefit were enhanced by substantial cost sharing of the next phase of the development. The vendor that has been successful to date in resolving the technical issues has expressed its interest in proceeding on to the next phase of the project if and when it is restarted.

Recommendation

Management recommends the deferral of the tool detailed design and fabrication phase of the Feeder Repair by Weld Overlay Project, which will result in savings of $53.2 Million in Capital over the next three years. During this deferral period, management will evaluate the need for the tooling and request Board approval to either resume or cancel the project.

Recommended By:

Wayne Robbins
Chief Nuclear Officer

Tom Mitchell
President and Chief Executive Officer

This Board memorandum was reviewed and approved for submission to the Board of Directors by the Nuclear Operations Committee on May 18, 2010.

PWU Interrogatory #2

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref (a): Exhibit D2-1-3, Page 3 of 19, Lines 6-12:

> Project #31524 Darlington Station Roofs Replacement: This project is to replace flat roofs on the main powerhouse and other protected area buildings. The roofs are approaching the end of their service lives and need to be replaced. The total project cost is $38.3M with an initial definition phase release of $0.8M. Initial planned final in-service date is December 2018. However, the 2016 capital project portfolio budget is currently oversubscribed (i.e. the number of approved projects exceeds available funding). As a result, this project has been deferred and a revised in-service date has not yet been determined.

Ref (b): Exhibit D2-1-3, Attachment 1, Tab 19 (#31524), Page 1 of 5:

> The station's existing roofs have reached the end of their 25-year design life. Currently there are 135+ Station Condition Record's and 60+ work orders associated with roof leaks. There has also been an Aging Management Program Component Condition Assessment (NK38-REP-2000-10003) carried out for Roofing Construction for buildings inside the protected area which concluded that station roofing is in poor condition.
>
> The current condition of the station roofs exposes Darlington to nuclear and conventional safety risks. Most, if not all systems on both the nuclear and conventional side were designed with the assumption that system operations will take place below a leak-proof roof and no precipitation introduced into the systems environment. Introducing leaked water into any system puts the station in an unpredictable condition that is outside the design basis and therefore creates a potentially hazardous situation.
>
> In addition, addressing the problem of the station's roof condition has been added to the Fukushima response actions and as such will receive special attention from the CNSC and the public. At present, there is an opportunity to avoid threats to the station's Power Reactor Operations License.

Ref (c): Exhibit D2-1-3, Attachment 1, Tab 19 (#31524), Page 2 of 5:

> Base Case: Status Quo – No Project

Witness Panel: Nuclear Operations and Projects

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

a) How many station condition records and work orders associated with roof leaks have arisen since November 2012, the BCS approval date?

b) Has the deferral of this project led to threats to the station's Power Reactor Operations License?

c) If the project is not proceeding due to the portfolio budget being exceeded, why is OPG not seeking to increase the portfolio budget?

Response

a) Since November 2012, there have been 21 Station Condition Records and 20 work orders initiated regarding roof leaks.

b) To date, there has been no threat to the station's Power Reactor Operations License due to deferral of this project.

c) The portfolio budget is determined using a number of inputs, including benchmarking with peers, project backlogs and, importantly, an assessment of the ability of the project organizations to execute the volume of work planned.

One of the objectives of the portfolio management approach described in Ex. D2-1-1 is to allocate projects so that the available project execution capacity is fully utilized. Given this capacity constraint, increasing the size of the portfolio budget would not allow this project to proceed since the project organizations would be fully engaged executing higher priority work.

PWU Interrogatory #3

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref (a): Exhibit D2-1-3, Page 3 of 19, Lines 20-29:

> Project #31535 Darlington Water Treatment Plant Replacement: This project is to replace the water treatment plant, which has been in-service since 1987 and is approaching the end of its 30 year design life. High quality demineralised water is required for station operation. While the plant is operating satisfactorily, operational experience from other stations indicates that their water treatment plants were replaced before the 30 year mark due to declining performance. The total project cost is $57.8M with an initial definition phase release of $5.2M. Initial planned final in-service is November 2019. However, the 2016 capital project portfolio budget is currently oversubscribed (i.e. number of approved projects exceeds funding). As a result, this project has been deferred and a revised in-service date has not yet been determined.

