EB2016-0152

In the Ontario Energy Board

Ontario Power Generation Inc.

Application for 2017-2012 Payment Amounts

Cross-Examination Compendium Panel 1A

Vulnerable Energy Consumers Coalition (VECC)

February 28, 2017

think the answer is no, but I would like you to confirm that.

MR. LYASH: I would say the answer is yes, and I think I've outlined that.

MR. BUONAGURO: I'm following up because I understand there may be perception of the company in terms of its role in Ontario and things like that, but I'm looking for an actual direct regulatory incentive. I think other than avoiding a prudence review, I don't see one.

MR. LYASH: Perhaps you have a particular incentive in mind that I haven't stated, but I think the incentive to run the company to maximize the opportunity for us to invest, to earn a net income and return on that, to be able to continue with the execution of this destiny project, to be able to deliver this at the lowest possible price and contribute to holding down customer rates as a reputational matter that creates opportunity for us to make future investments in the long-term, these are all very real and tangible incentives for OPG.

MR. BUONAGURO: Thank you.

I'm going to take you to an interrogatory we asked. This is Exhibit L, tab 4.3, schedule 5, CCC 18. There are some detailed questions in here about P50 versus P90, and that's not what I'm taking it to you for. I'm actually interested in part C of the question. Okay?

So Part C of the question asked:

> "Please list and describe all the risks that OPG considered may contribute to increased costs for

the DRP where the nature of the risk is such that, if manifested, the added cost would not be appropriately recovered from either OPG's contractors or from OPG's ratepayers, but rather absorbed by OPG directly."

MR. LYASH: Sorry, is that on the screen?

MR. BUONAGURO: The answer is on the screen. The question is on the page before, sorry. So do you want to take a second to read it?

Okay. And then the answer was fairly short. It said:

"There are no risks that OPG considered the program or project level that would not appropriately be recoverable through the CRVA."

And I followed up on this question at the tech conference, and this is at page 163 of the transcript, the same transcript I referred to, Volume 1 of the tech conference. So it's starting at lines 22-23. It says -- and specifically with reference to this answer, it says:

"Now, this answer talks about the program or project level, and that begs for me the question: Is there some other level that is missing from the answer? So if there's some other level that was considered, whether it be program costs that OPG would be -- would have anticipated as a risk that may manifest, you are going to have to absorb, rather than collect through the CRVA."

And, in this case, Mr. Rose, who I believe was on panel 2, answered, and he said:

"No, I cannot think of anything. So we manage the refurbishment as a program. In that program, we're executing 501 projects, contingencies allocated at both program and project level. What we are really saying here is that, if the risks that we have that are included in our base, they would -- that none of them are -- you know, we can't think of anything that would not -- that would be not recoverable through the capacity refurbishment variance account if they should happen."

Then he goes on:

"The correlation to projects in excess of 12.8 billion, that's our internal motivation to be able to deliver the four units at 12.8 billion. The question of CRVA and recoverability of those items is a different question."

So I ask:

"So how is that a different question?"

Mr. Rose:

"Well, the fact that I may not be able to -- I may deem the project a failure because it was delivered at 13 billion, but that 200 million may have been very prudently incurred."

And then I said:

"And, in fact, your answer here is that you can't conceive of a world where it wasn't prudent."

And he says:

"That's correct."

So I was left with the impression after the tech conference that, as far as OPG was concerned, there was nothing you could do that could be considered imprudent with respect to the DRP.

Now, all this came before the Schiff Hardin evidence was filed, so I would like to take you to the Schiff Hardin evidence, and specifically I've collected some things in the interrogatory response that we gave to them.

So looking at Exhibit M1, tab 4.3, schedule CCC-001. Okay? That should come up on the screen. So maybe I can ask while that's coming up: Do you agree with Mr. Rose's characterization?

MR. LYASH: And what characterization is that?

MR. BUONAGURO: Of the risks or absence of risk that OPG will have to absorb anything in terms of imprudent spending.

MR. LYASH: Well, not having read the whole flow of the testimony to understand the context, I'll try to respond.

There is certainly risk associated with the project, and risks may or may not materialize. So OPG's obligation is to prudently -- reasonably and prudently manage this. So the fact that the project -- if there was a series of events that caused the project to run over, that wouldn't necessarily mean OPG is imprudent. It wouldn't necessarily mean we were prudent. You would have to examine the events that occurred and OPG's action to make that determination.

And so, in that sense, OPG has risk. We have risk associated with any imprudence that's demonstrated. So our obligation was to take any issue that arises and address it in a way that is prudent.

MR. BUONAGURO: Thank you.

So I'm looking at the interrogatory that I gave to -- or that we gave to Schiff Hardin, and I excised in the interrogatory response OPG's answer to that Part C question about risks, where the answer was:

> "There are no risks that OPG considered at the program or project level that would not appropriately be recoverable through the CRVA."

And then I excised several statements from the Schiff Hardin evidence, and I don't propose to read through them, but, in general, they seem to me to describe different execution risks that OPG specifically bears during the course of the DRP. Would you agree with that?

MR. LYASH: I mean, OPG bears significant risk all the way through the process, and our obligation there is to manage those risks effectively, reasonably, prudently, and to the extent that there are variances that run through the CRVA, I would expect them to be examined and a conclusion made as to whether we passed that prudence test in dealing with any risk that might arise.

MR. BUONAGURO: So it seems to me that, having revisited this issue, and particularly in view of Schiff Hardin's evidence, it seems to me you are agreeing that there is risk associated with the DRP that, if they

5

functioning working relationship between OPG as Program owner and its contractors. Moreover, OPG must undertake rigorous planning to ensure proper scope and corresponding cost and schedule. However, this is not an end in itself. OPG must also require its contractors to execute the major work bundles in an efficient and cost effective manner and must conduct itself likewise in its capacity as owner. Furthermore, while executing the four-unit refurbishment, OPG must comply with all CNSC regulatory requirements. OPG must also comply with provincial requirements for nuclear refurbishment as set out in the Long Term Energy Plan ("LTEP").

The Program cannot be viewed through a single lens or by considering a single component. As a result, OPG's evidence is structured so as to enable the OEB to understand that OPG (i) has adopted the most appropriate contracting strategy; (ii) has established an effective organization that aligns with and supports that strategy; (iii) has through that organization and in conjunction with its contractors undertaken extensive planning to define the scope, plan the schedule and estimate the cost of the Program; and (iv) has an effective execution strategy to ensure safe completion of the Program on time and on budget. The evidence is organized as follows:

- Ex. D2-2-1 (Program Overview) provides a summary of the Program, the approvals sought, this evidence roadmap and a description of the relevant regulatory framework, including recent amendments to Ontario Regulation 53/05, the Province's Long-Term Energy Plan and the relevant requirements of the CNSC;
- Ex. D2-2-2 (Program Structure) describes OPG's overall commercial strategy for the DRP, which establishes OPG as the Program owner and defines OPG's relationships with its external contractors. In a project of the magnitude of the DRP, it is critical that the responsibilities and accountabilities for project risks and execution be clear. It is also important to ensure alignment between the commercial/contracting strategies and the owner's organizational structure. This schedule describes how OPG has structured itself as the Program owner as well as the management system structures used by OPG to exercise its role as owner;
- Ex. D2-2-3 (Major Work Bundle Structure and Contracts) describes how OPG has structured the major work bundles, as well as the contracting approaches that OPG

has used for each of the major work bundles and the SIO and F&IP projects. The contracting models employed by OPG and the specific contract terms, such as with respect to pricing, will play a significant role in determining how the work will be performed and the overall success of the Program;

- Ex. D2-2-4 to Ex. D2-2-8 (Program Planning, Program Scope, Program Schedule, Contingency, and Cost) are all related directly to the development and approval of the RQE. Program planning concerns the significant investment in planning made by OPG during the Definition Phase to establish detailed scope, schedule and cost estimates, thereby minimizing the risk of scope creep, schedule delays and resulting increases in cost. OPG's approaches to identifying, defining and developing the Program scope, schedules, contingency amounts and cost estimates are considered in greater detail in these schedules;
- Ex. D2-2-9 (Program Execution) focuses on how OPG will manage the Program during execution, including the methods by which OPG as Program owner will manage circumstances that affect scope, schedule, cost and quality during refurbishment execution. In particular, this schedule considers the key activities to be carried out by certain OPG functional support groups during execution, as well as other key controlling activities all of which will enable OPG to effectively track progress and manage execution risk; and
- Ex. D2-2-10 (In-Service Amounts) describes the capital in-service additions, including for Unit 2 refurbishment, unit refurbishment early in-service projects, SIO and F&IP projects, as well as applicable variance analysis.

A detailed breakdown of the DRP evidence structure is included in Attachment 1.

OPG has also engaged independent experts to review and verify key aspects of the Program. The following independent expert reviews are provided in support of the evidence:

- KPMG review of risk management and contingency development process (Ex. D2-2-7, Attachment 1);
- KPMG review of the governance and processes to develop the RQE (Ex. D2-2-8, Attachment 2);

- Modus Strategic Solutions Canada Company and Burns & McDonnell Canada Ltd. Review of the RQE development process (Ex. D2-2-8, Attachment 3); and
- an expert panel, comprised of four individuals with retube and feeder replacement experience, review of the cost estimate for retube and feeder replacement (Ex. D2-2-8, Attachment 4).

In addition, two independent experts have been engaged to give evidence as follows:

- Concentric Energy Advisors, Inc. to provide an independent, updated assessment of their report filed in EB-2013-0321 of the commercial strategies developed for the RFR work package (Ex. D2-2-11, Attachment 1); and
- Pegasus Global Holdings, Inc. to provide an independent and objective assessment of the degree to which OPG's plan and approach to execution of the Program are consistent with the way other megaprojects and mega programs of comparable magnitude, scale and complexity have been carried out (Ex. D2-2-11, Attachment 3).

4.0 REGULATORY FRAMEWORK

4.1 Amendments to O. Reg. 53/05

On January 1, 2016, Ontario Regulation 53/05, *Payments Under Section 78.1 of the Ontario Energy Board Act* (O. Reg. 53/05) was amended to include additional provisions that deal with nuclear refurbishment costs and to define the scope of the OEB's jurisdiction in considering this application. In relation to the DRP, the amendments concern the following key aspects:

- The need for the DRP has been established by the regulation. As set out in the regulation, in setting nuclear payment amounts during the period from January 1, 2017 to the end of the DRP, the OEB shall accept the need for the DRP in light of the Ministry of Energy's 2013 LTEP and the related policy of the Minister endorsing the need for nuclear refurbishment.[5]

(8)

[5] O. Reg. 53/05, s. 6(2), para. 12(v).

KPMG
cutting through complexity

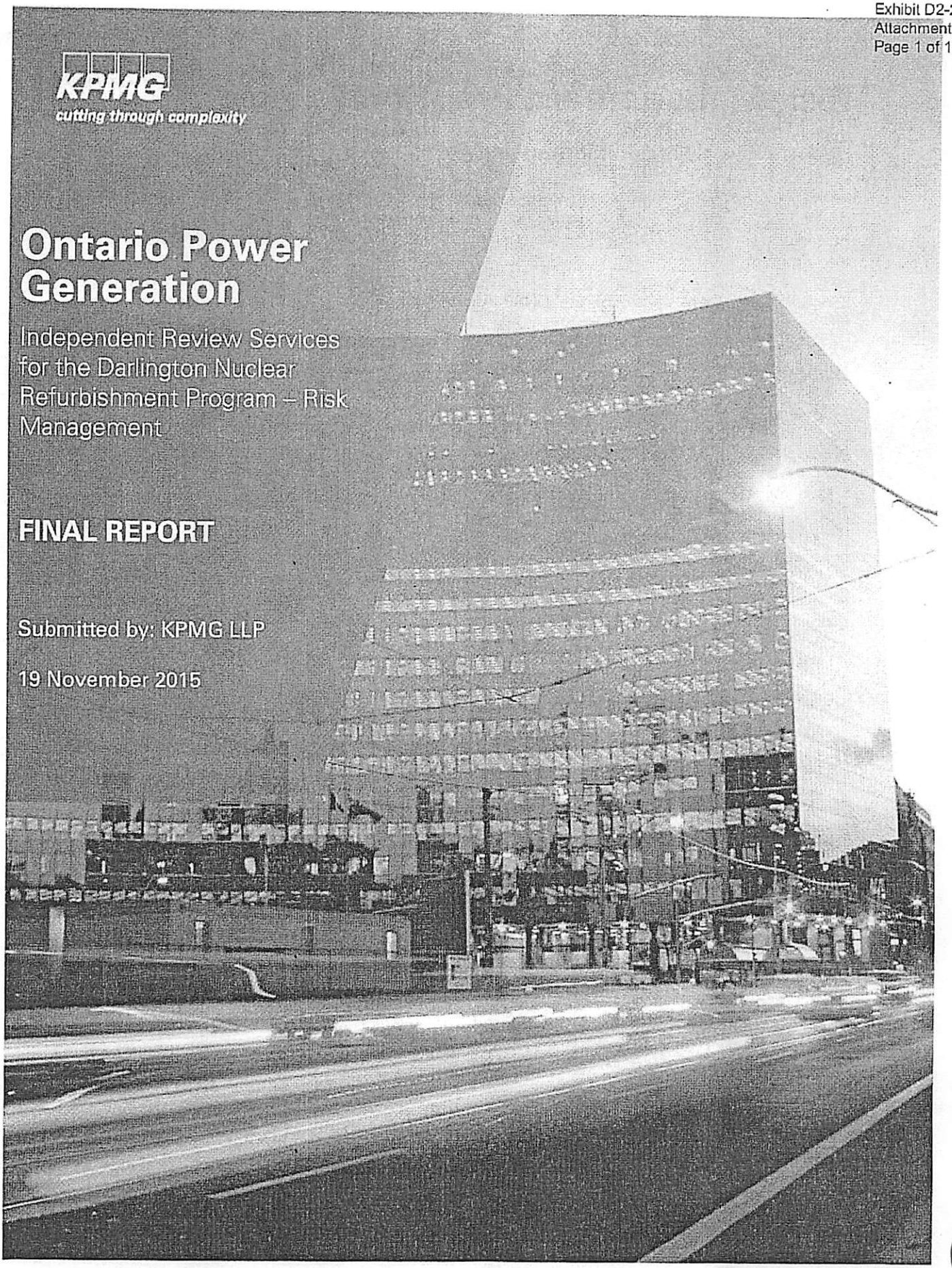
Ontario Power Generation

Independent Review Services for the Darlington Nuclear Refurbishment Program – Risk Management

FINAL REPORT

Submitted by: KPMG LLP

19 November 2015



9

Risk Management Program Review

Report Objectives and Methodology

KPMG LLP ("KPMG") was engaged by Ontario Power Generation ("OPG") to provide an independent review of the risk management and contingency development process for the Release Quality Estimate ("RQE") for the Darlington Nuclear Refurbishment Program ("DNRP" or the "Program").

KPMG's independent review of the DNRP risk management and contingency development process consisted of the following three primary focus areas:

- Comparison of OPG's current risk & contingency governance to AACE standards;
- Review of the output of the Monte Carlo Simulation and findings; and
- Risk and Contingency processes and reports as they relate to industry best practices.

It is worth noting that it is generally difficult to establish estimating benchmarks for contingency in the nuclear industry, and in particular for brownfield projects such as refurbishments. The primary reason for this is that very few recent nuclear projects have actually formally implemented schedule/cost risk contingency factors into their estimates. Another factor that limits direct comparison is that many of the refurbishments completed in North America have unique characteristics such as varying scope, different local factors (i.e., labour), tools and technologies (i.e., mock-up facilities) and often cannot be compared. In the absence of any meaningful refurbishment contingency benchmarks it is generally considered acceptable to follow AACE estimating guidelines to calculate the total estimated program contingency.

As a result the methodology used to perform the review is briefly summarized as follows:

- Review of the integrated contingency estimate and related documentation (see list of documents below). This included documents such as OPG's Contingency Development governance, OPG's Risk Management governance, and the Integrated Contingency Estimate – Snapshot 3 (Final).
- Conduct interviews with key OPG staff involved in the DNRP risk management and contingency development functional groups to clarify questions concerning the documentation reviewed, as well as better understand the estimate development and review process, and to understand the responsibilities of the various project team members.

