Supplemental Report to

Nuclear Oversight Committee

2nd Quarter 2014

Darlington Nuclear Refurbishment Project

Burns & McDonnell
Modus Strategic Solutions

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CONFIDENTIAL

I. Executive Summary

Burns & McDonnell Canada Ltd. and Modus Strategic Solutions Canada Company ("BMcD/Modus") provide the following Supplemental Report to the Nuclear Oversight Committee of the OPG Board of Directors ("NOC") regarding the status of the Darlington Nuclear Generating Station's Refurbishment Project ("Project" or "Refurbishment Project"). BMcD/Modus was requested by NOC to provide a Supplemental Report that summarizes our role, the oversight activities we are performing on the Project and major findings to date, while at the same time providing the broader context for these findings in light of the influx of new members to OPG's Board of Directors ("BOD") and NOC. In this regard, it is important that the comments and recommendations that BMcD/Modus made with respect to the Campus Plan Projects in our 2Q 2014 Report dated May 13, 2014 are viewed with the proper perspective. Additionally, BMcD/Modus provides NOC with an update on the issues raised in our reports to date and the Darlington Refurbishment Team's ("DR Team") responses and resultant actions to those issues.

In this Supplemental Report, we provide the following:

- Background of the Refurbishment Project including the pre-requisite Campus Plan Projects;
- Summary of BMcD/Modus's Oversight activities to date;
- Industry perspectives on critical issues that impact megaprojects like the Refurbishment Project;
- Summary of our NOC reports to date, highlighting our recommendations and the actions that OPG management has taken in response.

BMcD/Modus's engagement as the External Oversight team for the Project began on February 25, 2013. Since that time, we have provided NOC and the DR Team four reports, starting with an Initial Project Assessment report on August 13, 2013 that reviewed the DR Project's progression to the Release Quality Estimate ("RQE") in support of the Project. OPG has committed to providing the Shareholder with the RQE in October 2015. Subsequently, we provided three quarterly reports to NOC, each of which provided an assessment of the Project's current risks as well as more detailed "deep dives" into specific areas of interest. Our prior reports are attached as Exhibits 1-4.

As will be discussed in detail herein, BMcD/Modus has drawn the following major conclusions regarding the Project's current overall health:

- The Refurbishment Project is advancing at an appropriate pace toward the RQE milestone. The majority of the contracts for the Definition Phase have been awarded and essential preparatory work is moving forward. The upcoming 4d Cost Estimate will provide the DR Team with an essential "dress rehearsal" for RQE that will highlight gaps and challenges; these will require the Team's intense focus over the following year.
- The heart of the Refurbishment Project is the Retube & Feeder Replacement ("RFR") work which makes this the most significant risk. Prior CANDU refurbishments have suffered significant delays, cost overruns or both in this aspect of the work. The DR Team has incorporated in its planning the lessons learned from these prior refurbishments and other power megaprojects in order to mitigate the known risks. These mitigation activities include starting planning four years in advance of execution, completion of detailed engineering prior to the start of construction, and building a full scale mock-up to mitigate or avoid the issues that have adversely impacted prior refurbishments.
- The DR Team has devoted significant effort to locking down the Refurbishment Project's scope for RFR and other regulatory and non-regulatory life extension work, and is endeavoring to complete all detailed engineering by May 2015 in order to produce a high quality Project cost estimate for RQE. Engineering is currently challenged to meet this milestone. While it is implementing a plan to streamline its work, this will require intense monitoring and focus. The DR Team's approach toward scope management is a direct course correction from prior refurbishments including Pickering A Unit 4, and provides evidence that the team is inserting lessons learned into its plan.