Ref (b): Exhibit D2-1-3, Attachment 1, Tab 21 (#31535), Page 1 of 20:

> Failure of the WTP plant would result in a four unit sequential shut-down of DNGS after 24-48 hours (the time required to deplete the stored de-mineralized water inventory) since there is no backup supply of water available. Equipment aging, degradation and obsolescence combined with higher maintenance requirements will increase the likelihood of extended WTP outages which could result in forced DNGS unit outages. In addition, the risk of environmental spills of acids and caustic liquids used in the current WTP process could increase as the condition of the equipment degrades and maintenance activities increase.

Ref (c): Exhibit D2-1-3, Attachment 1, Tab 21 (#31535), Page 6 of 20:

> Alternative 2: Delay Work – Postpone Replacement of WTP
> A previous review of the options for the existing WTP was conducted in 2005 and concluded that a replacement of the existing WTP was not justifiable at that time. However, WTP has aged significantly since that time. OPEX from other CANDU nuclear stations suggests that the average life span for IX based water treatment plants is 28 years [Ref 1] which is short of their nominal 30 year design life. As a result, the estimated design End of Life (EOL) of the current WTP is 2015. Despite past reliable operation, the WTP will be challenged to maintain satisfactory system health status and reliability as it reaches or exceeds the end of its design life if this project were to be postponed.

Witness Panel: Nuclear Operations and Projects

a) Has the DNGS water treatment plant experienced the same decline in performance near the estimated design End of Life that other stations have experienced?

b) Is OPG aware of any other nuclear generating stations that have continued to keep a water treatment plant in service five or more years past its estimated design End of Life?

c) Is the risk of shut-down of the DNGS caused by failure of the water treatment plant materially higher with the existing plant than it would be with a replacement plant?

d) Have maintenance activities related to the water treatment plant increased as the plant passed its estimated design End of Life?

e) If the project is not proceeding due to the portfolio budget being exceeded, why is OPG not seeking to increase the portfolio budget?

Response

a) There has been no observed decline in performance of the DNGS Water Treatment Plant (WTP). OPG is maintaining the demineralized water quality within design parameters.

The WTP is designed with redundancy. Some reduction in redundancy has been experienced, with no impact on production.

b) Yes, OPG is aware of other nuclear generating stations that have continued to keep a WTP in service five or more years past its estimated design end of life. Of the approximately 110 nuclear power stations in North America, less than 10% are continuing to use their original equipment or some part of their original equipment. This is not unexpected, as the North American nuclear fleet is on average significantly older than Darlington.

c) The risk of a shutdown of DNGS is not materially higher in the short-term with the existing WTP than it would with a replacement plant. A bridging strategy is in place to allow the present WTP to operate with high reliability until a new WTP is in service. Activities are organized as follows:

- Contingency Actions – mitigate consequences of equipment failure
- Repair/Replace – improve material plant condition
- Enhance – restore or improve redundancy of WTP equipment

d) There has been no increase in maintenance activities at DNGS WTP.

e) Please see OPG's response to Part (c) of Ex. L-4.2-13 PWU-2.

PWU Interrogatory #4

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref (a): Exhibit D2-1-3, Page 5 of 19, Lines 18-22:

> Project #73706 Darlington Highway 401 and Holt Road Interchange: This project is to improve traffic flow and capacity at the Holt Road interchange by replacing the existing partial interchange with a new interchange with additional access points. This project is cost-shared with the Ministry of Transport with OPG's share of the project cost being $28.6M. Planned final in-service is December 2016.

a) What is the Ministry of Transportation's share of the project cost?

b) How was the Ministry of Transportation's share determined?

c) Does OPG still expect the project to be completed by December 2016?

Response

a) The Ministry of Transportation's share of the total project cost is $9.5M.

b) The Holt Road interchange work was originally planned by the Ministry of Transportation (MTO) to occur after the completion of the Darlington Refurbishment project. Earlier completion date was negotiated by OPG to improve the traffic flow in and out of the site as well as minimize the impact of this increased traffic on Highway 401 and the surrounding local roads. As such, the MTO agreed to pay for some portions of the project that supported OPG's needs and the full cost of changes that primarily support the 401-407 interconnection to be constructed west of Holt Road.

The Ministry paid the following portions of the project:

i. 64% of cost of clearing the site in advance of construction
ii. 14% of cost of Highway 401 modifications
iii. 8% of electrical relocations
iv. 34% of construction administration, utilities and other overheads

The Ministry paid the full amount of the following changes:

i. Relocation of the Waterfront Trail

ii. South Service Road west of Holt Road
iii. Solina Road
iv. Park Road

c) The project was declared complete by the Ministry in August, 2016.