The OPG documents that have been reviewed, in combination with the October 6th, 2015 interview of key OPG staff, include:

- RQE Contingency Development Plan, Dated 2015-06-04, NK38-Plan-09701-10006;
- RQE Contingency Development Report, Dated 2015-08-20, N-REP-09701-0556625;
- Nuclear Project Risk Management, Dated 2015-03-30, N-MAN-00120-10001;
- Nuclear Refurbishment Risk Management & Contingency Development Guide, Dated 2014-07-28, N-MAN-00120-1000;
- Nuclear Projects Risk Management and Oversight (RMO) TOOL, N-GUID-09701-10123;
- Presentation: "RQE Contingency Development", Dated 2015-06-24; and
- Integrated Contingency Estimate – Snapshot 3 (Final) dated September 30, 2015 – 'RQE Mgmt Summary – Contingency Snapshot 3.pdf'.

(10)

Summary of Findings

Overall, OPG's governance, methodology, and approach aligns with AACE guidelines and industry practice in terms of identifying and classifying risks and utilizing an integrated Monte Carlo based risk analysis.

OPG's integrated contingency estimate (Snapshot 3 – final) is based on a Monte Carlo analysis that consolidates the major contributors to contingency; namely: (a) cost uncertainty, (b) schedule uncertainty, and (c) discrete risks to determine the total contingency estimate for the DNRP.

The elements of contingency related to cost and schedule uncertainty are connected to the uncertain nature of the project work scope and depend on the following factors:

- Imperfect understanding of known work (e.g., estimator's interpretation of the contract documents, understanding of construction means and methods);
- Incomplete understanding of scope of work (e.g., quantity or type of materials); and
- Productivity factor / variability of factors applied (e.g., labour and equipment productivity).

The elements of contingency related to risk (i.e., discrete risks) are specific 'known' risks that have been identified by the project teams in the risk register (i.e., the RMO tool discussed below) and the project teams have applied three point estimates to each risk's (a) probability and (b) cost or schedule impact (i.e., dollars or duration) depending on the nature of the risk.

The OPG RMT confirmed that the contingency estimate in 'Snapshot 3' is calculated at a 'P90' which means that from a statistical standpoint there is a 90% chance that the actual contingency will be less than the estimated amount. It is important to note that this value is calculated as the result of a Monte Carlo risk analysis using computer simulations. The Monte Carlo analysis essentially simulates the project taking place over thousands of iterations. As it runs, the Monte Carlo analysis activates risks randomly throughout the project. As a result the total contingency estimate will be slightly different each time the risk analysis simulation is run.

Similarly, the same Snapshot 3 document shows the total outage delay at a P90 for the first unit (i.e., Unit 2) broken down into days of delay attributed to risk (i.e., discrete risk events that impact activities on the critical path) and days of delay attributed to schedule uncertainty.

OPG Contingency Development Process: AACE, Monte Carlo and Industry Best Practice Review

Contingency funds are allocated to manage uncertainty and risk throughout the life of a project or a program. Contingency development is an integral part of the estimating, scheduling and risk management process. Contingent funds should be a function of variables such as project size, duration, complexity, risk exposure, tolerance, prior experience with the work, and confidence levels set by management. In all cases, contingency development is predicated on a high quality base plan and a high quality risk register

Without a high quality base plan, one cannot effectively identify risks. Without a high quality risk register, one cannot effectively identify contingency. It is the expectation that the base plan is reasonable, achievable and endorsed by necessary stakeholders in advance of requesting contingency calculations.

It is KPMG's view that the risk register implemented by OPG, in the "RMO" tool, is of quality and integrity, it is also in alignment with industry guidelines and best practices. The RMO risk register adequately encompasses the risks identified by the project managers, and the broader OPG team through ongoing risk workshops and team meetings conducted by the OPG DNRP team.

The completeness of the risk register has not been assessed by KPMG team, nor have the specific dollar amounts associated to each of the risks in the register. KPMG's review focused solely on the processes and governance applied by OPG to identify and quantify risk and to determine contingency for the DNRP.

According to AACE recommended practices 40R-08, 57R-09, 41R-08 a risk management and contingency development methodology should address (at a minimum) these general principles:

1. Clearly defined contingency governance, processes and tools;
2. Identification of the risk drivers with input from all appropriate parties;
3. Clear linkages between risk drivers and cost / schedule outcomes;
4. Probabilistic estimating results in a way that supports effective decision making and risk management;
5. Inclusion of the impact of schedule risk on cost risk; and
6. Range estimating techniques applied to critical risk items.

The following tables outlines the DNRP Contingency Development Process observations as they correlate to AACE recommended practices outlined above:

AACE RP 40R-08	Recommended Practices as compared to OPG's Risk Management and Contingency Development Program
1. **Clearly defined contingency governance, processes and tools.**	▪ Overall, OPG's risk management and contingency development planning documentaion is considered to be in-line with AACE guidelines and industry practice in terms of defining the key elements of the risk/contingency development process and providing the roadmap for the DNRP's project teams to follow in the risk/contingency development process. For reference the following primary documentation (combined with the knowledge and experience of the RMT) provided guidance. • RQE Contingency Development Plan, Dated 2015-06-04, NK38-Plan-09701-10006; • RQE Contingency Development Report, Dated 2015-08-20, N-REP-09701-0556625; • Nuclear Project Risk Management, Dated 2015-03-30, N-MAN-00120-10001; • Nuclear Refurbishment Risk Management & Contingency Development Guide, Dated 2014-07-28, N-MAN-00120-10001; and • Nuclear Projects Risk Management and Oversight (RMO) TOOL, N-GUID-09701-10123. ▪ The core risk management team ("RMT") is a centralized function within the DNRP that has developed standardized risk management processes and tools for the DNRP. In addition to an oversight role, the RMT provides ongoing guidance and support to the project managers of the various project bundles in applying and interpreting the risk management methodology. The centralized nature of the Risk Management function allows the team to provide standardized processes and tools across the various bundles of the DNRP which is considered to be in line with best practices (ref. Document review list for a sample standard documentation). ▪ A key element of the contingency development process is the Risk Management and Oversight Tool (RMO) which KPMG considers to be leading practice. The

AACE RP 10R-08	Recommended Practices as compared to OPG's Risk Management and Contingency Development Program
	RMO tool is more than just a risk register that forms the basis of the contingency calculation for discrete risks – it is an application project managers will use to perform risk management activities throughout the course of the DNRP. The risk management team owns and administrates the RMO tool and provides training, support, and guidance to the organization. ☑ Another key element of the contingency development process is that the centralized risk management team has embedded local risk management team members within each project bundle (i.e., 'Single Point of Contact' or 'SPOC') to facilitate interpretation of the risk managment process and ongoing risk management. ☑ The RMT confirmed that the RMO tool will be scalable such that additional risks can be input as they are identified throughout the course of the DNRP. In addition, the RMO tool enables risks to be tracked, monitored and adjusted as the program progresses to provide management with a clear real-time overview of project risks.
2. Identification of Risk Drivers	☑ In accordance with OPG's risk breakdown structure, OPG's integrated contingency estimate (Snapshot 3 – final) contains three major contributors to contingency; namely: (a) cost uncertainty, (b) schedule uncertainty, and (c) discrete risks. **Discrete Risks** ☑ OPG's RMO tool is the primary tool for identifying and managing the risk drivers on the DNRP (i.e., the discrete risk component of contingency). It is a centralized database that contains all the risk events (i.e., the known unknowns) which are then used as inputs to to the risk modeling program (i.e., Palisades' @RISK discussed below) to calculate the 'risk' based component of the contingency amount (the other component related to cost / schedule uncertainty is described below). ☑ The risk register was initially developed by subject matter experts on each of the project teams (i.e., RFR, BOP, TG, etc.). The risk register was then vetted by a series of challenge sessions led by a panel of independent subject matter experts that interrogated the risks. **Cost & Schedule Uncertainty** ☑ The second major component of contingency "cost / schedule uncertainty" was developed in collaboration with individual project subject matter experts (i.e., the project directors) and the DNRP's estimating and scheduling functional groups. ☑ In terms of cost uncertainty, final estimates were approved and classified by the Estimating function and three point estimates (i.e., see estimating ranges discussed below) were provided by the project leads for each of the six major project cost elements: (1) Project Management, (2) Engineering, (3) Procurement, (4) Construction, (5) Commissioning and (6) Close-out (i.e., known as the 'PEPCC' elements). ☑ In terms of schedule uncertainty, after the schedules were accepted and classified by OPG's scheduling and estimating functional groups, OPG's subject matter experts provided three point estimates for the activities on the critical path. In addition, 'discrete risks' that relate to activities on the critical path were mapped to such activities so that the composite effects of 'risk' and 'uncertainty' on schedule were considered in the Monte Carlo risk analysis. This approach is

AACE RP 40R-08	Recommended Practices as compared to OPG's Risk Management and Contingency Development Program
	considered to be best practice – see Item 5 below – 'Inclusion of the impact of schedule risk on cost risk.'
3. **Clear link between risk drivers and schedule / cost outcomes.**	▪ A solid Risk assessment process involves both qualitative and quantitative risk assessment to help identify priority risk items. ▪ The qualitative risk assessment process assists the project teams (and Risk Management Team) to quickly determine the largest risks to the project and helps prioritize risks for risk response (i.e., developing strategic options and determining actions to reduce the threat). For the purpose of consistency the Risk Management team has developed a standard 'risk assessment scale' that enables each risk to be scored on the basis of probability and impact (financial or shedule). The qualitative risk assessment process is managed via the RMO tool, the risks themselves, initial risk scoring ('risk assessment scale' scoring), and risk response planning are tracked and monitored via the tool. This is aligned with best industry practices. ▪ The quantitative risk analysis process is performed on items that have a significant qualitative risk that would require contingency fund allocation. For each identified risk the project team assign a three point estimate for probability and impact (i.e., dollar value) of the identified risk on overall project objectives. This activity provides a clear link between risk drivers and schedule / cost outcomes, and all this data feeds into the Monte Carlo risk simulation software (@Risk) to determine the 'discrete risk' component of contingency. This is aligned with best industry practices.
4. **Probabilistic estimating results in a way that supports effective decision making and risk management.**	▪ OPG used a probabilistic Monte Carlo risk analysis (i.e., Palisades' @Risk software) to analyze the impact of risk and uncertainties using multiple simulations. The input for the probabilistic analysis was gathered from project leads and the estimating team. This involved obtaining three point estimates (Most Likely, Optimistic, and Pessimistic) for residual risk impacts and cost and schedule estimates. ▪ To support the RQE contingency development process the output of the Monte Carlo simulation depicted the probability distribution of cost and schedule outcomes based on input assumptions. This type of information was used by OPG to understand the expected cost/duration and the range/dispersion of the projected cost and durations. ▪ After the initial contingency development workshops were completed and a preliminary contingency estimate prepared, management reviews were held to validate the overall adequacy of the RQE contingency estimate. This ensured that the level of detail available for the estimate itself, and the input risks and uncertainties that comprise it, were reasonable and prudent. Reconciliation of the contingency estimate will be performed by the risk department in line with the RQE roadmap. ▪ As additional support to the RQE contingency development process the results of the Monte Carlo simulation included a cumulative probability distribution of total cost / schedule, in the shape of an S-curve. The S-curve was derived from the contingency analysis process and represents the variability in the cost/schedule estimate for the project. For example, the S-curve for schedule duration is illustrated in OPG's 'Integrated Contingency Estimate – Snapshot 3 (Final)'.

AACE RP 40R-08	Recommended Practices as compared to OPG's Risk Management and Contingency Development Program
	▪ Due to the size and complexity of the simulation that was required for the DNRP, the OPG Risk Management Team elected to bring onboard a Risk Modelling subject matter expert from Palisades (a recognized industry expert in risk modelling) which is considered best practice for infrastructure projects of this nature and scale. ▪ The KPMG team reviewed OPG's Integrated Monte Carlo Simulation (IMCS). It was found that OPG had developed a robust IMCS model by completing quality and data integrity checks after the Contingency Development Workshops held in July 2015. ▪ OPG utilized statistical correlations (also known as Markov chains) in the Monte Carlo simulation to simulate the interdependence of related activities which is considered to be best practice. Currently, OPG has applied a global correlation coefficient (i.e., $\rho = 0.7$ coefficient) to all its relationships. OPG ran multiple simulations and varied the correlation from weak to strong (see definition below) and it was shown that there was a relatively small impact on the overall contingency calculation. For reference, the correlations are described by the following coefficients: ◦ Weak Correlation ($\rho = 0.15$), ◦ Moderate ($\rho=0.45$), ◦ Strong ($\rho=0.8$ or higher)

AACE RP 57R-09	Recommended Practices as compared to OPG's Risk Management and Contingency Development Program
5. **Inclusion of the impact of schedule risk on cost risk.**	▪ Based on the DNRP's resource loaded 'critical path method' (or "CPM") schedule, OPG calculated (using Monte Carlo simulation) the (4) unit overall schedule duration P90 (including uncertainty & risk). This includes OPG's assessment of Project, Program, and JV owned risks that could impact critical path. It uses the uncertainty ranges for optimistic, most likely, and pessimistic outage durations. The basis for a program level cost burn rate (per day) has been documented by the OPG Finance team and is incorporated in the analysis. ▪ It is noted that a review of the inputs to this type of calculation were beyond the scope of this report. For reference these inputs generally include (a) a resource loaded schedule, (b) a contingency free cost estimate and (c) risk data with probability and impact parameter data. ▪ The OPG RMT reviewed the RMO tool to ensure that Schedule uncertainty values did not overlap with "discrete risks for schedule" to ensure that there was no "double counting" of contingency. ▪ The total integrated DNRP contingency estimate for the impact of schedule risk on cost risk for the (4) unit overall schedule comprises the largest overall percentage of contingency as illustrated in OPG's Integrated Contingency Estimate Snapshot 3 (Final).

AACE RP 41R-08	Recommended Practices as compared to OPG's Risk Management and Contingency Development Program
6. Range estimating techniques applied to critical risk items.	▪ The OPG risk register adequately captures the data for the Monte Carlo probabilistic analysis including the three point estimates (Most Likely, Optimistic, and Pessimistic) for risk impacts, cost and schedule estimates.

1. RQE Independent Review Executive Summary

1.1 Scope of the Review

KPMG LLP ("KPMG") was engaged by Ontario Power Generation ("OPG") to provide an independent review of their governance and processes to develop a Release Quality Estimate ("RQE") for the Darlington Nuclear Refurbishment Program ("DNRP" or the "Program").

KPMG's independent review of the DNRP RQE processes and estimates consists of the following two focus areas:

1) Governance and Process Assessment ("Work Stream 1"), and
2) Cross Cutting Vertical Slice Review of the estimates ("Work Stream 2")

The KPMG scope does not include the validation or assessment of the quantities, figures, or calculations performed to arrive at the final RQE cost figure.

The draft report for Work Stream 1 was delivered to OPG in May 2015. The draft report for Work Stream 2 was delivered to OPG on September 2015. Since then, both reports have been progressively updated based on OPG's feedback and documentation provided by OPG to help address or close the gaps and findings.

1.2 Work Stream 1 – Governance and Process Assessment

The objective of Work Steam 1 is to assess OPG's estimating governance and management processes for developing the RQE against the following AACE[1] guidelines:

- Development of Estimate Plan Process (AACE No. 36R-08);
- Development of Estimate Plan Content (AACE No. 36R-08);
- Basis of Estimate (AACE No. 34R-05);
- Estimate Classification System (AACE No. 18R-97);
- Estimate Review, Validation, and Documentation (AACE No. 31R-03); and
- Developing a Project Risk Management Plan (AACE No. 72R-12)

OPG have demonstrated knowledge of the AACE guidelines and have generally interpreted and correctly applied them to the DNRP program.

KPMG also noted that OPG's estimating governance and processes for the DNRP RQE are strong in the following areas:

1. The **estimate classification system** has been developed in direct alignment with AACE guidelines and tailored to fit the nuclear industry. The estimating team has strong knowledge of the terminology and significance of the AACE concepts with regards to cost classification and levels of maturity and project definition.
2. **Historical knowledge** of risks, opportunities and lessons learned from other projects have been well integrated and considered across most project bundles.
3. The RQE **risk management framework** has been developed and implemented following a

[1] The Association for the Advancement of Cost Engineering ("AACE") is a non-profit organization recognized throughout the construction industry for publishing a set of guidelines for the effective application of professional and technical expertise to plan and control resources, costs, profitability, and risk.

thorough process and utilizing best practice tools at the corporate and project level.

4. OPG have designed and implemented processes for challenging and performing **quality reviews of vendor estimates**. Such processes are tailored to the nuclear projects environment, and therefore are in alignment with AACE guidelines and best estimating practices.

As would be normal for a program of this size, KPMG has identified some procedural (non-critical) gaps from recommended AACE guidelines and industry leading practices. For context, gaps are classified under two categories of priority:

Table 1: Explanation of Risk Categories for Work Stream 1

Category	Definition
A	Category A: Items that could potentially impact the level of confidence in final RQE value and could be considered a priority.
B	Category B: Items that will have less of an impact than Category A items on the level of confidence in final RQE value, but will impact the quality of the final estimate produced and should be addressed in 2016 (prior to the execution stage) as part of the check estimate process.