- The DR Team has shown the willingness to change and evolve as issues have arisen. The DR Team determined that such key areas as scope development, schedule methodology, project reporting and the BOP procurement method required changes, and the DR Team has made those changes. Further management challenges will present themselves as OPG recognizes that a multi-year megaproject is a different endeavor than the company's day-to-day business practices. In our 2Q 2014 Report, we identified corporate procurement and hiring processes as areas for OPG to examine, as corporate policies and controls needed for the Project may vary from those used for OPG's core business.
- Project & Modifications' ("P&M") early management of the pre-requisite Campus Plan Projects, and in particular the D2O Storage Facility and Auxiliary Heating Steam system ("AHS"), exposed some critical project management gaps. The initial cost estimates for these two pre-requisite projects were poorly developed, thus the cost variances now reported are being compared to poorly developed baseline budgets. Senior management addressed these problems by making changes at the Project executive level, installing new leadership with proven ability, and altering the management model. While these pre-requisite projects will cost more than initially anticipated, and continue to present schedule threats to Refurbishment, P&M's new leadership has this work and other Campus Plan Projects on a much more predictable course. Moreover, many of the cost variances appear to be scope based, i.e. OPG is getting more value albeit for a higher cost.
- The causes of the cost overruns in the early Campus Plan Projects root from mistakes made by management that are not being repeated on the Refurbishment Project. There is no evidence we have seen to date that the problems we found in management of the D2O Storage and AHS projects represent a trend or a systemic failure for the Refurbishment Project.
- Both P&M and the DR Team have learned early and essential lessons from D2O Storage and AHS and are using these lessons to modify OPG's management plan for the entire Refurbishment Project. In particular, P&M is abandoning the "hands-off" contractor oversight strategy that was initially prevalent and is adopting an active management role, while the DR Team used these lessons to increase contractor accountability. It is important to note, however, that this is a cultural shift that will present on-going challenges to the organization in the short term.

At this time, the most significant question is whether the upper-end of the Refurbishment Project's anticipated $6-$10B[1] cost is at risk. In all, OPG believes that the cost variances from the Campus Plan Projects will be approximately [redacted] which equates to approximately 2.5-3% of the Refurbishment Project's total $10B working budget. Even if the Campus Plan Projects' overruns are 50% higher than current projections, the Refurbishment Project would still have preserved over [redacted] in contingency and management reserve remaining as part of its working budget. Since the Project is still in the Definition Phase, the cost estimates for the work, contingency and related scope decisions will remain under review until RQE.