PWU Interrogatory #5

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref (a): Exhibit D2-1-3, Tables 2a-2e

a) Please identify any projects with a final in-service date prior to October 2016 that are not yet in-service.

b) For projects related to safety please provide updated final in-service dates. Have project delays had a material effect on the safety of employees or the public?

Response

a) There are five projects shown in Ex. D2-1-3, Tables 2a-2e with a final in-service date prior to October 2016 that are not yet in-service. They are shown in Table 1 below.

b) The project delays have not impacted employee or public safety since the existing safety-related equipment and procedures remain in place until the projects are completed. Table 1 below identifies the projects from part a) that are safety-related (i.e., they include safety-related equipment and procedures) and their revised in-service dates.

Table 1
Capital Projects in Ex. D2-1-3, Tables 2a-2e (Projects $5M - $20M) with an original final in-service date prior to October 2016 that are not yet fully in-service

Line No.	Project Name	Project Number	Category	Original Final In-Service Date	Safety Related? (Yes/No)	Revised In-Service Date
1	DN Passive Auto-Catalytic Recombiners	31306	Regulatory	Jun-16	Yes	Apr-17
6	DN Replacement of Obsolete Computer Components	33509	Sustaining	Jul-16	Yes	Jan-18
9	DN MOT Capital Spares	36002	Sustaining	Jul-16	No	Dec-16
19	PN Fire Code Compliance for Relocatable Structures in Un-Zoned Area for Pickering Station	49146	Regulatory	Jul-16	Yes	Jun-17
47	DN Computer Upgrade for HWMS (TRF/SUP)	31436	Sustaining	Feb-16	No	Feb-18

Note: All projects in Exhibit D2-1-3, Table 2c have been completed or cancelled

PWU Interrogatory #6

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Ref (a): Exhibit D2-1-3, Table 2e, Line No. 60:

Line No.	Facility	Project Name	Project Number	Category	Project Description	Start Date	Final In-Service	Total Project Cost
60	DN	DN Station Lighting Retrofit	31516	Sustaining	Replace obsolete florescent lighting in powerhouse with new	Dec-12	Deferred	11.4

a) Please provide the BCS for project no. 31516 DN Station Lighting Retrofit.

b) Why has this project been deferred? Please provide the rationale and, if applicable, any documents to support the decision.

Response

a) See attached file at L-4.2-13 PWU-6, Attachment 1 which has confidential content as marked.

b) The project was deferred to 2016 by the Asset Investment Screening Committee to focus budget and resources on higher priority projects. A Project Change Request Approval Form (see L-4.2-13 PWU-6, Attachment 2 which has confidential content as marked) was approved to document the decision. The project is expected to resume in Q4 2016.

ONTARIO POWER GENERATION

Records File Information:
See Guidance Section

OPG-FORM-0075-R003*

Type 2 Business Case Summary

Final Security Classification of the BCS: **Internal Use Only**

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

Part A: Project Information

Project #:	16-31516	**Title:**	Station Fluorescent Lighting Fixtures Retrofit		
Phase:	Definition	**Release:**	Partial	**Records File:**	D-BCS-56100-10001
Facility:	Darlington	**Class:**	Capital	**Investment Type:**	Sustaining

Business Need:

We recommend the release of $542 ([redacted] base cost plus [redacted] contingency).

This release is for proceeding with the definition phase of the Darlington Station Fluorescent Lighting Fixtures Retrofit project. The estimate at completion is [redacted] with a target completion date of August 31, 2017.

The business objective of this sustaining project is to improve the condition of the station lighting to a reliable and maintainable state, due to the following issues:

1) Deteriorating luminescence levels, due to the large work load required for ballast and bulb replacements (13,000 fixtures and 26,000 fluorescent bulbs).
2) Short bulb replacement intervals of less than 2 years due to inherent drop in lighting output.
3) High maintenance burden; requires 10 FTE.
4) High cost of materials, labour and disposal ($1,400k annually).
5) Low efficiency lighting load of approximately 1MW annually.
6) The supply of existing T12 lights is discontinued and spares inventory will be depleted in 2013. The 8 feet lights are unavailable.
7) 2.88 person rem per outage to maintain lighting in the unit vault.
8) T12 fluorescent lights contain mercury and toxic gases that contribute to hazardous waste.