KPMG has completed the analysis of 186 items of RQE against the AACE guidelines. Out of 186 items analyzed, KPMG's current classification of the gaps is:

- 0 items as category A (critical) gaps
- 33 items as category B (non-critical or procedural) gaps

The 33 category B gaps are quality issues related to governance documentation that can be improved to further substantiate and support the estimate. This number of category B gaps is considered normal and could reasonably be expected for a capital program of this size. The process for developing the RQE is a significant undertaking to consolidate, update, validate and summarize information for 538 project numbers (bundle costs) and functional cost estimates. The fact that there are no category A gaps in our assessment is a reflection of the effort deployed by the OPG team, and the quality of the processes and governance implemented to arrive at the RQE which is in general alignment with AACE guidelines.

It is expected that the 33 remaining category B gaps will be actioned and addressed by the OPG team throughout 2016 to support the "check estimate" process, allowing for a robust estimating basis and baseline for execution.

Detailed tables with descriptions of the gaps and findings in Work Stream 1 are provided in the final report.

1.3 Work Stream 2 - Cross Cutting Vertical Slice Review

The objective of Work Stream 2 is to perform a cross cutting review of estimate documentation, utilizing three vertical slices of the DNRP, and provide a report on overall traceability, data integrity, and level of detail in the preparation of the RQE.

The three vertical slices selected by KPMG are:

- Re-tube and Feeder Replacement ("RFR");

- Balance of Plant ("BOP"); and
- Operations and Maintenance ("O&M").

KPMG found that the vertical slices reviewed are generally well organized, complete, and traceable to estimate detail and source data. KPMG also found that the level of detail in the estimate packages is generally acceptable and sufficient when compared to other similar projects and best industry practices.

As would be normal and expected for a program of this size and complexity, the 'estimate slices' reviewed by KPMG contained some non-critical gaps/quality issues (i.e., referred to in this report as Category B and C issues). OPG is working collaboratively with its vendors to reduce the number of quality issues in the estimates.

Table 2: Explanation of Risk Categories for Work Stream 2

Category	Definition
A	Category A: Items that could potentially impact the level of confidence in final RQE value and could be considered a priority.
B	Category B: Items that will have less of an impact than Category A items on the level of confidence in final RQE value, but will impact the quality of the final estimate produced and should be addressed in 2016 (prior to the execution stage) as part of the check estimate process.
C	Category C: Items that likely will not materially impact the level of confidence in the final RQE, but could have an impact on the quality of the final estimate or expose OPG to commercial risk and should be addressed in 2016 as part of the check estimate process.

Out of 554 items analyzed, KPMG's current classification of the gaps for Work Stream 2 is:

	Open (as of November 6, 2015)			
Category	RFR	BOP	O&M	Total
A	0	0	0	**0**
B	9	27	4	**40**
C	8	29	7	**44**
Total:	**17**	**56**	**11**	**84**

As of the submission date of this report 0 higher risk (i.e., Category A) gaps remain open.

There are 84 Category B and C issues that remain to be actioned and closed. For a program of this size and complexity this number of non-critical issues is considered reasonable and would normally be expected.

OPG's Darlington Nuclear Refurbishment Program is a program of massive scope and performing a comprehensive cost review represents an enormous undertaking.

To ensure a thorough review is completed, KPMG has utilized a systematic review structure to examine the RFR, BOP and O&M vertical slices. These slices represent a substantive portion of the

RQE (36% or $4.6B of the total $12.8B RQE cost). This structure includes the use of existence and traceability checks for each cost category. Our approach, for example, was applied to the review of the RFR vertical slice, which represents $3.6B or 28% of the RQE, and is the largest and most significant portion of RQE. The review of the RFR vertical slice involved 364 individual checks which covered approximately 60% of all RFR costs across the four units. Of these 364 checks, our results produced 42 identifiable issues in the initial RFR estimate draft (Rev. 0) which included 1 Category A, 33 Category B, and 8 Category C issues. With the latest RFR estimate (Rev. 1), the number of issues have now declined by 60% to 17 issues, which include 0 Category A, 9 Category B and 8 Category C issues.

KPMG believes this is reasonable low number of issues for a project of this scale, and have determined the issues are not critical for the purposes of RQE.

It is anticipated that these quality issues (combined with OPG's own checklist of quality issues) will provide a comprehensive 'checklist' for closing gaps when the estimates undergo the final 'check estimate' in 2016 and we consider that OPG have ample time to work with vendors in addressing these gaps prior to execution. This process should be started as soon as possible.

The themes below are the primary generators of the 84 gaps. These quality issues are listed in their respective 'estimate slice' section of the final report for reference purposes.

Key Themes of remaining Category B and C gaps:

1) Basis for labour rates in the estimates not always clearly specified in the estimate package or documented in the BOE.
2) Some bundle estimates do not adequately identify strategies or assumptions that were made with regard to the workweek schedule (hours worked per day, days worked per week, shifts worked per day, etc.) and planned use of overtime.
3) Some estimates have not adequately defined its resource strategy such as its approach to resource levelling and allocation of the PMT and indirect costs across multiple projects.
4) The project assumptions/exclusions are not in all cases clearly reflected in the estimate package for some project bundles (Basis of Estimate) and not clearly linked to the estimate workbooks.
5) Project schedules within the BOP project bundle have certain negative characteristics with respect to logic and integrity that degrade their ability to provide accurate analysis and forecasting. OPG's scheduling team have identified the same issues as KPMG, and are currently working with the BOP vendor to improve the schedules and address the findings. Currently, when measured against industry recommended standards, the quality level of their construct /configuration does not indicate a reasonable level of confidence or reliability in their usefulness as a forecasting tool.
6) Data integrity issues with numerous hard coded numbers (i.e., hours and dollars) in the estimate without explanation, Excel worksheets with broken links to other missing worksheets, etc.
7) There are examples of "plug pricing" for major equipment with no unit cost basis (i.e., source, year).

It should be noted that the issues identified by KPMG (or issues of a similar nature) should be addressed throughout the DNRP estimate, not just in the three vertical slices that were the focus of the final report.

Detailed tables with descriptions of the gaps and findings in Work Stream 2 are provided in the final report.

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

Nuclear External Oversight Assessment Report of DR Team's Process for Developing the RQE Estimate

OBJECTIVE AND SCOPE

Burns & McDonnell Canada Ltd. and Modus Strategic Solutions Canada Company ("BMcD/Modus") have assessed the DR Team's process for developing the Release Quality Estimate ("RQE") which OPG and the DR Team have been developing since 2009. The DR Team's major focus over this time period has been the development of detailed cost estimates of sufficient quality and basis in order to establish a four-unit, program level ***control budget*** for the DR Project. In order to develop the control budget, the DR Team was required to mature its planning to the point where the cost estimates were of substance and able to be relied upon. In keeping with OPG's funding release strategy, the DR Team will continue to refine the unitized estimates for each of the four units in order to make specific funding requests through the established gating process. However, the RQE control budget will be the baseline against which both the stakeholder confidence and public trust will be measured for the life of the DR Project. In order to plan and develop the RQE, OPG developed its governance and adopted industry accepted guidelines with respect to cost estimating to facilitate the efforts of its project teams and vendors.

This report addresses the following issues related to RQE and the processes the DR Team used in developing its multiple sub-components:

- Has OPG properly developed and supported its control budget for the DR Project in conformance with OPG's governance and applicable industry guidance, in particular those of the Association for the Advancement of Cost Engineers International ("AACE International")?
- Was the process used for RQE reasonably robust and thorough in regard to the development of the DR Project's control budget?
- Was OPG's process for developing the control budget for RQE successful in advancing the overall maturity of the effort and characterizing its project estimates?
- Did OPG develop contingency in a manner reasonably consistent with prevailing industry practices and its adopted Governance?
- Did OPG properly document the RQE Basis of its Estimate ("BOE") in a manner that allowed for reasonable vetting by Senior Management?

In the foregoing, BMcD/Modus focused on the manner in which the DR Team developed, vetted, iterated and finalized the major elements of RQE, including:

- Base or direct cost estimates for the multiple sub-projects, or "bundles", which were largely developed by OPG's vendors and vetted by OPG for purposes of establishing commercial agreements with the contractors;
- Functional costs for OPG's project management team, which were prepared by OPG;
- Project and program contingency, which was developed by OPG.

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

It should be noted that this assessment's entire focus has been on the process the DR Team used for developing the RQE. BMcD/Modus has not evaluated whether the particular quantum of any of the costs estimates in part or in whole are sufficient for performing the work. We have not performed independent estimates or Monte Carlo simulations. We do not express an opinion whether the DR Project can be successfully performed within the funding envelop that RQE's control budget provides, nor do we have an opinion regarding whether the amount of contingency is sufficient for covering the DR Project's risks. We have not assessed in any manner OPG's projections used for RQE for escalation or foreign exchange rates. Rather, we have only evaluated whether the major processes that the DR Team used for formulating the control budget were reasonable, sufficiently robust and thorough, and in general conformance with what is commonly done in the industry on similar large capital projects.

In addition to assessing the development and status of the RQE, BMcD/Modus provides recommendations for addressing potential improvements, in particular for future cost estimating updates for each of the DR Project's four units. Some of the goals that the DR Team had for RQE were not met, including the maturation of all of the Project bundles to AACE International Class 3 cost estimate or better along with the completion of an integrated baseline project schedule. While the DR Team mitigated the uneven maturity level represented by the cost estimates and schedules prepared for RQE, it will still need to close the gap or the DR Project could be subjected to unanticipated risk cost and schedule overruns. Hence, while BMcD/Modus believes that OPG has substantially met the goals for RQE, the DR Team will have considerable work to complete prior to Unit 2's breaker open in October 2016.

PERIOD OF ASSESSMENT

November, 2014 through November, 2015.

OVERALL ASSESSMENT RISK SCORE:

The overall risk score for RQE is **Low to Medium.** However, we have identified some significant risks associated with certain items of RQE which the Project Team intends to address, though if not corrected for the Unit 2 Estimate, could have a medium- to-high impact on the Unit 2 Estimate and thereafter.

BACKGROUND AND METHODOLOGY

From the outset of our engagement, BMcD/Modus has been focused on the DR Team's progressive development of RQE. Our team has monitored and evaluated the processes developed and utilized by the DR Team as they have evolved through the budget development process. We have issued two prior assessments that focused on RQE inputs, our Initial Assessment in August 2013, which discussed the then-current status of budget development, and our Observations of the 4d Cost Estimate in November 2014. Throughout our engagement, BMcD/Modus has been partially embedded in the development of the DR Team's and the EPC contractors' development of direct cost, project bundle estimate development, the DR Team's development of the functional estimates and project contingency. We have issued more than 200 separate recommendations, most of which have had direct or tangential relationships to elements in RQE. The DR Team has dispositioned all but nine of these recommendations to date.

In monitoring the development of the project bundle estimates from a process perspective, we have actively participated in (on a selective basis) detailed vetting sessions for each of the bundles, with specific emphasis on the Retube and Feeder Replacement ("RFR"), Turbine Generator upgrades, Balance of Plant ("BOP"), Shut-down/Lay-up ("SDLU") and Refurbishment Support Facilities ("RSF").

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

Together, these bundles represent approximately 90% of the RQE direct field work costs. We have performed detailed review of each of SNC/Aecon's RFR successive estimate submissions and provided the DR Team with our comments regarding the process used and components of the estimate, specific cost quantum excluded. As part of the RFR Class 2 review, we provided the DR Team with in excess of 200 comments and participated in multiple weeks of review and vetting sessions. We have also participated in executive steering committee meetings with SNC/Aecon and OPG at which the commercial aspects of the RFR, Turbine Generator and D2O Storage Facility projects have been discussed.

With respect to the functional costs, we have monitored the DR Team's development of functional management plans, cost estimates and challenge sessions and issued multiple specific recommendations regarding the development of roles and responsibilities for the DR Team. We note herein that the DR Team did not fully define roles and responsibilities of the functional groups, thus the specifics of the functional area cost estimates will require significant additional work prior to the start of Unit 2.

Recognizing the critical importance of risk management and contingency development, BMcD/Modus has closely followed the risk management and contingency programs since early 2013. We closely monitored the development of the Risk Program for OPG activities and for contractor activities, especially related to SNC/Aecon's RFR project performance. In February 2014, BMcD/Modus issued an Assessment Report on the DR Risk Program and worked with the DR Risk Team to address and close the assessment's recommendations. From a process perspective, BMcD/Modus has maintained constructive and close interface with the DR risk group throughout the Definition Phase, and the DR Team has been receptive to our comments. BMcD/Modus also performed periodic process reviews of the SNC/Aecon and DR Project risk registers and relevant procedures, with resulting comments provided to appropriate DR Project's project managers.

The BMcD/Modus team also participated in numerous risk and contingency coordination meetings between management and subject matter experts of SNC/Aecon and the DR Team. The DR Risk Team conducted risk vetting sessions for each project bundle's estimate, each function's estimates and, ultimately, the finalization of contingency for RQE.

Our team attended the periodic Risk Oversight Committee ("ROC") meetings and provided process feedback and recommendations to the DR Risk Team. We engaged in periodic interface discussions with the OPG corporate risk management personnel, as well.

As detailed RQE contingency development proceeded, BMcD/Modus attended contingency workshops and management review sessions, providing detailed observations and recommendations to the DR management and the risk team with respect to process issues. We performed detailed reviews of contingency input documents and provided feedback to the DR risk team.

Finally, BMcD/Modus participated in the DR Team's RQE vetting sessions, during which each Project Team presented its proposed cost estimates and schedules for NPET review. BMcD/Modus further participated in the NPET's vetting of final RQE contingency analysis, from a process perspective.

INTERVIEWS AND DISCUSSIONS WITH THE FOLLOWING INDIVIDUALS:

Mike Allen, VP Refurbishment Execution	Roy Brown, Senior Director, RFR Project
Art Rob, VP Projects & Modifications	Perrrik LeDreff, Manager, RFR Project
Meg Timberg, VP	Sorrin Marinescu, Project Director, Fuel Handling/Defueling/ Specialized Projects

23

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

Gary Rose, Director, Project Controls	Scott Guthrie, Project Director, BOP
Karen Fritz, Director, Outage Management	Todd Josifovski, Project Director, Turbine Generator
Ryan Smith, Manager, Risk Management	Tracy Leung, Project Controls Manager, SDLU
Andy Elliott, Manager, Project Controls	Peter Moore, Manager, Turbine Generator
Leo Saagl, Director, Controllership	Sudhaker Pulagam, Project Controls Manager, RFR
Steve Wiacek, Manager, Finance	Julian Read, Section Manager, Projects & Modifications
Carlos Barrios, Planning & Controls	Al Arnott, Director, P&M
Ian Sansom, Planning & Controls	Norton Thomas, Senior Manager, Enterprise Risk Management
Rob Obertreis, Manager, Estimating	
Nader Rahmaty, Sr. Planning & Reporting	
John Haight, Estimating	
Michael McNeill, Planning & Controls	
David White, Estimating	

ATTENDED THE FOLLOWING MEETINGS:

A sampling of the meetings BMcD/Modus attended in preparation of this Assessment include but not limited to the following:

- Quarterly Risk Oversight Committee Meetings
- Project and Function Contingency Workshops
- NPET RQE and Contingency Review Meetings
- RFR Class 2 Estimate Vetting Sessions with SNC/Aecon and OPG
- Executive Steering Committee Meetings with OPG and contractor management teams
- RFR DR & JV SME Risk and Uncertainty Alignment Meetings
- RFR Risk and Uncertainty DR & JV Management Review Sessions
- RFR Class 2 Estimate Monte Carlo Report Review
- Numerous one-on-one sessions with Risk Team and Project/Function Managers

REVIEWED THE FOLLOWING DOCUMENTS:

The documents BMcD/Modus reviewed in preparation of this assessment are too voluminous to comprehensively list. The following comprise the more significant documents or categories of documents that were utilized in the preparation of this assessment, as it relates to OPG's process:

- RQE Roadmap, multiple iterations from January to September 2015
- NK38-PLAN-09701-10235-R000 RQE Cost Estimate Plan dated March 9, 2015
- NK38-PLAN-09701-10004RQE Project Management Plan, dated November 20, 2014
- N-MAN-00120-10001-RISK-04-R002 - Nuclear Refurbishment Risk Management & Contingency Development Guide
- N-REP-09701-055662 RQE Contingency Development Report, dated August 20, 2015
- NK38-NR-PLAN-09701-10006 RQE Contingency Development Plan

24

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

- 509407-0000-00000-33RA-0172-00 – DNGS RFR Project - Class 2 – Contingency Target Cost and Target Schedule Development
- N-MAN-00120-10001 Sheet PC-12 – Nuclear Refurbishment Change Management
- N-MAN-00120-10001-RISK – Nuclear Projects Risk Management
- SNC/Aecon Class 2 Estimate (Rev.0 and Rev.1) for RFR and Turbine Generator Projects
- RQE Estimating file site June to September 2015, including ES Fox contractor estimates, comments and disposition forms, estimate checklists and declarations.
- RQE Release Consolidation files, including bundle files, function files, master consolidated file, snapshot 1 dashboards, source data for final cash dashboards, source data for August 18, 2015 point estimates
- NK38-REP-09701-0568870 – RQE Total Cost Summary, 4 vFinal, dated October 30, 2015
- NK38-REP-09701-0568872 – RQE Total Cost Overview NPET Final Package
- NK38-REP-09701-0548257 – Program BOE Report
- RQE Release bundle and function estimate files, including fully populated templates, for April, May, June, and September 2015 updates
- RQE NPET cost, schedule and scope reports for all bundles and functions, various drafts and final packages, and documentation for final closeout
- Weekly/monthly status updates from each project bundle
- Functional management plans for each DR Project function
- NK38-REP-09071 – RQE Quality Assessment Report (Draft)

OVERALL ASSESSMENT:

Overview

On November 12, 2015, the DR Team issued the RQE to its Board of Directors in the total amount of $12,800,000,000 including contingency, interest and escalation. A high-level breakdown is attached as Appendix A. Based on our nearly three years of oversight involvement of the DR Project's planning, BMcD/Modus believes the process used for developing the DR Project control budget and the associated critical path schedule[1] that form the basis for RQE meets general industry thresholds. The control budget is based, most notably, on well-defined scope and detailed engineering, which has sufficiently matured to allow classification using the AACE International guidelines in the manner OPG intended for RQE. In addition, the general level of detail in the RQE control budget is in line with that seen on other projects of similar nature and should provide the foundation for a robust project controls regime that will be used to track progress against the control budget. From a process perspective, the Team performed a reasonable amount of vetting of the risks in finalizing RQE.