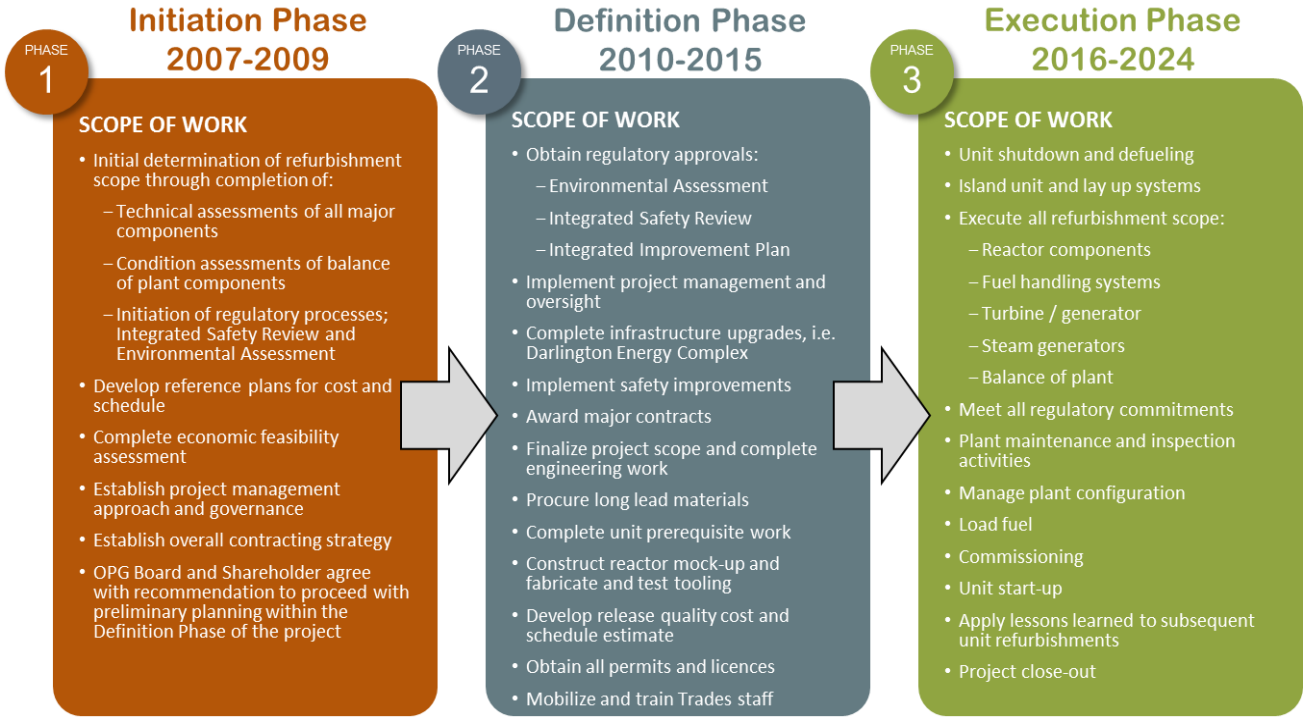
II. Background

A. The Project

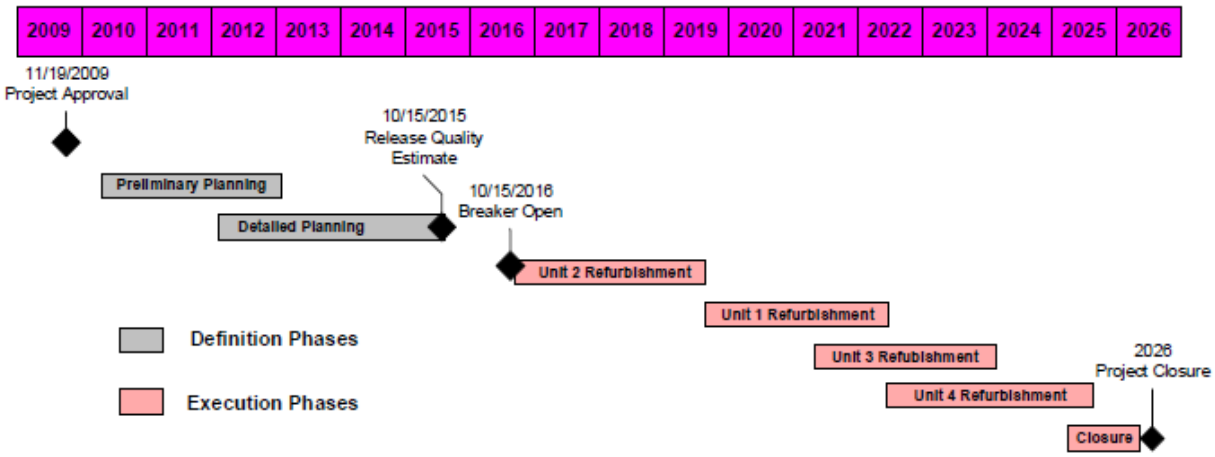
Due to the longevity of materials operating in high radiation fields, the Darlington Nuclear units are currently predicted to reach their nominal end of service lives in 2019 to 2020. However, various factors from Darlington operations could result in the units reaching the end of life earlier or later than the present predictions indicate. In June 2006, the Ontario Government directed OPG to begin feasibility studies regarding the refurbishment of the Darlington Nuclear plants in order to extend their service lives. In late 2007, OPG commenced "Phase I" of the Project called the "Initiation Phase" in order to determine the preliminary scope of work for the Darlington Refurbishment Project and to perform an

[1] This initial cost range for the Project was prepared and presented in 2009, and therefore is expressed in CAD $2009. Due to the length of the Project, escalation from market forces, cost of living increases, and other time-valued costs could not be calculated with confidence, and therefore is not included in the estimated cost.

economic feasibility assessment. Phase I was completed in 2009. The following graphic from the Refurbishment Team provides an overview of the Refurbishment Project's three phases:



The Refurbishment Project is currently in the Definition Phase, during which the DR Team anticipates completing award and negotiation of all vendor contracts, finishing detailed design, performing the front-end planning and locking down the Refurbishment Project's scope, budget and schedule. In addition, the Campus Plan Project work is to be largely completed in this period (with some work extending beyond RQE), as each of these various projects is needed in some manner before the breaker open of Unit 2. The phasing of the work depicted above allowed for the Project to proceed with its initial planning based on yearly incremental funding releases approved by the BOD with developmental targets and key milestones optimized for the completion of the RQE in October 2015. RQE will be the definitive estimate for the Execution Phase of the Project. Breaker Open for Refurbishment of Unit 2 (the first unit to be refurbished) is scheduled for October 2016 as depicted in the schedule below:



From the above schedule, it is worth noting OPG's major decision to "unlap" the execution of the first and second units. The Project's initial schedule required that the refurbishment of the second unit would begin before the first unit was returned to service. In the summer of 2013, Refurbishment Project management presented the current sequence that allows for the full "breaker-to-breaker" performance of Unit 2 prior to the start of the subsequent units. Management based this decision on the need for the first unit to be the singular focus of the DR Team during this time period and to allow adequate time to incorporate any lessons learned or process improvements into the next units' work. BMcD/Modus supported this decision, which was approved by the BOD as part of the 2014 Business Plan.