All of these issues challenge the work groups, create maintenance burden and reduce the safe working environment. (See Nuclear Safety Review Board (NSRB) finding in A/R #28116921).

Preferred Alternative: Conceptual Design Recommendations

The Conceptual Design Report recommends replacing the existing T12 fluorescent lights and magnetic ballasts with T8 fluorescent lights with electronic ballasts in containment areas. In non containment areas, the T12 lights will be replaced with light emitting diode (LED) lights. The suitability of LED lighting for nuclear containment areas is yet to be established. However, the technology is constantly evolving.

It is proposed to start Preliminary Engineering in Jan. 2013, issue an EPC contract in the Fall 2013, Target Unit 2 for installation start in February 2015 and Compete Unit 2 Installation by July 2015.

A pilot project was approved as a NICR to replace the fluorescent lights in Unit 4 pump house with LED lights. It has been a year now and the project is successful.

Base Case: Status Quo – No Project

Do nothing is not an option. This decision can lead to potential safety issues in the station. T12 fluorescent lights are proving difficult to procure and when the existing inventory runs out the existing lights cannot be maintained.

Alternative 2: Delay Work – Deferring This Project into the Future.

This option should not be considered. A new alternative must be in place in order for the Station to maintain safe lighting levels and find a replacement for T12 fluorescent tubes. Also there is an opportunity to save on energy consumption, maintenance costs and reduce potentially hazardous waste.

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

Type 2 Business Case Summary

Alternative 3: Replace the existing fixture with T5 Fluorescent Lighting.

This option is not recommended as T5 lighting requires new fixtures. These new fixtures would have to be requalified which is a very expensive endeavour.

Alternative 4: Replace the existing lights with T8 Fluorescent lights with Electronic Ballasts.

To replace the present T12 lights with T8 will be substantially more expensive than a T8 and LED combination.

Deliverables:	Milestones:	Target Date:
Modification Outline.	Award EPC Contract	November 15, 2013
Design Scoping Check List.	OAR approval of next BCS release	January 15, 2014
Modification Design Requirements.	Complete preliminary engineering.	February 15, 2014.

References:

Conceptual Design Report for Darlington NGS – Fluorescent Lighting Retrofit Project NK38-REP-56100-10009.
Darlington Design Manual - Building Electrical Services – NK38-DM-56000-R001.
Station Fluorescent Lighting Fixtures Retrofit Charter – D-PCH-56100-10002.

Part B: Project Cash Flows

k$	LTD	2013	2014	2015	2016	2017	2018	Future	Total
Currently Released									
Requested Now	-	542							542
Future Required	-		1,048	5,020	4,639	130			10,837
Total Project Cost		542	1,048	5,020	4,639	130			11,379
Ongoing Costs	-								
Grand Total		542	1,048	5,020	4,639	130			11.379

Estimate Class[1]:	Class 4	Estimate at Completion[1]:	[redacted]	OAR Approval Amount:	$542k

Additional Information on Project Cash Flows (optional):

Contingency percentage = [redacted]

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

Type 2 Business Case Summary

Part C: Financial Evaluation					
Choose an item.	Preferred Alternative	Base Case	Delay Work	Alternative 3	Alternative 4
Project Cost	N/A	N/A	N/A	N/A	N/A
NPV (after tax)					
Other (e.g., LUEC)					

Summary of Financial Model Key Assumptions (see Guidance on this Type 2 BCS Form):

As per OPG-STD-0076 an economic evaluation is not required for Sustaining Projects.

Part D: Risk Assessment

Risk Class	Description of Risk	Risk Management Strategy	Post-Mitigation	
			Probability	Impact
Cost	Accuracy of estimate	Accept risk and refine estimates for future release.	Medium	Medium
Scope	Scope definition incomplete	Conduct Scoping COMS with stakeholders, document on Scoping Checklist.	Medium	Low
Schedule	Review and evaluation of contract bids. May require clarification from vendor.	Work with procurement to evaluate bids in a timely manner. Float has been included in the schedule.	Low	Low
Resources	No Design issues identified for this phase.			
Quality/ Performance	No Quality or Performance issues identified for this phase.			
Technical	No Technical risk identified for this phase.			