While there is still considerable work ahead for the DR Team to further refine its cost estimates, schedule and execution planning for each of the Project's units, the DR Team has substantially met the goals it set forth in 2009 at the DR Project's inception for its Definition Phase and has completed the necessary work to establish a control budget for the Program. Moreover, the DR Team's confidence level with the control budget does not appear to be inappropriately characterized, in that the team is aware of both the strengths and weaknesses in the current Program.

[1] The development of the critical path schedule is the subject of a separate BMcD/Modus assessment issued simultaneously with this assessment.

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

Project Bundle Costs

The Basis of Estimates ("BOE's") for the DR Project's project bundle costs range from quite detailed (for RFR and Turbine Generator in particular) to developmental/conceptual (for approximately half of the BOP and SDLU packages). The process that the DR Project used to characterize the estimates reasonably conforms to AACE International guidelines. We have confidence that process has been reasonably robust and achieved a level of accuracy commensurate with the assessed classification. Overall, 90% of the direct cost estimates are Class 3 level or better. Nonetheless, improving the accuracy and confidence level for the bundles that have not matured to at least AACE International Class 3 level presents a challenge for the DR Team in development of its Unit 2 Estimate. These estimates are mostly being developed by a contractor that has struggled with estimating inaccuracies in regard to OPG's Campus Plan Projects under the terms of the same commercial agreement. For purposes of the control budget, OPG chose to accept that 45% of these estimates were in large part no more mature than AACE International Class 4/5 level and carried substantial contingency to account for potential estimating inaccuracy and performance issues related to the ESMSA contractors. However, in light of that contractor's track record, there is an inherent risk that this level of contingency will not fully account for the risks. Refurbishment is utilizing the lessons learned from the Campus Plan Projects and has taken actions intended to mitigate these issues, as discussed herein.

In addition, while the RFR, Turbine Generator, Defueling and Fuel Handling bundles each have reasonably mature (Class 3 or better) estimates, there was still remaining work for each to further refine its estimates for Unit 2, including resolving the size of the vendors' project management teams for execution, final application of shift premiums, wage rate discrepancies and other costs needing refinement. In addition, the DR Team is considering shifting some work to different contractors to achieve efficiency and potential economies of scale, which could result in some cost differences. Thus we have rated the risk associated with the Project Bundle costs as low-to-medium, though this could rise depending on the DR Team's work in the upcoming 1Q of 2016.

Functional Costs

The DR Team's efforts to assess and monetize its internal functional costs has taken many different turns and still is not complete, with additional work remaining to capture roles and responsibilities that may ultimately impact cost. From 4d to RQE, the total functional budget held to approximately $2.3B (excluding contingency), which is 22% of RQE. During this period, $232M of Operations & Maintenance cost was apportioned to the station, while the remaining functions actually grew by $253M, or 20%, offsetting these reductions.

The DR Team's goal for RQE was to define the extent of the funding envelope for the functions and work to comprehensively define the team's roles and responsibilities during the Readiness to Execute period. Moreover, the DR Team's staffing plan for RQE calls for immediate increases in staffing that may not be achievable. From a process perspective, while we do not have a strong concern that the DR Team will maintain the functional costs within the budget, BMcD/Modus remains concerned that the DR Team has not fully worked out the roles and responsibilities for its execution organization and the associated risk has potential consequences that extend far beyond the cost of the team itself, including potential confusion over direction given to the Project's contractors. Thus, we rate the risk associated with the functions to be medium-to-high, and the delineation of roles within the DR Team will require significant focus.

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

Contingency

During the Definition Phase, considerable effort was expended on the RFR project, which is the largest and possibly highest risk component of the Refurbishment. OPG and SNC/Aecon spent considerable effort identifying discrete risks, developing response plans (e.g. mitigation), and quantifying the impacts of post-mitigated risks. Assessments of the RFR discrete risk and schedule impact have been reviewed and challenged in considerable detail by OPG management, SNC/Aecon management and subject matter experts (SMEs) from both parties. In the course of developing the remaining RQE contingency, a well-defined process was developed and all project and function managers increased their focus on contingency input matters to ensure that risks were identified; response plans were established; and occurrence probabilities and impact quantification were developed. Challenges and reviews of the input parameters occurred at various levels of the organization.

In addition to this effort, a comprehensive Monte Carlo model was initially constructed and run for Release 4d, which provided lessons learned and an excellent base for creating a very robust RQE model.

While, risk management and contingency development has many subjective aspects, the DR process has been reasonably well constructed and executed. It is perhaps in the upper percentile of comparable project practices. Nonetheless, because of uncertainties and unknowns, contingency values do not enjoy perfection, but the DR process likely contributes to a reasonably reliable and defensible RQE quantum, all from a process perspective.

EVALUATION OF OPG'S GOVERNANCE PROCESS AND ADHERENCE TO AACE INTERNATIONAL GUIDANCE

In order to aid itself in its development and characterization of the RQE estimate, OPG appropriately chose to utilize AACE International's Cost Estimate Classification System[2], which explains the importance of these guidelines and the intent of their general use:

> *An intent of the guidelines is to improve communication among all of the stakeholders involved with preparing, evaluating, and using project cost estimates. The various parties that use project cost estimates often misinterpret the quality and value of the information available to prepare cost estimates, the various methods employed during the estimating process, the accuracy level expected from estimates, and the level of risk associated with estimates,... improving communications about estimate classifications reduces business costs and project cycle times by avoiding inappropriate business and financial decisions, actions, delays or disputes caused by misunderstandings of cost estimates and what they are expected to represent.*

As a recommended practice of AACE, the *Cost Estimate Classification System* provides guidelines for applying the general principles of estimate classification which typically range from Class 5 to Class 1, the criterion for which is primarily based on the maturity level of project definition deliverables. Typical Class 5 estimates are based upon a low-level of project scope definition and therefore these estimates have the highest amount of uncertainty and the lowest level of expected accuracy range

[2] See AACE's Recommended Practice No. 17R-97, Cost Estimate Classification System (November 29, 2011) and Recommended Practice No. 18R-97 Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries (November 29, 2011)

97

values after application of contingency. In contrast, the typical Class 1 estimate should have reduced uncertainty and higher expected accuracy range values after application of contingency. The actual accuracy range is determined through the risk analysis of the specific project. As noted in our past assessments of the DR Team's prior cost estimates (4c and 4d), this approach is appropriate and allows for better understanding of the cost estimates underpinning RQE.

Pursuant to the Nuclear Refurbishment Project RQE Cost Estimate Plan (NK38-PLAN-09701-10235):

> *The target classification of the RQE cost submission is AACE Class 3 with an expected 50% level of confidence on the point estimate and accuracy range, exclusive of applying escalation, interest and management reserve, within:*

Class 3	*Level of Project Definition: 10% to 40%*	*Budget authorization or control*	*Accuracy Range: L: -10% to -20% H: +10% to +30%*

> *An assessment of the class of estimate achieved by each project bundle will be performed by the NR Estimating Team based upon AACE Recommended Practices and the nature of the project scope of work.*

As stated above, AACE International's guidelines use maturity level of project definition deliverables as the primary characteristic for classifying estimates. In its governance, OPG listed the specific deliverables unique to the nuclear industry that would need to be developed in order to sufficiently advance the Project to support an RQE within the target Class 3 classification.

BMcD/Modus concurs that the DR Team has sufficiently matured the work in these areas in order to support RQE as a Class 3 estimate and establish a control budget, from a process perspective. Attached as Appendices B and C are evaluations BMcD/Modus performed of the DR Team's conformance to its governance. The most significant remaining gaps as noted are: (1) some project bundles lack Class 3-level maturity (i.e. BOP and SDLU/RSF); (2) the functional costs need further refinement and definition; (3) the US Cost database was not fully utilized, as the method the DR Team used for compiling costs was largely via Excel, which introduces potential human error.

Differences in maturity are not unusual for projects of this complexity and size, and the DR Team appears to have a reasonably full understanding of those parts of the work that need enhanced definition. In the detailed sections of this assessment, we provide our analysis of the remaining gaps and risks to the DR Project.

During the Definition Phase, the DR Project's scope was substantially developed and supported with detailed engineering packages. With some exceptions, the detailed engineering packages were prepared in sufficient time for that scope to be adequately assessed and estimated by the DR Project's EPC vendors. Additionally, as we noted in our 3Q 2015 report to the DRC, the process the DR Team used for validating and vetting the cost estimates for the Project's bundles has followed the approved DR Project RQE Cost Estimate Plan, and the result of this process was as intended – the vendors' estimates for project cost have been classified so that management understands the underlying quality, accuracy range and reasonableness. This knowledge aided management in identifying potential risks in performance, gaps in the vendors' planned approaches, and areas to shore up for the future unit-specific cost estimates.

Moreover, with this effort complete for the control budget, the DR Team is better positioned to execute its remaining cost estimating work, which will be considerable during the Project's lifecycle. The Unit

28

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

2 Estimate the DR Team intends to deliver in the 3Q of 2016 to the Board of Directors will support that unit's execution. The team is committed to performing a similar quality estimate prior to each unit's execution. In addition, projects of this type must have ongoing cost estimate support for evaluating potential change orders, claims and cost overruns. The process the DR Team has used for RQE coupled with the lessons learned from that effort should be adaptable for each of these future needs, given aggressive management. The DR Team should consider the benefit of employing permanent estimating staff to meet these demands.

In addition, with the development of the control budget, the DR Team has advanced its understanding of the Project's estimated costs such that it should no longer need to depend upon AACE International's cost estimate classification. The DR Team has now established its own measuring stick. With the exception of those projects (BOP, Shut-Down/Lay-up and Refurb Support Facilities) that have not advanced to Class 3 designation and which still need to reach appropriate level of maturity of project definition deliverables, OPG should henceforth measure its progress against the control budget without further regard to AACE International classification.

In summary, BMcD/Modus found that OPG has substantially conformed to the governance it put in place for RQE and the guidance from AACE International on which that governance was based.

COMPARISON OF PROCESSES - 4D COST ESTIMATE TO RQE

In November 2014, BMcD/Modus prepared a Supplemental Report to the Board of Directors Nuclear Oversight Committee regarding our Observations of the 4d Cost Estimate (4d Cost Estimate Assessment). The main purposes of our 4d Cost Estimate Assessment were to: (1) document the process the DR Team used for the 4d Cost Estimate; and, (2) provide recommendations for RQE based on the lessons the team learned from 4d. In this section of this assessment, we discuss the extent to which the DR Team followed our recommendations from the 4d Cost Estimate Assessment.

- **Estimate Maturity:** The DR Team reasonably met its goal for maturing the project bundle estimates for RQE to Class 3 estimates or better. As of the 4d Cost Estimate, approximately 64% of the project bundle derived cost estimate was at the Class 3 level, while other portions were less defined. With the maturation of the project estimates, as illustrated in Figure 1[3], 90% of the project estimates in RQE were assessed at Class 2 (64%) and Class 3 (26%).

  Another measure of RQE is the granularity of the vetting performed by the DR Team in OPG's estimate review process. The following Table 1 illustrates the average value of detailed estimate line items OPG examined in its vetting of the bundle estimates.

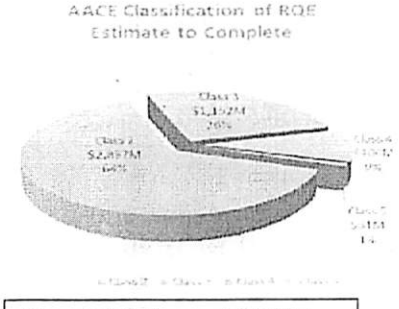


Figure 1: Data Source – RQE Total Cost Summary

[3] The estimates in Figure 1 exclude interest, escalation, inflation, contingency and functional costs.

29

MODUS STRATEGIC SOLUTIONS

BURNS McDONNELL

Table 1 – Summary of Line Items Reviewed per Bundle Cost Estimate

Project Bundle	Estimate Lines Reviewed	EPC Estimate ($K) Cost 2016-2026 (excl. fees)	$ per Line of Estimate Reviewed
RFR	165,880	$2,327,288	$14,030
Turbine Generator	39,917	$438,317	$10,981
SDLU	19,607	$196,814	$10,038
BOP	17,813	$353,380	$19,838
Refurbishment Facilities	4,099	$50,286	$12,268
Islanding	1,921	$84,198	$43,830
Steam Generator	1,209	$98,844	$81,757
Specialized Projects	1,152	$78,732	$68,344
Fuel Handling	428	$120,183	$280,801
Defueling	-	$2,487	
Grand Total	**252,026**	**$3,660,895**	$14,526

The OPG estimating team vetted 100% of the direct field labour line items, while indirect and PMT costs in contractors' estimates were vetted on the basis of standard percentages compared to direct labour cost. Overall, the process resulted in an aggregate average cost of $14,526 per estimate line item. As with 4d, estimates for the largest cost components – the RFR and Turbine Generator bundles – were the most mature, though the Fuel Handling/Defueling/Specialized Project bundle has matured to the expected Class 3 level. The lagging bundles continue to be BOP, SDLU, and RSF. For the most part, Design Engineering is substantially complete with some select packages (approximately 3-4%) requiring additional time to complete.