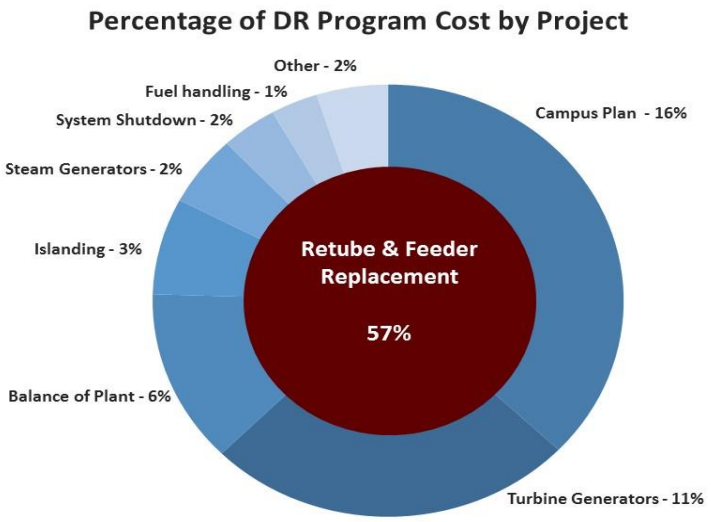
B. Project Management Model

OPG has chosen to manage the Darlington Refurbishment as a "Program." According to the Project Management Institute ("PMI"), "A Program is a group of related projects managed in a coordinated manner to obtain benefits and control not available from managing them individually." OPG's stated overall commercial strategy for the Program is premised on OPG acting as the General Contractor and Program Manager for the full Program. Within the Program, there are seven discrete Projects, each with its own project management team (including functions that are matrixed, such as engineers, commercial managers and project controls leads). The seven Projects (also known as "Project Bundles") encompass the following scopes of work:

- Retube and Feeder Replacement
- Islanding/Containment Isolation
- Fuel Handling/Defuelling
- Turbine Generator Maintenance and Controls Upgrade
- Boiler and Auxiliary Systems (Steam Generator Lancing)
- Shutdown, Layup and Services
- Balance of Plant

Each of these Project Bundles is being procured on an Engineer, Procure and Construct ("EPC") basis, meaning that a single contractor will be responsible for providing the all three services under a single contract. In addition to the Refurbishment Project, there is a significant amount of work (including the Campus Plan and other prerequisite projects) that needs to be completed and placed in service prior to the Execution Phase in order to support Refurbishment. The DR Team is responsible for planning and executing the bulk of the Refurbishment Project work. The P&M organization is responsible for completing the Campus Plan and other prerequisite projects. In contrast to the Program approach adopted by the DR Team, P&M is responsible for managing a Portfolio of hundreds of small projects for the Darlington and Pickering nuclear generating stations and the Western Waste Management facility.

In discussing specific aspects of the Campus Plan or the Project Bundles, it is possible to lose sight of the fact that the Retube and Feeder Replacement ("RFR") Project comprises the majority of the Refurbishment—in terms of schedule, budget and complexity, and as a result, comprises the most risk. As an example, for this Project, the major objective is the retubing and feeder replacement of Darlington's four nuclear units so that the plant can operate for another 30 years. All of the Refurbishment Project's other goals are subsidiary to the RFR work. Sixty percent (60%) of the Project's critical path is formed from the RFR scope; the remaining critical path work is either in preparation for RFR or commissioning and re-starting each unit after RFR completes. The following diagram depicts how much larger the RFR project is in comparison to all other project work, including the Campus Plan Projects:



Source: 4c Cost Estimate excluding contingency and functional costs, 2013; updates were made by BMcD/Modus to the RFR and Campus Plan Projects to reflect the most likely current estimates.