Part E: Post Implementation Review (PIR) Plan

Type of PIR	Target Project In Service Date	Target PIR Completion Date
Simplified	2016-12-31	2017-06-30

Measurable Parameter	Current Baseline	Target Result	How will it be measured?	Who will measure it? (person/group)
Annual maintenance cost for lighting	Annual lighting maintenance Costs for the station	To reduce the annual operating cost by 50 %	Tracking the total cost annually for maintaining lights	Control maintenance working with Performance Engineering.
Energy consumption for lighting.	1 Mega Watt	Reduction of 50%	Tracking annual consumption for lighting	Control Maintenance.
REM exposure	2.88 Person REM	Reduction of 50%	Tracking annual dose rate for lighting maintenance.	Rad Control.

Type 2 Business Case Summary

Part F: Review/Approvals			
	Signature	**Comments**	**Date**
This BCS represents the best option to meet the validated business need in a cost effective manner.			
Recommended by: D. Muir Project Sponsor	D. Muir		4 Dec 12
I concur with the business decision as documented in this BCS.			
Finance Approval: C. Carmichael VP Nuclear Finance	C. Carmichael		7/12/12
I confirm this project will address the business need, is of sufficient priority to proceed, and provides value for money.			
Approved by: S. Stock Director of Station Engineering, Darlington, per OAR 1.1	S. Stock		11 DEC 2012

Summary of Estimate Sheet										
Project Number:	16-31516		**Facility:**	Darlington						
Project Title:	Station Fluorescent Lighting Fixtures Retrofit									
Estimated Cost in k$										
	LTD	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Future**	**Total**	**%**
OPG Project Management		116	110	279	238	58			801	8
OPG Engineering		116	49	124	104	24			417	4
Permanent Materials				856	936	8			1,800	18
[redacted]										
Total		542	1,048	5,020	4,639	130			11,379	112
Removal Costs Included										

Notes			
Project Start Date	2013-01-01	**Project Completion or In-Service Date**	2017-12-31
Interest Rate	5.00%	**Escalation Rate**	2.00%
Definition Cost Included	$ k or M	**Estimate at Completion**	$ k or M

Type 2 Business Case Summary

Prepared by:	Approved by:
Name: Brian Graham Title: Section Manager, Design Projects 2012-10-29	Name: George Makdessi Title : Manager Design Projects 2012-10-29

PCRAF (Printable Version) (Form) **/ 31516 - DN Station Lighting Retrofit #PCRAF001** (Item) **/ Today** (Data as of: Feb 28, 2014)

Primavera Portfolio Management

Form Report, printed by: zzAdministrator, System, **Feb 28, 2014**

PCRAF (PRINTABLE VERSION)

PCRAF Details

Name of Change Request:	31516 - DN Station Lighting Retrofit #PCRAF001	
Project Manager:	Monize, Peter	
Message:	WARNING: This PCRAF has not been approved or declined.	◆
Work Flow Status PCRAF:	Sponsor Accpt Complete	

Project Details

Initiation Date:	Jan 13, 2014
Cost Classification:	Capital
Phase:	Definition
Current Release Type:	Partial
Estimate Quality:	Conceptual (+ 60%)
Facility:	Darlington
Sponsoring Organization:	Darlington
Executing Organization:	P&M

Type of Change

Directed Change:	Yes	*Yes/No*
Contingency Request:	No	*Yes/No*
If Yes, what amount?		
Milestone Change:	Yes	

Revised Project Annual AISC Approved Cash Flow

	LTD 2012	2013	2014	2015	2016	2017	2018	2019	Future	Total
Control	[redacted]									
New										
Change		-128	-926	-4,482	0	4,364	1,381	0	0	209

Release, Contingency & Last Month End Actuals

Release /w Contingency	542			**LTD Actual**	157
Release w/o Contingency	[redacted]			**YTD Actual**	10
Contingency Withdrawn				**New Project Total**	[redacted]
Total Allotted to Project	[redacted]				
Total Cost /w	11,379				

Contingency					

Schedule Impact

Milestone Changes (Milestone, Existing Date, New Date):

Award EPC Contract
15Nov2013 30Jul2016
OAR Approval of BCS
15Jan2014 15Jun2016

NOTE: The current line total does not match the BCS Total without Contingency, due to the Aug 2013 Blanket PCRAF, and is being corrected now.

Required Background

Description (very brief project purpose, affected systems and project status):

Project was initiated to replace the aging flouresent lights throughout the protected area with new LED lights, preliminary design has been completed and a RFP for engineering, procurement and installation has been issued.