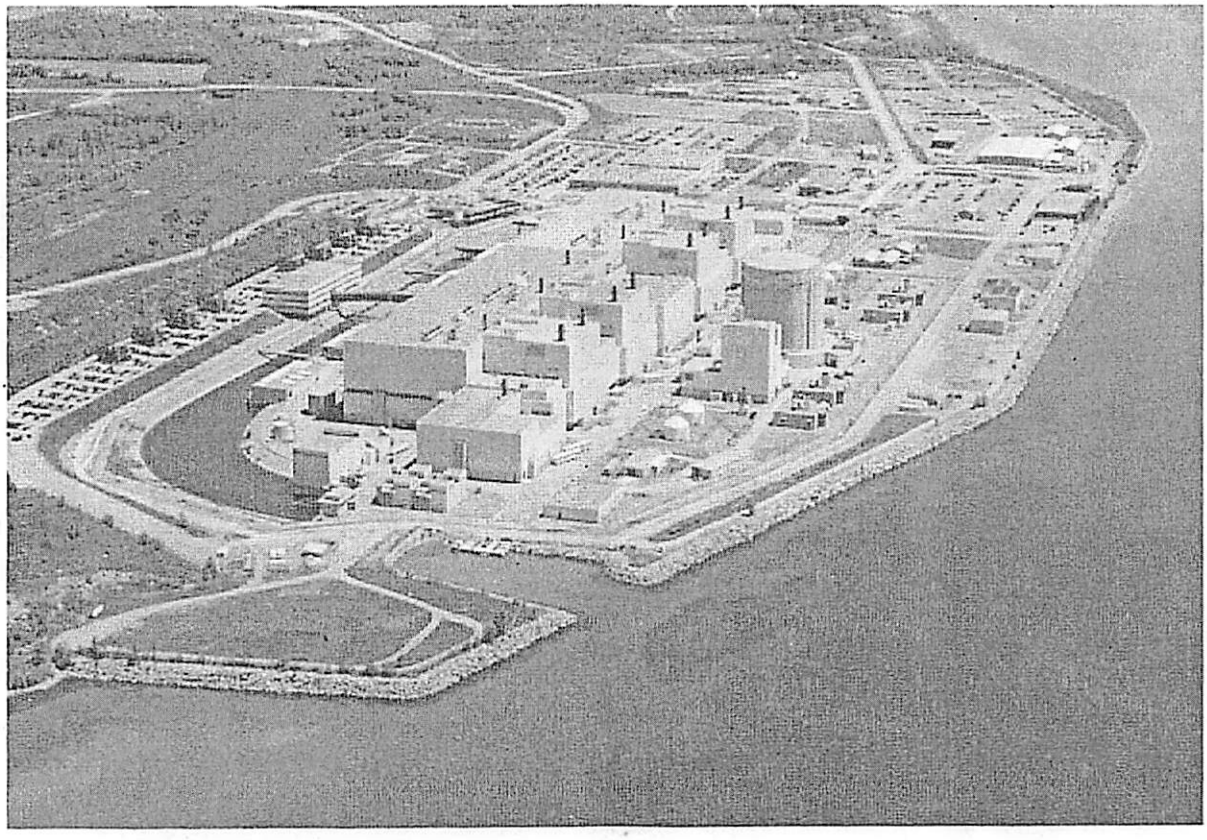
In the following sections, we evaluate the extent to which the DR Team advanced the cost estimating process from 4d to RQE.

- **Commercial Strategy as a Key Driver to RQE:** The 4d Cost Estimate had embedded assumptions regarding the expected outcome of future commercial negotiations with key vendors that needed to transpire before RQE. In particular, the DR Team management allocated in excess of $700M in potential savings relative to SNC/Aecon's Class 3 estimate and negotiating the final terms of the RFR and TG contracts with SNC/Aecon. In fact, the final RFR target price of $2.706B is $63.7M less than SNC/Aecon's $2.77B Class 3 estimate and more than $600M less than SNC/Aecon's initial Class 2 estimate submission. However, the final RQE value, when compared to what was carried in 4d, is more than $600M higher, offsetting the majority of the presumed $700M savings included in 4d. Although some of the $700M in savings included in 4d was achieved through the Class 2 development process, the value of other scope changes and the final negotiated Fixed Fee and Contingency exceeded the 4d assumptions.

  Nonetheless, the final resolution of SNC/Aecon's target price represented significant work by the parties to narrow the direct cost elements of the RFR work. As illustrated in Table 1a below, SNC/Aecon's estimate increased significantly from its June 2014 Class 3 estimate to the initial Rev.0 submission of its Class 2 in May 2015, and then was reduced through the vetting of the final estimate.

Darlington RFR Project

Class 2 Estimate – Expert Panel Review



Submission Date: November 24, 2015

31

EXECUTIVE SUMMARY

The main components (fuel channels and feeder pipes) of the Darlington Nuclear Generating Station (DNGS) reactor cores are approaching the end of their original design service life. Most CANDU reactor operators have chosen to extend the life of their reactors as a cost-effective and reliable source of carbon-free generation by planning and executing a major refurbishment outage.

Ontario Power Generation (OPG) established the Darlington Refurbishment Project to develop and implement a comprehensive work program that will extend the service life of the four reactor units for an additional 30 years of operation. The Project Definition Phase, which began in 2009, has now reached completion. The Project is continuing preparation for the Outage Execution Phase which will extend through the period between 2016 and 2024 to refurbish all four units.

Replacement of the fuel channels and calandria tubes in the reactor core (retubing) and the feeder pipes connecting the fuel channels to the reactor headers is the longest series of activities or critical path of the Refurbishment Project. This work is known as the Retube and Feeder Replacement (RFR) Project. OPG entered into a contract with a Joint Venture (JV) of SNC-Lavalin Nuclear Inc. and AECON Construction Group Inc. to perform the Definition Phase of the RFR Project.

One of the Definition Phase deliverables of the JV is an AACE (Association for the Advancement of Cost Engineering) Class 2 Estimate to perform the execution phase of the RFR Project. As OPG prepares to accept this estimate from the JV as part of the determination of an execution phase target price, then ultimately the Release Quality Estimate for the Darlington Refurbishment Project, due diligence requires independent review of the Class 2 Estimate.

A Third-Party Expert Review Panel (the "Panel") was constituted by OPG to perform one of these reviews. The Panel is composed of four individuals with previous Retube and Feeder Replacement experience at senior levels in the primary contractor or customer organizations. The product of the Panel's review is this report outlining both compliance to prudent industry practices as well as observations and recommendations on any potential areas for improvement. The Terms of Reference (TOR) for the Panel are attached as Appendix A. Although the process and schedule followed by the JV and OPG to produce and review the Class 2 Estimate were more complex than anticipated in the TOR, the Panel is confident it has fulfilled its mandate.

The Panel was provided all of the documents necessary to complete its review. The initial set of documents from the Class 3 Estimate submission formed a good knowledge base on how to approach the review of the Class 2 Estimate and where significant effort was required by the JV to progress from Class 3 to Class 2. During the final stages of preparation and following delivery of the first version of the Class 2 Estimate (R0), both the JV and OPG accommodated all requests for additional documents, to observe meetings, and to carry out interviews. Transparency and free sharing of information continued over the period of April to October 2015 through the progression of interaction between OPG and the JV leading to the JV's submission of the final version of the Class 2 Estimate (R1).

In determining compliance to AACE Class 2 requirements, the Panel concluded that while AACE Class 2 methodology and practices form a sound basis for preparing the Class 2 Estimate, given the unique challenges of this large "brownfield" nuclear project, there should be caution in interpreting the range and confidence levels of the overall result. The Panel concludes that the JV Class 2 Estimate followed the AACE requirements for preparing a Class 2 Estimate. The integrity of the Class 2 process was maintained during the evolution of the estimate from Class 2 R0 to Class 2 R1. As independent verification, the Panel assessed the overall result obtained from the Class 2 Estimate against operating experience. If the actual schedule duration achieved for a Darlington unit RFR is not more than 7 ½ months longer than Wolsong unit 1, after adjusting for unit differences and avoidable delays, then the cost should be within the Class 2 Estimate upper bound. The Panel considers this to represent a very achievable outcome.

Compliance to the OPG contracting strategy is specifically addressed in the Compliance Chapter Report (509407-0000-00000-33RA-0173 "Class 2 Milestone - Compliance"). It is the opinion of the Panel that the strategy used to develop the estimate is in compliance with the OPG contracting strategy as prescribed by the Agreement. It should be noted the Estimate Chapter Report on Scope identifies scope items assumed in the Estimate that require formal acceptance by OPG.

The Panel found risk management to be the most challenging area to review. Risk registers and risk mitigation strategies were being developed and refined in parallel with the Panel review. The Panel is also not certain that they were provided a clear view of all of the JV and OPG internal risk registers due to their confidential and commercially sensitive nature. Nevertheless, the Panel was able to conclude the risk management processes, taken in the context of all of the risk related information provided, is sufficiently mature to support the Class 2 Estimate. The Panel recognizes risk management is a dynamic ongoing process at this stage of a project and, as a result, has made the following recommendations on continued effort in this area:

Recommendation 1: *The Panel recommends the JV continue efforts to refine their understanding of the project risks within their scope of work over the next several months and continue effort on mitigation strategies through the standby phase and into construction.*

Recommendation 2: *The Panel recommends OPG continue efforts to refine their understanding of the complete envelope of all risks related to the RFR Project, including risk ownership, to avoid gaps and duplication over the next several months; and continue effort on mitigation strategies through the standby phase and into construction.*

In the course of its review, the Panel has identified opportunities to improve the basis and accuracy of the Class 2 Estimate. The majority of these findings and recommendations were provided to the JV and OPG project teams early enough for the resulting improvement actions to be incorporated into the Class 2 Estimate R1. The remaining recommendations provided in this report were derived from observations on the status of project preparation and risk mitigation as of the end of October 2015. Any risk to the success of the project posed by the most recent findings can be addressed in the remaining time to the start of related construction activities and through implementation of a comprehensive Standby Plan.

The Target Schedule, based on tool performance testing at the DEC, is essentially equivalent to the one achieved for Wolsong 1 retubing and feeder replacement, adjusted for physical differences between the reactors, and with elimination of known problems. For the first Darlington unit in particular, the Panel believes this Target Schedule is very challenging, but technically achievable based on OPEX and tool/process demonstrations to date.

Recommendation 3: *A realistic working schedule with duration between the best achievable and the most likely schedule needs to be established to align project planning in both organizations. The earlier this schedule is in place, the more effectively the impact of task and logic changes can be managed going forward.*

One of the cornerstones in the retube technology planned to be used on the Darlington RFR Project is volume reduction of high-level retube waste. The highly radioactive reactor components will be put into shielded flasks that will protect the workers from the radiation and then transported to a separate building where they will be volume reduced/segregated in parallel with the reactor face removal work. There are first-of-a-kind concepts associated with the process to be used at Darlington, and while the volume reduction of pressure tubes and calandria tubes has been performed on all recent retube projects (in the reactor vault, in those cases), it has not gone well on any past project.

Recommendation 4: *The Panel believes retube waste processing remains a significant risk to the project. The Panel recommends OPG and the JV put in place a program to perform additional performance tests after factory acceptance testing and then to plan and allow time for comprehensive commissioning and "shake down" tests when the lines are assembled at site.*

The success of all large projects involving construction on an operating site relies heavily on a strong working relationship between the operations organization, the owner's project team, and the project contractor. This is particularly true of major nuclear refurbishment projects where it is difficult to create a fully independent construction island because of common services and common hazards with the operating units.

Recommendation 5: *As the Darlington RFR Project moves toward the implementation phase, it is important create a constructive working relationship between OPG Operations, the OPG Project Team and the JV.*

Recommendation 6: *The impact of the contracting strategy on project execution and teamwork should be examined as it plays an important role in shaping behaviors of the parties.*

The Panel does not see evidence the Project's Radiation Protection (RP) organization has been put in place early and is effectively part of the team planning for the project. As a result, there is a risk that project-specific RP processes and input to retube series procedures will come late and will extend series durations, pushing out the retube schedule.

Recommendation 7: *Establish a Darlington RFR RP organization early with streamlined project-specific procedures. Invest in technology to increase RP effectiveness and reduce dose to both RP technicians and workers.*

- The JV have identified their "Tool Management System" as the mechanism to identify, track, repair and test retube tooling. The Panel foresees challenges in keeping this very large and complex toolset at peak performance over four (4) units and 10+ years. Tool performance should be carefully monitored for early signs of potential maintenance/endurance issues during mock-up testing and initial training. The retube mock-ups at the Darlington Energy Centre (DEC) represent a tremendous asset and opportunity to fully prepare for the work. The Panel recommends the DEC be used to its full potential throughout the coming year, including before formal training starts as dictated in the Standby Plan. Although the Standby Plan has not yet been formally accepted by OPG, this acceptance is expected shortly. The Panel see this Plan as an integral part of the preparation for the project, and not an optional exercise.

Recommendation 8: *The mock-ups at the DEC are far superior to anything used on past retube projects. The Panel recommends the DEC be used to its full potential throughout the coming year to refine the processes and challenge the tooling to be used. Some aspects of the concerns identified by the Panel elsewhere in this report can be addressed through a well-executed Standby Plan.*

The aggregate knowledge and experience of the joint venture and OPG subject matter experts (SMEs) who worked on the Class 2 Estimate is commendable. The teamwork that developed in the combined JV/OPG organization established to finalize the Class 2 Estimate R1 was exemplary. It's important this talent be retained and additional experienced staff be brought in to execute the Standby Plan and in staffing for the Outage Execution Phase. Performance on the first unit can be enhanced by having experienced leaders on the construction Project Management Team, even if it means moving some talent from OPG to the JV. This strategy of moving key individuals from the owner's organization to the contractor has been carried out successfully on previous retube projects.

CONCENTRIC

UPDATED ASSESSMENT OF COMMERCIAL STRATEGIES DEVELOPED FOR THE DARLINGTON REFURBISHMENT PROGRAM RETUBE & FEEDER REPLACEMENT WORK PACKAGE

PREPARED FOR ONTARIO POWER GENERATION

JULY 2016

CONCENTRIC

TABLE OF CONTENTS

I. INTRODUCTION

On April 11, 2016, Torys LLP retained Concentric Energy Advisors, Inc. ("Concentric") to:

- Assist legal counsel to OPG, for purposes of providing legal advice, by providing an opinion on the contract for the Retube & Feeder Replacement work package for the Darlington Refurbishment Program (the "Program"). In particular, building on conclusions from Concentric's previous work regarding Ontario Power Generation Inc.'s ("Ontario Power Generation's" or the "Company's") commercial and contracting strategies for the Program, provide an opinion as to whether the final contract for the Retube & Feeder Replacement work package is reasonable and prudent, and appropriately establishes a target price and allocates risk between OPG and the joint venture formed by SNC Lavalin Nuclear, Inc. and Aecon Industrial, a division of Aecon Construction Group Incorporated ("SLN-Aecon" or the "Joint Venture").

This report includes a summary of our findings with regard to the final contract for the Retube & Feeder Replacement work package, as amended, with the Joint Venture. This report contains: (1) Concentric's assessment of the process the Company used to arrive at an Execution Phase amendment to the contract for the work package; (2) a review of the reasonableness and prudence of the commercial terms in the final amended contract; and (3) our evaluation of the allocation of risk between Ontario Power Generation and the Joint Venture that is articulated in the contract.

Concentric was initially engaged by Torys LLP in August 2011 to review the commercial strategies and contracts developed and implemented for the refurbishment of four CANDU heavy water reactors at Ontario Power Generation's Darlington Nuclear Generating Station ("Darlington" or the "Plant"). We provided a written report summarizing our review in September 2013. That report was submitted into evidence in Ontario Power Generation's last rate case (EB-2013-0321), and Concentric's Chairman and Chief Executive Officer, John J. Reed, appeared as an expert witness in that proceeding. That report has also been re-filed in Ontario Power Generation's current rate case (EB-2016-0152, *see*, Exhibit D2-2-2, Attachment 1).

The Program will include removal and replacement of the reactor calandria tubes and pressure tubes from each reactor,[1] replacement of all feeders (referred to together with the calandria and pressure tube replacement as the "Retube & Feeder Replacement work package"), refurbishment of the existing fuel handling equipment, refurbishment of the existing turbine generators, refurbishment of the existing steam generators, and a set of supporting refurbishment projects aligned with existing station systems. The plant modifications are currently planned to be made during outages for each of the four Darlington units between October 2016 and 2026.[2]

The Retube & Feeder Replacement work package, which is the focus of Concentric's analysis for this report, is the largest single component of work under the Program. Assuming that all four units are ultimately

---

1 The amended contract envisions refurbishment of all four units at Darlington, but contains off-ramp opportunities that allow the Company to choose to complete fewer than four refurbishments at its discretion.

2 Ontario Power Generation's contract with SLN-Aecon (executed in March 2012) for the Retube & Feeder Replacement scope of work was applicable to the Definition Phase of the work package. In order to transition to the Execution Phase of work the Company and SLN-Aecon agreed to a contract amendment on January 11, 2016 that included key terms and conditions for the Execution Phase.

refurbished, the Retube & Feeder Replacement work package is currently expected to cost approximately $3.6 billion, or 65% of the total Program cost for work bundles.[3]

II. SUMMARY OF CONCLUSIONS

As discussed below, Concentric has concluded that, based on Ontario Power Generation's activities with regard to amending and finalizing the Retube & Feeder Replacement contract since our last report (*i.e.*, September 2013), the terms of the Retube & Feeder Replacement contract, including the target price and the allocation of risk, are both reasonable and meet the regulatory standard of prudence as we defined that concept in our September 2013 report and repeat herein for convenience.

Concentric's opinion is not without certain caveats and limitations, which are discussed in the sections that follow. Similarly, the basis for our opinions are described throughout the remainder of this document.

III. STANDARD OF REVIEW

Torys LLP asked Concentric to evaluate whether the final, amended Retube & Feeder Replacement contract is reasonable and prudent, including the risk allocation terms of the contract. To perform our evaluation, Concentric used the same definition for the regulatory standard of prudence that we used in our September 2013 report.