C. The Process for Developing RQE

Large, complex projects in general, and nuclear refurbishment projects in particular, have been challenged to meet their original budgets and schedule. For purposes of measuring the maturity of a project, the industry commonly uses project scope definition as a leading indicator of the underlying quality of a project's cost estimate and schedule. Projects can be at risk if they start construction prior to completing engineering, though this is a fairly common practice in the industry. For purposes of tethering its estimating effort to known industry standards, the DR Team has embraced utilizing the estimating standards from the Association for the Advancement of Cost Engineering ("AACE") and its guidelines for the classification of cost estimates[2]. These guidelines establish engineering and scope definition as the key underlying metric for developing certain "classes" of cost estimates from Class 5 (most conceptual with the largest range of potential variability) to Class 1 (most mature with the narrowest range of potential variability), as follows.

	Primary Characteristic	*Secondary Characteristic*		
ESTIMATE CLASS	**MATURITY LEVEL OF PROJECT DEFINITION DELIVERABLES** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

Notes: [a] The state of process technology, availability of applicable reference cost data, and many other risks affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

[2] 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).

Thus, RQE for Refurbishment is intended to be a Class 2 Estimate, a type of estimate that typically forms a project's "Control Budget." By utilizing this methodical approach to developing RQE, the DR Team should be able to produce a high-confidence estimate against which the Project's performance can be properly measured so long as each of the inputs are carefully vetted and understood. It is also important to understand and accurately characterize what each of the estimates represent prior to RQE within the context of the level of project definition and the accuracy range. It is not unusual on highly visible projects for actual project costs to be compared against early (i.e. Class 5) point estimates without a discussion of their accuracy ranges, which could mislead external stakeholders.

A concept within the estimate that is commonly misunderstood is the application of contingency. Contingency is included in the base estimate and refers to costs that will probably occur based on past experience. As a result, contingency is expected to be spent as the project progresses through its life cycle. The utilization of contingency is not an indication of poor management.

OPG is taking significant steps in engineering and scope definition in order to provide a fundamental basis for RQE by: 1) utilizing the AACE guidelines to characterize the Project's scope and engineering maturity through a progression of cost estimates; 2) completing detailed engineering prior to the start of construction for all work; and 3) mitigating potential performance risk and estimating errors through construction and the use of a full scale mock-up for RFR. Proper planning of the execution phase of the Project will provide confidence in the reliability of RQE as well as minimize the risks of cost and schedule overruns during construction.

D. Timeline of Key Events

The following timeline of key events shows the parallel development of the Campus Plan Projects and the Refurbishment Project.

Date	Key Events
	Early Project Development – Initiation Phase (2006 to 2010)
2006 – 2010	• Feasibility studies for DNGS Refurbishment, leading to February 2010 announcement of Refurbishment Project • DR Program Charter approved • D2O Storage and Auxiliary Heat Steam system projects approved, then put on hold • Refurbishment Project's Scope Definition Phase begins, categorizing core and non-core scope • Environmental Assessment Studies submitted to the CNSC • Procurement process for RFR project begins
	Refurbishment Project Definition Phase (2011 to Current)
2011	• Bill Robinson retires; replaced by Albert Sweetnam as SVP of Nuclear Projects • Mike Peckham named VP of Projects & Modifications • OPG submits Integrated Safety Review (ISR) to CNSC • Environmental Impact Statement issued • Project charter for D2O Storage project issued August 2011; high-level scope and estimate of $210M provided to P&M management • Refurbishment Project' Release 4a Cost Estimate provided to Board of Directors
1Q 2012	• P&M negotiates and executes Extended Service - Master Service Agreements ("ESMSA") with two vendors – Black & McDonald and ES Fox – for use on Campus Plan Projects • SNC/Aecon Joint Venture selected as EPC for RFR project
2Q 2012	• D2O Storage Gate 3A conducted with revised EPC Project estimate - $108M • DR scope review conducted to identify potential scope to be deferred
3Q 2012	• AHS bid and award of EPC to [redacted] – total project estimate - $45.6M
4Q 2012	• P&M seeks full funding releases for D2O Storage and AHS • Refurbishment Project Release 4b cost estimate shows potential for upward pressure on budget