Need for Change (describe change drivers, cause of change, risk event realized):

Due to cashflow constraints, AISC has directed project deferral until 2016.

New milestone dates also account for lessons learned and the need to get a 3rd party estimate prior to awarding a contract.

The requested 2014 amount is less than the approved business plan by $1,002k.
The requested 2015 amount is less than the approved business plan by $4,481k.
The requested 2016 amount matches the approved business plan.

Other Impacts (how scope, quality, strategy, risk & stakeholders are impacted by implementation of change):

None.

Preparation - Submit for Approvals

Name:	Graham, Brian	
Status:	Approved	★
Date:	Feb 6, 2014	
Notes:		

Approval - Executing Organization

Name:	Popovic, Dragan	
Status:	Approved	★
Date:	Feb 20, 2014	
Notes:		

Approval - Project Sponsor

Name:	Stock, Sandy	
Status:	Approved	★
Date:	Feb 26, 2014	
Notes:		

Approval - AISC Chair

Name:	Elliott, Mark	
Status:		-
Date:		
Notes:		

SEP Interrogatory #1

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Exh. D4-1-1 p.1 "OPG capitalizes only those overhead costs that are directly attributable to the acquisition or construction of an asset."

a) Please comment on what factors or criteria OPG uses to determine which overhead costs are directly attributable to specific projects.

Response

In determining which overheads are directly attributable to a project and eligible for capitalization, OPG considers whether the staff in question are working directly on the project. Overhead costs considered to be directly attributable and eligible for capitalization are typically separately identifiable and incremental, with adequate support for such attributes. The costs of the Board of Directors, executive management and general administrative functions are not capitalized.

SEP Interrogatory #2

Issue Number: 4.2
Issue: Are the proposed nuclear capital expenditures and/or financial commitments (excluding those for the Darlington Refurbishment Program) reasonable?

Interrogatory

Reference:
Exh. D4-1-1 p.3 "OPG continues to apply the following thresholds for the materiality assessment …"

a) Please confirm that OPG's capitalization materiality thresholds are periodically reviewed for necessary adjustments due to inflation or other factors such as technological changes.

b) Are OPG's materiality thresholds periodically benchmarked with those used by other major North American utilities?

Response

a) OPG's capitalization thresholds are the same as those used in EB-2013-0321, EB-2010-0008 and EB-2007-0905. In EB-2007-0905 Ex. L-14-46 and EB-2010-0008 Ex. L-1-055, OPG outlined the factors considered in assessing these thresholds. OPG does not believe that circumstances have changed to warrant a reassessment or modification of the thresholds, and that the thresholds remain appropriate and in accordance with US GAAP.

With respect to the possibility of revising of thresholds for inflation raised in the question, OPG observes that previous ScottMadden benchmarking reports have suggested that OPG's capitalization threshold of $200,000 per unit for generating asset classes is higher than those of the majority of other companies in the nuclear industry, a factor that would not support raising the thresholds.[1]

As previously indicated in EB-2013-0321 Ex. L-6.4-1 Staff-086, a primary consideration of OPG's capitalization policy is the nature of the expenditure and its ability to satisfy certain criteria, making the materiality threshold secondary to the nature and purpose of the expenditure. The criteria that OPG uses to capitalize expenditures are listed in Ex. D4-1-1 Section 2.0. In EB-2010-0008 Ex J3.9, OPG indicated that, based on a high-level review, it was unable to identify instances in which these criteria could be met for typical work programs or activities below the threshold of $200,000 per unit applied to generating asset classes.

[1] EB-2013-0321 Ex. F2-1-1, Attachment 1, p. 72 and EB-2010-0008 Ex. F5-1-1, p. 138.

b) No, OPG does not undertake periodic benchmarking of capitalization thresholds. As noted in (a) above, ScottMaden historically has provided observations in this area with respect to one, but not all, of the capitalization thresholds used by OPG.

OPG notes that while it would consider available information about other companies as part of an overall assessment of its capitalization thresholds, this information would represent one of a number of factors that would need to be considered. Other factors include: the extent to which a different threshold would change the level of capitalized costs given that other capitalization eligibility criteria must be met, the overall materiality to OPG's income statement, the impact on administrative costs, and the method by which a change in the thresholds could be implemented in accordance with US GAAP. Therefore, OPG would not necessarily adjust its thresholds in response to information about the thresholds used by other companies.