The definition of regulatory prudence that we applied for our review was based on Concentric's work before state, provincial and federal energy regulators in both Canada and the United States. The definition of regulatory prudence that Concentric has applied is consistent with the Supreme Court of Canada's 2015 overview of the prudent investment test provided in *Ontario (Energy Board) v. Ontario Power Generation Inc.*[4] In addition, the definition used by Concentric is consistent with decisions rendered by the Ontario Superior Court of Justice,[5] the Court of Appeal for Ontario,[6] the Ontario Energy Board[7] and the U.S. Supreme Court,[8] among other jurisdictions. Specifically, Concentric defined the prudence standard as examining the range of actions that a reasonable manager would take given the facts or circumstances that were known or knowable at the time of the decision or action. This definition rejects the use of hindsight as a basis for determining the prudence of a decision or action. In addition, the definition relies on an evaluation of decisions or actions. Project costs are neither prudent nor imprudent. Instead, costs are prudently or imprudently incurred as a consequence of the decisions and actions of management.

IV. GENERAL LIMITATIONS OF OUR OPINION

---

3 Excludes campus plan, Ontario Power Generation functions cost, contingency, interest and escalation. Of the total $12.8 billion Program cost estimate, the Retube & Feeder Replacement work package is approximately 28% of the cost.

4 Supreme Court of Canada Decision, *Ontario (Energy Board) v. Ontario Power Generation*, Docket 35506, September 25, 2015.

5 2005 CanLII 4941 (Ont. Div. Ct.).

6 Court of Appeal for Ontario Decision, Docket: C55602, C55641 and C55633, June 4, 2013.

7 Decision with Reasons, RP-2001-0032, December 13, 2002. This Decision deals with Enbridge Gas Distribution Inc.'s (formerly Enbridge Consumers Gas or ECG) application for a Board Order approving rates for the 2002 Test Year.

8 Separate, concurring opinion of Justice Louis Brandeis, Missouri ex. Rel. Southwestern Bell Telephone Co. v. Public Service Commission, 262 U.S. 276 (1923).

38

The following are general limitations regarding the scope of our review:

- First, our review is limited to Ontario Power Generation's actions and documents prepared through April 5, 2016. This opinion builds on the report Concentric provided in September 2013, and reflects our evaluation of Ontario Power Generation's actions beginning in late 2009. Concentric did not complete a thorough review of Ontario Power Generation's actions related to the Program prior to or after that time period.
- Next, Concentric did not independently verify the appropriateness, sufficiency, or correctness of the Program schedules, cost estimates, or scope. Concentric was informed of the processes used to develop and to define further these planning assumptions. As such, we have considered these processes in the context of our review, but not the technical specifications that are the result of these processes.
- Concentric assumes Ontario Power Generation will continue to retain adequately qualified personnel to complete the Program generally and the Retube & Feeder Replacement work package specifically. Those resources are critical to the success of the Program, and may be sourced internally, hired directly, or engaged through contracts with third parties.
- Concentric did not perform a compliance audit to determine whether Ontario Power Generation and the Program complied with Ontario Power Generation's internal policies, procedures, instructions and guidelines, or applicable Provincial and Federal regulations. Similarly, Concentric did not conduct a legal review of Ontario Power Generation's agreements or proposed agreements with any contractors. Notwithstanding that limitation, Concentric did review relevant Ontario Power Generation internal policies and procedures, and relevant provincial and federal laws and regulations when developing our opinion. Concentric also notes that Ontario Power Generation has separately retained outside counsel to advise it on the legal terms of the agreement with the Joint Venture performing the Retube & Feeder Replacement work package.
- Finally, Concentric's review is not an assessment of the Program's likelihood of success. Successful execution of the Program generally, and the Retube & Feeder Replacement work package specifically, will require the efforts of many entities and individuals over many years. The development and implementation of the Program's contracting strategies is only one contributor to project success.

V. RETUBE & FEEDER REPLACEMENT CONTRACT AMENDMENTS

Since Concentric's September 2013 report, Ontario Power Generation has continued with the planning activities necessary to prepare for the Execution Phase of the Program. Since Concentric concluded our review in September 2013, Ontario Power Generation entered into four more amendments to the RFR contract:

1. Amendment 2 on February 28, 2014;
2. Amendment 3 on November 2, 2015;
3. Amendment 4 on January 11, 2016; and
4. Amendment 5 on February 1, 2016.

Amendment 2 modified the scope and milestone schedule for the work performed by the Joint Venture related to Darlington reactor mock-up. Amendment 3 incorporated certain Project Change Directives and the milestone schedule, pricing, and tooling milestone payment schedule. Amendment 4 is the most significant in terms of progress on the Retube & Feeder Replacement work package. With that amendment, which incorporated the milestone schedule, target schedule, target price, and submittal schedule, Ontario Power Generation made the decision to move forward with the Execution Phase of the Program. Amendment 4, and its incorporation into the Retube & Feeder Replacement contract, was a primary emphasis of our review. Amendment 5 addressed contractual terms related to the retube waste processing building.

Throughout 2015, Ontario Power Generation undertook an iterative process that involved further defining the scope of work and allocation of risk under the contract, and that would ultimately result in the schedule and cost parameters of the Execution Phase of the Retube & Feeder Replacement work package. Risk registers, which identified the risks that each party would bear during the execution of the work package, were key components of that iterative process and led to the allocation of risk that is embodied in the contract.

Once the initial risk allocation was negotiated, the parties focused on establishing the budget and schedule parameters of the contract. The Retube & Feeder Replacement contract's target cost and schedule were the subject of lengthy negotiations between Ontario Power Generation and the Joint Venture during the summer 2015. In order to make the significant progress that was required and to remain on schedule, Ontario Power Generation assembled a team of skilled nuclear cost estimators and engineers in late spring to validate and develop a comprehensive understanding of the elements within the target price deliverables that the Joint Venture had provided through May of 2015. The Ontario Power Generation team worked closely with the Joint Venture's experts and construction project managers to investigate all cost elements. Through this close collaboration and a detailed challenge and review process that addressed over 50,000 distinct line items with cost, schedule, and risk implications, Ontario Power Generation was able to identify and eliminate risk-related costs that did not belong in the Joint Venture's estimates. Ontario Power Generation was able to reduce the Joint Venture's cost by approximately $550 million through this process. At the conclusion of this validation process the parties agreed on the risk sharing arrangement incorporated in the Retube & Feeder Replacement contract, as well as the target price and schedule. Specifically, Ontario Power Generation and the Joint Venture agreed upon a target price and schedule for the Retube & Feeder Replacement work package based on a probabilistic analysis of the work package's costs and schedule estimates.

To put itself in a position to succeed during the Darlington refurbishment, Ontario Power Generation has undertaken numerous planning and front-end engineering and design activities. Those activities included testing the tooling provided by the Joint Venture to ensure that the tooling met performance requirements. During the negotiations, Ontario Power Generation also undertook several measures to keep competitive pressure on the Joint Venture and to put the Company in a position to fulfill its commercial goals in the Program. Those measures included benchmarking the Program against other CANDU refurbishments such as those at the Wolsong nuclear plant in South Korea, the Bruce nuclear plant in Ontario, and the Point LePreau nuclear plant in New Brunswick. Ontario Power Generation and the Joint Venture also engaged an expert panel (made up of two individuals selected by Ontario Power Generation and two selected by the Joint Venture; the panel's report was filed in EB-2016-0152 at Ex. D2-2-8, Attachment 4) to insert additional third-party independence and objectivity into the process of developing the final pricing. Ontario Power

Generation was also working on a "Plan B" to serve as a back-up plan in the event that Ontario Power Generation and the Joint Venture could not come to agreement on the cost and schedule of the Execution Phase. This Plan B was a self-perform option, under which Ontario Power Generation would have performed the Execution Phase itself. In the end, Ontario Power Generation was able to successfully reach agreement with the Joint Venture both on contractual terms and risk allocation.

The following are, in Concentric's view, the key risk sharing terms in the amended contract for the Retube & Feeder Replacement work package:

- Tooling performance guarantee: The Retube & Feeder Replacement contract requires that the tooling meet established minimum performance thresholds: If the tooling had not met those requirements (which it did), there would have been a reduction of up to 10% of the tooling fixed price.
- The parties agreed to productivity gains under the contract.
- Up to 80% of the Joint Venture's fixed fee under the contract is at risk, and Ontario Power Generation has an obligation to pay financial incentives of up to 40% of the fixed fee.
- Cost incentives: The Execution Phase has a +/- $75mm neutral band above and below the Execution Phase target cost. Cost incentives are based on an aggregate basis across all four units.
- Limitation on change orders: The contract restricts the ability of the Joint Venture to initiate project change directives or make claims for excusable delays or force majeure. This provision in the contract pertains to all changes that have would cause a delay of less than three days.
- Schedule incentives: the guaranteed schedule duration is 10% greater than the target schedule duration. For any full day that is 10% above the target schedule duration, the Joint Venture will pay Ontario Power Generation $250,000 per day. Ontario Power Generation is obligated to pay the Joint Venture $125,000 per day for every day by which the schedule is shorter than the target schedule.
- Performance incentives: The Joint Venture will bear the costs of any defective or warranty work.

The apportionment of risk between Ontario Power Generation and the Joint Venture is a key element of the Retube & Feeder Replacement contract. In general, Ontario Power Generation's goal has been to assign the risks embodied in the contract to the party that has the greatest ability to mitigate or control each risk. Based on this principle, the Joint Venture bears the majority of risks except in areas where Ontario Power Generation has significant control. For instance, a key risk that Ontario Power Generation has retained is management of the Radiation Protection function across the Darlington site over the full term of the Program. The resources required for Radiation Protection are small in comparison to any specific work package, but radiological exposure risk applies to many activities that are on the Program's critical path. Radiation Protection programs could, therefore, have a material effect on the Program. In addition, the Program will address units in sequence: units that are not in an active phase of refurbishment execution will continue to operate, creating a coordination challenge for the Radiation Protection teams tasked with managing dosage and exposure risks for personnel across shifts, contractors, and units. Staff that will be affected by Radiation Protection processes will be working not just on the Retube & Feeder Replacement work package, but on other components of the Program and on ongoing operations and maintenance activities at the site. Ontario Power Generation has also retained risks related to oversight of contracts, and must manage conflicts between the Company's processes and its contractors. While the Joint Venture will

manage the work of its subcontractors, Ontario Power Generation will manage interfaces between the Joint Venture, contractors completing other work packages, and the Plant's ongoing operations. The Company is, therefore, likely to be better able to manage the Radiation Protection and exposure risks that apply across the Program.[9]

Other key risks related to the Retube & Feeder Replacement work package were allocated among the parties, with the Joint Venture bearing the majority of the risks under the contract. Ontario Power Generation retained those risks that either it is in the best position to mitigate or that neither party can reasonably influence (*e.g.*, cost impact of inflation above and beyond expectations).

Ontario Power Generation has developed and continues to monitor risk mitigation plans for each risk that it retains under the Retube & Feeder Replacement Execution Phase contract. These plans should describe the Company's plans to reduce its risk exposure to the degree possible by minimizing the cost and schedule impact of the risk materializing. Maintenance of risk mitigation plans and ongoing risk monitoring will be key objectives for the Company throughout the Program's Execution Phase.

VI. CONCLUSIONS

Concentric's review of the process by which Ontario Power Generation reached agreement on the terms and conditions of the Execution Phase Plan confirmed the reasonableness and prudence of the Company's contract for the Execution Phase of the Retube & Feeder Replacement work package as well as the target price and risk allocation within the contract.

Specifically, Concentric has the following findings:

- The terms of the final Retube & Feeder Replacement contract are consistent with what Concentric would expect for a project of this scale and nature.
- The parties have agreed on a reasonable allocation and apportionment of risks that holds each party responsible for those risks over which it has the most control.
- The review and validation process Ontario Power Generation followed to arrive at a target price estimate was both comprehensive and prudent.
- The contract provides a reasonable structure by which the Joint Venture has incentives to meet and outperform the cost and schedule budgets (and is penalized for exceeding those budgets).

We emphasize that while the terms of the Retube & Feeder Replacement work package are both reasonable and prudent, the existence of a strong contract will not ensure success alone. Ontario Power Generation must continue to recognize that it still faces significant risks in the execution of a project of this scale and duration.

[9] Furthermore, the Joint Venture perceived a significant cost exposure for managing Radiation Protection. Ontario Power Generation felt it could manage the risk effectively and that it would not be able to transfer the risk affordably.

As Concentric noted in its September 2013 report, no Canadian CANDU refurbishment or return to service project to date represents a model of a successful commercial strategy. While Ontario Power Generation has taken reasonable and prudent steps to allocate and apportion risks and provide incentives and disincentives to the Joint Venture to perform the work on time and on budget, there are many challenges that will need to be overcome in the execution of the construction and refurbishment. It is critical that, among many other important objectives, Ontario Power Generation maintains rigorous and extensive project controls and oversight processes to enable successful implementation of the Program. The Company must continue to demand the highest standards of safety, quality and workmanship by the Joint Venture in all of its work within the scope of the Program.

TESTIMONY OF
DR. PATRICIA D. GALLOWAY
PRESIDENT AND CHIEF EXECUTIVE OFFICER,
PEGASUS GLOBAL HOLDINGS, INC.
ON BEHALF OF
ONTARIO POWER GENERATION INC.
RE: EB-2016-0152 – 2017-2021 PAYMENT AMOUNTS APPLICATION
BEFORE THE
ONTARIO ENERGY BOARD

JULY 2016

EXECUTIVE SUMMARY

Sections I-III of my testimony begins with an introduction of my background, qualifications and experience relevant to the engagement, followed by the purpose and summary of my testimony that identifies the scope of the assessment and overall conclusions, and lastly provides educational information on megaprojects and megaprograms, including organization of such projects, the policies and procedures commonly used, project controls, pre-execution planning, and cost treatment of megaprograms in a regulatory environment.

Section IV provides the detailed findings and conclusions of my assessment of the Darlington Refurbishment Program (DRP or Program). These findings and conclusions are specifically identified by the following corresponding subsections as they appear in my testimony:

A. DESCRIPTION OF THE DARLINGTON REFURBISHMENT PROGRAM

- The DRP is considered a megaprogram by every measure generally used within the industry.
- OPG is treating the DRP as a First-of-a-Kind (FOAK) program, which is appropriate in my opinion.
- Specific FOAK and First-in-a-While (FIAW) work has been elevated as a key risk and factored into the probabilistic modeling for the $12.8B estimate.[1]
- OPG is utilizing a multi-prime contractor model, with OPG serving as the integrator between the prime contractors and having responsibility for the entire Program.
- OPG anticipates each unit outage to have a duration of 37 to 40 months, with an overall duration of 112 months for the complete refurbishment of all four reactors.

B. ORGANIZATION AND PEOPLE

[1] The $12.8B estimate includes $2.4B in interest and escalation.

45

- OPG is using a strong matrix organization comprised of full-time project managers with considerable authority and full-time functional support staff, which I consider appropriate.
- The content and scope of OPG's program and project management plans is consistent with industry best practices and other megaprojects and megaprograms I have reviewed.
- OPG sought to find the most qualified individuals in the industry to manage the Program and I found that the individuals assigned to the Program are qualified and competent.
- OPG has efficient oversight in place, including senior and executive management and a Board of Directors (Board) with a focus on important process/progress issues; participation in strategic decisions; and, active in issue resolution.
- The Program Management Organization and Staff decisions were reasonable and in accordance with good utility practice.

C. POLICIES AND PROCEDURES

- OPG's policies and procedures are exemplary in their thoroughness and alignment with other individual policies and procedures and industry best practices.

D: PROJECT CONTROLS

- Project controls are managed from both a program and project-level, with appropriate project controls systems in place.

1. ESTIMATING AND COST MANAGEMENT

- OPG's estimating process and basis of estimate align with industry best practices, with appropriate adaptations to account for the uniqueness of the Program.

45

- Due to the FOAK nature of the DRP, benchmarking was largely tied to OPG's operating experience and subject matter expertise, but also included available cost data from other refurbishment projects.
- The $1.7B of contingency included in the estimate is reasonable, and based on a thorough risk assessment and Monte Carlo analysis, utilizing a P90 confidence level.
- There is no specific confidence level considered as a best practice, but using a P90 confidence level provides OPG with a high probability of completing the Program within the $12.8B estimate.
- OPG's cost management procedures align with industry standards for program financial monitoring and control.
- OPG established appropriate processes and oversight for the management of contingency.
- OPG has procedures and processes in place to effectively monitor and capture actual costs and evaluate performance against the physical work completed, similar to or beyond what I have observed on other megaprograms.