Date	Key Events
1Q 2013	• Refurbishment begins early gate review process for major projects • P&M publishes Lessons Learned report for D2O Storage – schedule overruns and multiple rejections of vendor's conceptual design lead P&M and Refurbishment to change model of development of project scope • Change in engineering strategy presented to NOC • Mr. Sweetnam leaves OPG • BMcD/Modus begins role as Independent External Oversight to NOC
2Q 2013	• Mr. Robinson returns as SVP of Nuclear Projects • DR Team management identifies early lessons learned from EPC model and moves to more direct oversight of contractors • Refurbishment scope review identifies priority ranking of project work • Refurbishment presents strategy to streamline Project by "unlapping" Unit 2, rationalizing project scope and deferring Turbine Generator controls to next unit • SNC/Aecon provides Class 4 project estimate for RFR project
3Q 2013	• Mr. Peckham leaves OPG • BMcD/Modus provides Initial Project Assessment to NOC • Refurbishment scope review performed based upon operational experience • Refurbishment revises procurement approach for Balance of Plant ("BOP") allowing direct award of work based on vendor qualifications • Soil conditions and underground utilities delay and increase cost of Campus Plan Projects within DNGS protected area • Refurbishment modifies scheduling approach for Definition and Execution Phases, embracing a level 3 integrated, resource loaded schedule
4Q 2013	• Integrated Implementation Plan (IIP) and Global Assessment report (GAR) submitted to CNSC • Release 4c Cost Estimate provided to BOD – overall cost estimate of $10B (with [redacted] contingency and [redacted] management reserve) with reductions in scope and unlapping • Results of the scope review by the Blue Ribbon panel reduces the Refurbishment Project's cost and defer execution of non-Refurbishment enhancements • Contractors release estimates showing variances to original contract values for D2O Storage and AHS after BOD approval of the 4c Cost Estimate.
1Q 2014	• Minister's Long Term Energy Plan released • Terry Murphy begins as VP of P&M • Refurbishment and P&M begin collaborative approach to engineering, scoping, planning and cost estimating of Campus Plan Projects and BOP work • Turbine Generator performance contract awarded to SNC/Aecon • P&M team provides root cause analysis of delays to D2O Storage; Mr. Robinson requests BMcD/Modus to provide independent assessment • Revised cost estimates for Campus Plan Projects provided by ESMSA contractors, leading to revisions to Business Cases • RFR mock-up facility completed
2Q 2014	• Revised BCSs presented to BOD for approval for Campus Plan Projects – AHS, Water & Sewer and OSB – management defers request for funds for D2O Storage, awaiting updated Class 2 estimate from vendor • BMcD/Modus provides assessment of Campus Plan Projects to NOC • SNC/Aecon produces Class 3 RFR Estimate for OPG's vetting

III. BMcD/Modus' External Oversight Role

After a thorough RFP and selection process that started in April of 2012, OPG contracted with BMcD/Modus to provide External Oversight services for the Refurbishment Project. This engagement began on February 25, 2013. BMcD/Modus assigned very senior level individuals with extensive experience and expertise in all aspects of nuclear project development, management and independent oversight. Our central role is to report to NOC and assist the SVP Nuclear Projects by providing independent assessments on the performance of the Refurbishment Project. At a high level, this involves:

- Reviewing and monitoring the definition, development and risk management of the Refurbishment Project;
- Monitoring progress of the Refurbishment Project against targets, including cost, schedule and risk;
- Reviewing execution performance of the Refurbishment Project; and
- Offering recommendations for improvement where appropriate.

The BOD approved our Work Plan for performing oversight activities on the Project in May 2013 and included both day-to-day monitoring of events and "deep dives" on critical areas that we believed would be indicative of the Refurbishment Project's health. We anticipated developing reports for NOC that would track the status of the Refurbishment Project's activities in an ongoing manner and provide our view of the Project's risks and potential gaps, as well as recommendations for mitigating those risks. Our focus during the Definition Phase has been to examine the DR Team's planning efforts related to the Project's development of scope, schedule, cost and risk identification which are the key inputs to RQE. To date, the cooperation from OPG and Refurbishment contractors has been excellent. The BMcD/Modus team has had the appropriate level of access to personnel, documents and meetings, which provides insight and clarity to Project activities and plans.