2. SCHEDULE MANAGEMENT

- OPG ensures that contractors prepare schedules in accordance with OPG's policies, which are reviewed and aligned to the Program Integrated Master Schedule (PIMS).
- Schedule development activities and the level of detail developed at this time is consistent with what I have observed on other megaprograms.
- OPG's selection of a P90 confidence level for the Unit 2 schedule is reasonable and in accordance with the robust risk analyses that were performed.

- It is typical for megaprograms, such as the DRP, to be managed on a planned duration that is less time than reflected in the high-confidence schedule.
- OPG has the plans and processes in place to effectively develop, manage, and control the schedule in full alignment with industry standards and best practices.

3. RISK MANAGEMENT

- OPG undertook a number of activities in its identification of key risks to the Program and development of processes in order to manage those key risk factors.
- OPG's risk management processes is typical of what I would expect to find in a megaprogram such as the DRP and utilizes the fundamental steps of: planning; identification; assessment; treatment; and, monitoring and control.
- OPG identified key risk areas from major themes of risk and incorporated these into the risk registers, with risk mitigation plans developed for the identified risks.
- OPG appropriately took into account lessons learned from other refurbishment projects, other nuclear projects, and other megaprojects and megaprograms.
- OPG's cost and schedule contingency development aligns with industry standards through identifying risks, estimating the probability of occurrence and impact, considering risk responses, addressing cost and schedule dependency, assessing overall outcomes through Monte Carlo simulations, and estimating and evaluating contingency.
- OPG has identified those risks that could potentially impact the Program and instituted practices in accordance with industry standards that allow OPG early identification of emerging risks to quickly implement mitigation plans.

4. REPORTING MANAGEMENT

- OPG has established a repository for metrics and reporting data, including a comprehensive and tiered metrics infrastructure.
- OPG has developed an Integrated Reporting Plan (IRP) to communicate how information and data is distributed on the Program.
- Performance and progress will be measured through Earned Value Management (EVM) techniques, which is typical within the construction industry.
- The types of reports that OPG is and will be using are what I would expect to see on a megaprogram such as the DRP.

E. PROGRAM EXECUTION

- The Facilities and Infrastructure Projects (F&IP) and Safety Improvement Opportunities (SIO) were not necessarily completed per the initial planned schedule and estimate, however, I did not find any fundamental issues that would impact the Program execution and there is no impact to the Breaker Opening milestone.
- Many of the F&IP and SIO were executed under the pre-existing Projects and Modifications organization before the DRP organization was in place and did not use the "gated process" that will be used for the DRP execution.
- OPG's decision to substantially complete Unit 2 before starting Unit 3 will allow for effective implementation of lessons learned from Unit 2.
- The DRP development is at a point in its execution where I would expect an owner to be in a megaprogram at this stage of execution.

AMPCO Interrogatory #100

Issue Number: 4.3
Issue: Are the proposed nuclear capital expenditures and/or financial commitments for the Darlington Refurbishment Program reasonable?

Interrogatory

Reference:
Ref: D2-2-11 Attachment 3 Page 70 Footnote 86

Please provide the Memorandum of Understanding on Collaboration during Ontario's Refurbishment Period Between Bruce Power LP (Bruce Power) and Ontario Power Generation (OPG), November 12, 2015

Response

Please see the requested Memorandum of Understanding between Ontario Power Generation Inc. and Bruce Power L.P. dated November 12, 2015 attached.

ONTARIO POWER GENERATION

Jeff Lyash
President and Chief Executive Officer

Bruce Power

Duncan Hawthorne
President and Chief Executive Officer

Memorandum of Understanding on Collaboration during Ontario's Refurbishment Period

Between

Bruce Power LP (Bruce Power)

and

Ontario Power Generation Inc. (OPG)

Effective Date: November 12, 2015

BACKGROUND

I. The Bruce Power and Darlington generating stations provide a low-cost, reliable and clean source of electricity for the province. Ontario's 2013 Long Term Energy Plan (2013 LTEP) outlines an important continued role for nuclear power in the Province meeting approximately 50% of the Province's electricity for decades to come through the refurbishment of the Bruce Power and Darlington Units.

II. The 2013 LTEP also outlines the importance of collaboration between the Province's two nuclear operators in order to *"find ways of finding ratepayer savings through leveraging economies of scale in the areas of refurbishment and operations. This could include arrangements with suppliers, procurement of materials, shared training, lessons learned, labour arrangements and asset management strategies"*.

III. Bruce Power operates the world's largest operating nuclear generating facility and is the source of roughly 30 per cent of the electricity for the Province of Ontario in Canada. The company's site is in Tiverton, Ontario and is Canada's only private sector nuclear operator. Formed in 2001, Bruce Power is an all-Canadian partnership among Borealis Infrastructure Management (a division of the Ontario Municipal Employees Retirement System), TransCanada, the Power Workers' Union and the Society of Energy Professionals. Bruce Power operates 8 CANDU nuclear Units under long-term lease from OPG.

IV. OPG, a successor in title of Ontario Hydro, was established in 1999 under the *Business Corporations Act* (Ontario) and is wholly owned by the Province of Ontario. The company operates a diversified generating portfolio, consisting of two nuclear (Darlington and Pickering), 65 hydroelectric, and three thermal generating stations. Through these generating facilities, OPG generates about 50 per cent of Ontario's electricity.

V. All nuclear facilities in Canada are regulated by the Federal Government through the *Canadian Nuclear Safety Commission* (CNSC) and as such the Bruce Power and OPG facilities share a common regulatory model.

VI. Bruce Power and OPG have a long-standing relationship as operators of CANDU reactors sharing best practices and information through a range of industry forums including the CANDU Owners Group (COG) and the World Association of Nuclear Operators (WANO).

50

VII. Both organizations historically and since the release of the 2013 LTEP have been collaborating in a range of areas that allow both operators collectively to leverage economies of scale to continue to position nuclear power as a low-cost provider of electricity to ratepayers.

VIII. Bruce Power and OPG have developed a range of lessons learned and strengths through their respective operation of CANDU reactors and are committed to building a long-term relationship to enhance the co-operation between the two organizations.

IX. Bruce Power and OPG have experience with the refurbishment of CANDU nuclear reactors and a range of other important investment activities that will be continued for many years to come as these CANDU Units play an important role in meeting the electricity needs of the province.

X. Both organizations share a similar labour relations environment with their two primary unions – the Power Workers Union and the Society of Energy Professionals, along with bargaining arrangements through the Electrical Power Systems Construction Association (EPSCA) for construction labour.

XI. As nuclear operators, Bruce Power and OPG are committed to the value of 'Safety First' and achieve this high standard through active collaboration, transparency and continuous improvement.

XII. Bruce Power and OPG have a joint liaison committee that meets to work together on issues related to the lease of the Bruce Site and related ancillary agreements including waste and heavy water services.

The parties accept the following non-binding Memorandum of Understanding.

PURPOSE

The purpose of this MOU is to confirm a bilateral collaboration framework in which Bruce Power and OPG can build on their successful working relationship over the last 14 years with a particular focus on further leveraging the economies of scale of both organizations and successfully delivering the refurbishment programs anticipated at both Bruce Power and Darlington nuclear generating stations.

AREAS OF COOPERATION

The parties endeavour to collaborate with each other to implement the following objectives which will focus on improving both parties' refurbishment programs.

a) Ensure strong alignment between the Executive Team at both Bruce Power and OPG to continue to leverage economies of scale wherever possible in the operations and refurbishment programs for both facilities. This will be achieved by establishing a joint forum of the leadership from both organizations who will review the areas of collaboration on a regular basis.

b) To build on a strong, long-standing relationship as operators of CANDU reactors sharing best practices and information through a range of industry forums including the CANDU Owners Group (COG), Operational Safety and Review Team (OSART) Missions and the World Association of Nuclear Operators (WANO).

c) To consider opportunities to leverage economies of scale in the areas of procurement, contract services and strategic spares of key plant components in both refurbishment and operations activities.

d) To pursue a continued collaborative approach to labour relations as both organizations work with the Power Workers Union and the Society of Energy Professionals, along with bargaining arrangements through the Electrical Power Systems Construction Association (EPSCA) for construction labour.

e) To identify opportunities to become more efficient in the reduction of waste generated from nuclear facilities and refurbishment activities using best practices and new technology.

f) To advance innovation and business development opportunities

g) Seek opportunities to develop a joint approach to solving issues facing both operators in order to reduce the cost of operation or refurbishment activities.

h) To share and collaborate on approaches and strategies to communicate openly with the public and on the safe, cost-effective and reliable operations from CANDU reactors.

ENGAGEMENT & REPORTING

a) Bruce Power and OPG will continue to engage and advance these areas of co-operation. A joint steering committee will meet on a regularly scheduled basis to align and advance these various issues with management representatives from both organizations.

b) Bruce Power and OPG will create the Executive Committee responsible for setting strategy and objectives and reviewing results of collaboration. The Executive Committee will consist of senior executives of both organizations and will be chaired by Chief Nuclear Officers of Bruce Power and OPG. The Executive Committee will meet on an as required basis. It is estimated that the Executive Committee will be meeting approximately twice a year.

c) This MOU will be made available to the public through the Bruce Power and OPG websites.

d) An annual *summary report* of collaboration activities will be prepared through mutual agreement by Bruce Power and OPG, and the report will be jointly published by both organizations.

e) Both the annual *summary report* and a more detailed technical report will be submitted annually to the Ontario Ministry of Energy for review and to follow-up on activities taking place under this MOU.

CHANNEL OF COMMUNICATION AND NOTICES

For the purpose of facilitating the implementation of this memorandum, the single points of contact are:

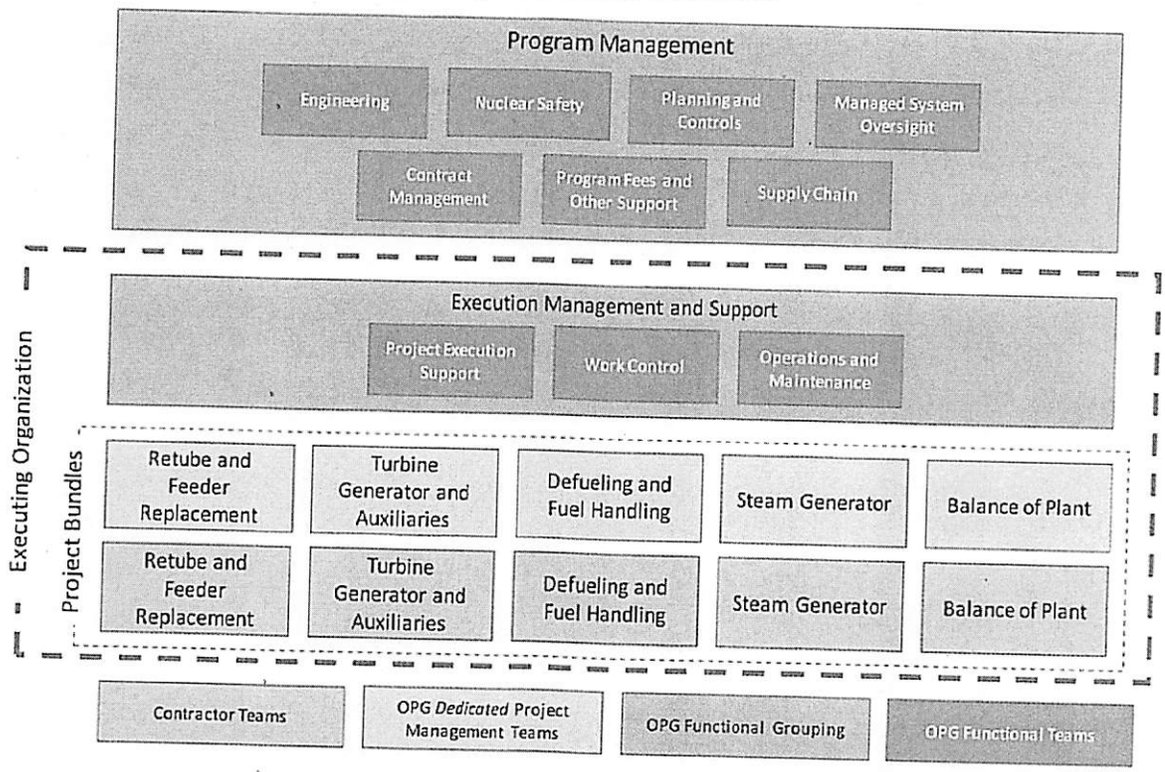
a) For execution:

Bruce Power:
Jeff Phelps
Vice President, Project Management and Construction
P.O. Box 1540, 177 Tie Road
R.R.#2
Tiverton, ON N0G 2T0
226-930-0380
jeff.phelps@brucepower.com

OPG:
Michael H. Allen
Vice President, Nuclear Refurbishment
1855 Energy Drive
Courtice, ON L1E 0E7
289-388-6746
michael.allen@opg.com

Figure 1

DRP Organizational Structure



As shown in Figure 1, the Functions are either contained within the Executing Organization and are responsible for day-to-day execution support, or are at the Program Management level where they are accountable for the overall delivery of the Program, including planning, oversight, monitoring, reporting and contract management of each project executed within the Program. This provides segregation of the day-to-day tactical activities from the overall management activities and also creates a layer of independence within the DRP team which is effective for project oversight and project controls.

3.1 Project Management Teams

As described in Ex. D2-2-3, scopes of work have been grouped into five major work bundles. Each of the five major work bundles has an OPG project director. The project director is responsible for ensuring the effective planning and successful execution of their major work bundle within the overall Program, and for ensuring that the corresponding contractors deliver the contracted services safely, to the quality specified, on time and on budget. The

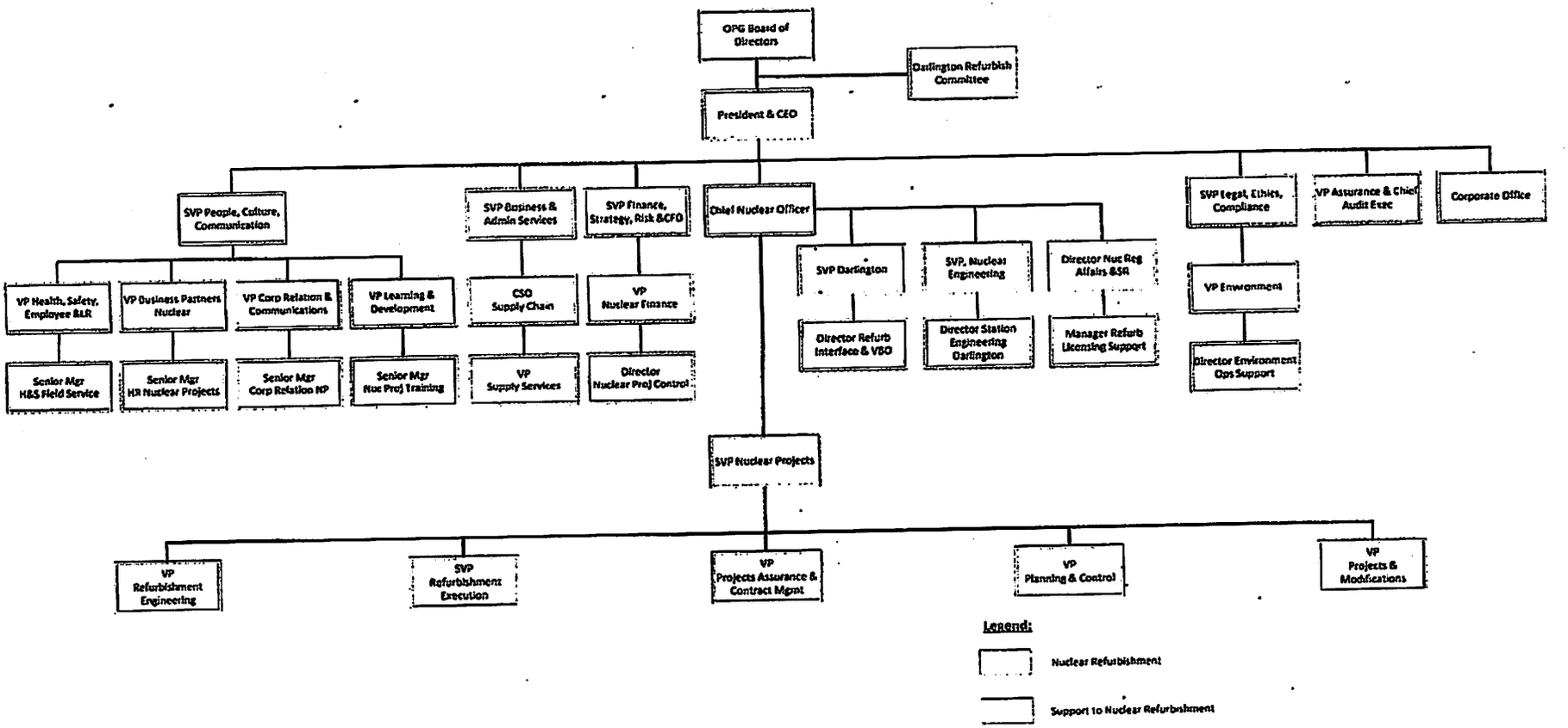
ONTARIO POWER GENERATION

Charter

Internal Use Only	
Document Number: D-PCH-09701-10000	Usage Classification: N/A
Sheet Number: N/A	Revision: R003

Title: DARLINGTON REFURBISHMENT CHARTER

Appendix B: Nuclear Refurbishment Organizational Structure



This chart provides a high level overview of the Refurbishment organizations and key functions and roles that provide direct service/support to the NR Program. Please refer to OPG Org chart for the latest information.

- control of work protection and work authorization;
- start-up of the refurbished unit, including execution of modification commissioning plans, system restart plans, demonstration of readiness for service, and returning the unit to station operations; and
- managing non-radiological waste and waste disposal.

5.0 CHANGE MANAGEMENT

Change is inevitable in a project. A robust change management process provides guidance on how changes are assessed, implemented and reported. The primary purposes of change management are: (1) to control cost, schedule and scope changes against approved baselines; (2) to manage the proper allocation of contingency funds; (3) to document the nature and causes of changes; and (4) to analyze and minimize the impact of the changes on DRP scope, cost and schedule.

The key principles that OPG applies with respect to change management include:

- the executing organization will first attempt to mitigate the impacts of change so that change is managed at the lowest authorized level of the organization;
- change that has a significant potential impact on scope, cost and schedule is reviewed in detail and the recommended direction is approved at the appropriate level;
- only after a change is approved by the appropriate authority level is the work assigned for action by the executing organization; and
- changes are not made solely for the purpose of correcting performance issues that are within the control of the work program owner.

The change control process is applied from project inception through completion. The constraints of cost, schedule and scope will be continuously and rigorously managed by rejecting or approving changes and subsequently incorporating approved changes into the revised Program and performance measurement baseline, where applicable.

Details of OPG's Change Management Process are set out in Attachment 1.

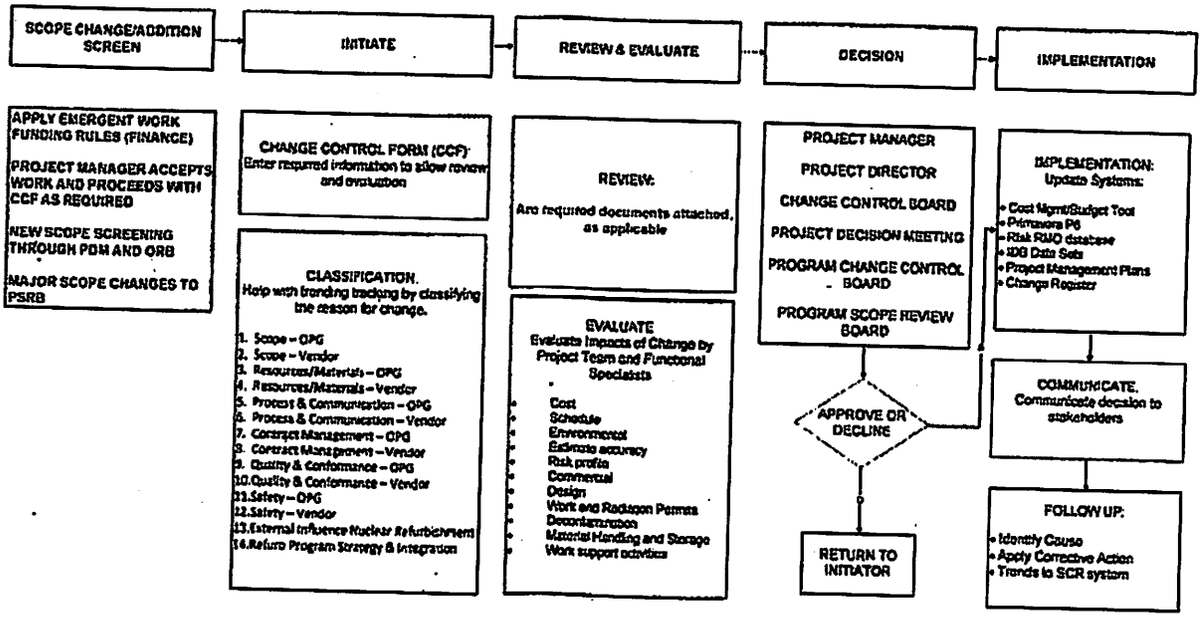
OPG'S CHANGE MANAGEMENT PROCESS

1.0 CHANGE MANAGEMENT PROCESS

OPG's Change Management process is made up of five key steps, which are illustrated in Figure A-1 and further described below.

Figure A-1

Change Management Process Overview



1.1 Screening, Scope Changes/Additions

All proposed scope changes (including removal and additions) are screened by managers and subject matter experts.

1.2 Initiation

The initiator starts the process by describing the change in a Change Control Form ("CCF"). The change is then classified by the reason for the change (see Figure A-1 for classifications). All CCFs must:

- show business rationale or justification for the requested change;

- show technical supporting documents if applicable;
- show cost estimates, if applicable, prepared by OPG and/or contractors in sufficient detail to allow review, including hours, rates, quantities and assumptions (contractor estimates are reviewed and validated by OPG estimators);
- show a resource loaded schedule with affected activities and critical path impacts listed, if applicable;
- identify impacts to the work breakdown structure including to the overall Program, if applicable;
- identify impacts to the risk register, including listing any additional risks, closed risks, changes in impacts on probability, schedule and cost and mitigating actions required;
- show a listing of the Work Packages affected by the proposed change;
- identify impacts to remaining contingency;
- identify the impact to the project life cycle estimate at completion, and provide a definitive estimate at completion and compare to the approved budget; and
- show any other relevant supporting documents that facilitate review and evaluation of the change.

1.3 Review and Evaluate

The evaluation of the impacts of the change on the Program or project is integral to the success of the change management process. If required, the CCF is routed to the appropriate functional support group or subject matter experts for an independent evaluation of the impacts of the change. Impacts that must be independently evaluated are cost, schedule, basis of estimate, estimate-at-completion and risk.

1.4 Decision

The core expectations relating to the change procedure are that: (a) change is managed at the lowest level of the organization that has the authority to do so, (b) change with a significant potential impact on Program or project scope, cost and/or schedule is reviewed in detail, and (c) the recommended direction is approved at the required level, as set out in Figure A-1. For example, depending on the level of impact to the project or Program,

changes may be referred to the Change Control Board or the Program Change Control Board, as required.

The Change Control Board is chaired by the Senior Vice President of Refurbishment Execution (or delegate). Other voting members come from the Darlington Refurbishment Program ("DRP") senior management team, Nuclear Refurbishment Finance, and the functional support groups, including the Engineering Function, Project Execution Support Function, Planning and Controls Function, and Operations and Maintenance Function.

The Program Change Control Board is chaired by the Vice President, Planning and Controls. Other voting members come from Nuclear Projects' senior management team, Darlington Generating Station, Nuclear Refurbishment Finance, and the functional support groups, including the Engineering Function, Planning and Controls Function, and Contract Management Function.

1.5 Implementation

The final decision and disposition of a CCF will be communicated in writing to all stakeholders listed on the CCF. The status of a CCF will be changed to "Approved", and follow-up actions, if any, are tracked to completion.

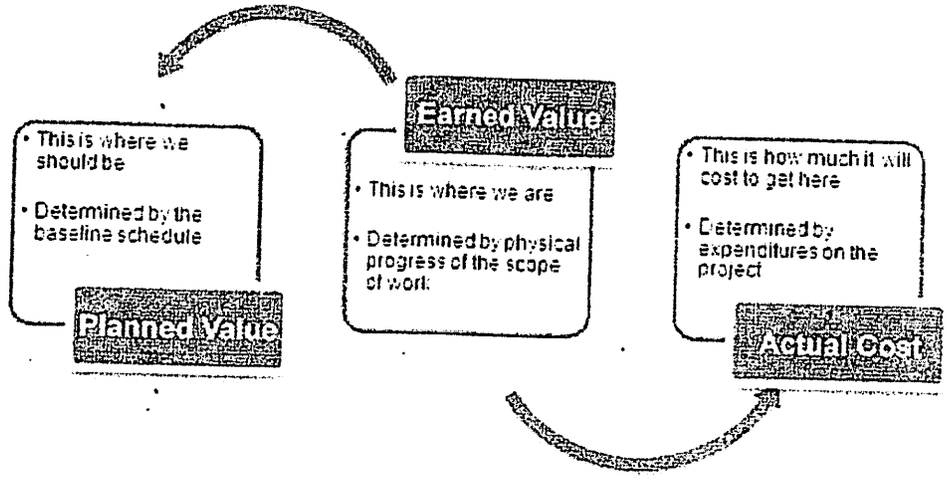
6.0 COST PERFORMANCE MONITORING

The Earned Value Management methodology is used by OPG as the primary architecture for DRP cost management and monitoring. Earned Value Management ("EVM") is a standard project management technique for quantifying and measuring project progress and performance. It not only compares actual costs against budgets, but also allows for continuous analysis of progress achieved against plan throughout the project timeline and across individual tasks forming part of a work component. In other words; the project "earns" progress as work steps are completed, thus allowing management to implement strategies should the project track "off-plan".

In order to conduct EVM analysis, three components are needed: (1) the Planned Value to be earned, (2) the Earned Value (physical progress percent complete against budgeted value), and (3) Actual Cost (from finance/accounting or contractor invoices and accruals). The Earned Value Process is illustrated in Figure 1 and further described below:

Figure 1

Earned Value Process Summary Diagram



Cost performance is measured using standard industry metrics at the program, project, and functional levels. The means by which these standard earned value metrics are calculated, and the significance of the resulting values, is demonstrated through the following scenario. In the scenario, assume that there are four valves that were to have been installed by the current date and that each has a budget or planned value of $1,000, for a total budget of $4,000. As of the current date, only three of the valves have been installed and the total amount spent has been $2,500. The cost of installing the fourth valve, based on experience installing the first three, is forecast to be $800. The standard earned value metrics would be as follows:

- *Schedule Performance Index ("SPI")* is a measure of progress achieved compared to planned progress (SPI = Earned Value / Planned Value). An SPI of 1.0 indicates that the project has completed all planned work. A value of less than 1.0 indicates that all work that was supposed to have been completed has not been completed. A value of greater than 1.0 indicates that work planned for the future has been advanced. Using the above scenario, the SPI would be $3,000/$4,000 or 0.75, which indicates that the project is behind schedule.
- *Cost Performance Index ("CPI")* is a measure of the value of work completed compared to actual cost incurred (CPI = Earned Value / Actual Cost). If the work was completed or 'earned' at the same cost as planned, the CPI would be 1.0. If the cost of the work was higher than planned, CPI will be less than 1.0 and if the work has been completed for less than the planned cost the CPI will be greater than 1.0. Using the above scenario, the CPI would be $3,000/$2,500 or 1.2, which indicates that the project is being executed more economically than had been planned.
- *Cost Variance* is the difference between the budgeted value of work performed and the actual cost of that work (Cost Variance = Earned Value - Actual Cost). For example, the Cost Variance is $3,000 - $2,500, or a favourable variance of +$500.
- *Schedule Variance* is the difference between the budgeted value of work planned and the actual cost of work performed (Schedule Variance = Planned Value – Earned Value). For example, the Schedule Variance is $4,000 - $3,000, or an unfavourable - $1,000.

Schedule Performance Index, CPI and variance metrics are all past-performance oriented. For the DRP, OPG also uses forecasts at the Program and project levels against approved life cycle estimates in order to proactively assess future success and take early corrective action where required. A key metric used for this purpose is *Forecast or Estimate at Completion*, which is determined by adding the Actual Cost and the Estimate to Complete (Estimate at Completion = Actual Cost + Estimate to Complete). For the example, the Estimate at Completion would be $2,500 + $800 based on the forecast provided, for a total of $3,300. Note that the forecast can be determined through a variety of methods, including simply by using the original planned value, or actual unit cost to determine the forecast. The *Variance at Completion* is equal to the Budget at Completion less the Estimate at Completion, which in the example is calculated as $4,000 - $3,300, or $700.

7.0 REPORTING

An integral part of successful project management is reliable and accurate performance information. Reporting provides this performance information through the collection, collation and presentation of data and information. The key objectives of reporting are to:

- ensure information is being communicated to the right stakeholders such that the appropriate decisions can be made, actions taken, or awareness generated;
- communicate the status of the program including any trends, variance from plan, and how the potential variance is being addressed or corrected; and
- ensure information is reliable, accurate and transparent.

OPG plans to issue annual status reports to the public for the duration of the Program through its website. This reporting will include a range of measures, including construction completion, cost performance, schedule performance and safety performance. Chart 1 illustrates the measures that will be provided in the public domain for the duration of the DRP.

Chart 1

Public Reporting on the DRP

Category	Measure
Progress	• Key Achievements • % Complete
Safety	• All Injury Rate
Quality	• Quality Compliance (metrics to be determined)
Cost	• Cost Performance Index • Life-to-date cost • Forecast to Complete • Estimate at Complete
Schedule	• Schedule Performance Index • Status of Key Milestones • Critical Path Progress • Forecasted Completion Dates

8.0 OVERSIGHT

OPG has developed and implemented an assurance plan that is comprised of several layers of oversight, including from Program staff, external contractors, Program leadership, enterprise leadership and external advisors. The plan ensures appropriate oversight during the execution readiness and Execution Phase of the Program, with a focus on key risk areas. Specifically, oversight will help to ensure that the DRP meets safety, quality, cost and schedule expectations, that issues are identified and resolved expeditiously, and that transparent and accurate information flows up to the Board of Directors.

OPG's oversight and assurance processes are supported by transparent, timely and accurate information flows to support decision making at appropriate levels within the organization. Key aspects of OPG's DRP oversight include:

- *project-specific oversight processes and practices* based on risk management, operating experience, contract requirements, scope of work and reviews of contractor performance by each of the Project Management Teams, as well as by the Project Execution Support Function (see: section 3.2.1 of Ex. D2-2-2);
- *oversight of the Executing Organization* (see Ex. D2-2-2, Figure 1) by the DRP leadership team and by Program functions, including the:

- *Managed Systems Oversight Function*, which provides programmatic oversight based on risks and themes emerging from operational experience, project oversight data, and Program and project risks (see section 3.2.6 of Ex. D2-2-2). Through the Program Assurance Group, the Managed Systems Oversight Function conducts surveillances across the projects focused on identifying emerging problems and opportunities in time to address them, including: process improvement, lessons learned and providing coaching and assistance to the project team and contractors as part of an effective risk management culture; and
- *Planning and Controls Function*, which ensures cost and schedule compliance including forecasting, change management, and milestone adherence, effective risk management, and complete and accurate metric and progress reports.

- *OPG's Internal Audit group*, which provides oversight in a broad range of areas such as scheduling, cost estimates, contractor procurement, quality assurance, cost management, contractor time keeping and EPC contracts. OPG's Internal Audit group has functional independence from management. The Internal Audit group publishes the results of audits in a report and requires management actions be assigned, and tracked to completion. The results of all audits are presented to OPG's Chief Executive Officer and the OPG Board of Directors;
- the *Refurbishment Construction Review Board* ("RCRB"), which supports Program level oversight by the Chief Nuclear Officer and the Chief Executive Officer. The RCRB provides independent assessments of DRP progress, estimates and schedules for early intervention and correction of any shortfalls in execution. The RCRB is comprised of approximately six external members with expertise in nuclear plant operations, mega-projects and relevant regulatory requirements, typically with support from one internal OPG member. It meets quarterly and reports directly to OPG's Chief Executive Officer and its Chief Nuclear Officer. The RCRB will also provide the OPG Board of Directors with an annual report on the scope and execution of the DRP; and

- the *Darlington Refurbishment Committee of OPG's Board of Directors*, which supports Program level oversight by OPG's Board of Directors. During the Definition Phase, OPG's Board of Directors engaged BMcD/Modus to provide oversight support. A copy of the final quarterly oversight report from BMcD/Modus to OPG's Board of Directors in respect of the Definition Phase is provided in Attachment 2. OPG's Board of Directors has recently re-engaged BMcD with Modus as subcontractors, to provide independent oversight services during the Execution Phase. BMcD will validate the accuracy and transparency of reports from the DRP to the Darlington Refurbishment Committee and validate that DRP assurance processes at the Program level are healthy, robust, and reviewing the right areas.