IV. Industry Perspective

In our engagement, we are relying on our team members' long history with large capital megaprojects, particularly in the nuclear industry. Megaprojects (generally defined as high-profile projects costing more than $1B) have a rhythm all their own and typically involve large sums of money, lengthy, multi-year project schedules and significant risks to the companies who engage in them. In 2013, the Project Management Institute ("PMI") produced a study for its Global Executive Council membership which demonstrated the high cost of poor performance on megaprojects. PMI's study found that 28% of project funding is at risk in organizations that do not properly plan and manage capital projects.[3] This figure is in comparison to 2% of the budget being at risk for high-performing organizations.

Gaining understanding of these common megaprojects' risks requires understanding of certain essential facts:

- Megaprojects like the Refurbishment Project need large, clearly visible objectives so that all participants and stakeholders can objectively measure progress towards these major goals. RQE is an example of such a major goal.
- Major project goals (cost, schedule, performance) need to be viewed as a whole, rather than as a sum of the parts. As such, megaprojects' risks need to be viewed at a macro level, as day-to-day assessments can be misleading and uninformative. As an example, an owner could chose to mitigate a larger risk to the overall project by accelerating a predecessor project at additional cost. Without the context of the larger project, the cost-benefit analysis to incur the additional cost could not be justified.

[3] Project Management Institute "2013 Pulse of the Profession™: The High Cost of Low Performance," October 2013.

- Engineering and scope identification are the most common leading indicators of a megaproject's success. Projects with loose scope or engineering errors, omissions and schedule delays are typically beset with large cost increases and additional downstream schedule delays. A common mistake that usually results in such increases is beginning work in the field without a completed design and appropriately sequenced work. This was a key factor in the cost overruns for Pickering A Unit 4 which OPG first addressed with Pickering A Unit 1 and now with the Refurbishment Project.
- Owners typically rely on large, sophisticated contractors with requisite experience for megaproject performance, and the contracting model owners typically default to is EPC. However, even when EPC contracts are on a firm, fixed-price (which the EPC contracts for the Refurbishment Project are not), the contractors never accept as terms of the contract all of the performance risk, as the premium a contractor would demand to shift such a large amount of risk would be untenable. Therefore, owners must decide their level of risk tolerance and negotiate for appropriate levels of transparency and control over the performance of the work. With the exception of the ESMSA, the EPC contracts for the Project were all negotiated with the specific scope of work for each Project Bundle in mind.
- Non-critical work on megaprojects needs to be properly calibrated to either facilitate or stay out of the way of the work that is on the critical path. Nuclear operations tends to insert processes, appropriate for the discipline and certainty required for an operating nuclear generating station however, in a project environment these same processes make work management exceptionally complex. A key part of our Independent Oversight role is identifying issues that could draw away the attention of management from the most critical work.

Our experience with megaprojects similar to the Refurbishment Project—including, for many on our team, the Return to Service of Pickering A Unit 1 a decade ago—allows BMcD/Modus to characterize the effort required and expended on this Project. There are three core nuclear industry principles that are essential ingredients to our oversight mission:

(1) In the nuclear community, there is wide acceptance of the need for ***continuous improvement*** based on learning lessons from operational experience ("OPEX"), which provide a basis for judging progress and effectiveness;

(2) Nuclear projects and operations are in a constant search for corrective actions which are specific recommendations for mitigating or recovering from problems; and

(3) When problems are identified and corrective actions attempted, it is essential to establish the extent of the condition to properly characterize the magnitude of any one problem or set of problems.

These concepts must work in unison; otherwise one can get an entirely false read of the significance of issues as they arise. As an example, during operations of a power plant, each "Station Condition Report" or "SCR" documents and reports events of all types with the same level of veracity. However, SCRs can range in significance from serious problems like a unit trip to a line worker slipping on the ice during winter. Thus, defining the extent of condition provides management with the appropriate characterization of a potential problem.

Our reports incorporate these principles so that management and the NOC can understand the nature of a deficiency, see the recommended solution or corrective action that management is taking, and evaluate the extent to which this problem impacts the overall Project. In preparing our reports, BMcD/Modus intentionally seeks out areas where there are perceived gaps and we attempt to define and characterize the risks these problems may present to the overall Project.

V. Synopsis of BMcD/Modus Reports and Major Findings

As part of our NOC approved Work Plan, in August 2013, BMcD/Modus produced an Initial Project Assessment Report ("Initial Assessment Report") in which we established a baseline for assessing and measuring the DR Team's activities through the current Definition Phase. Subsequently, BMcD/Modus has produced three quarterly reports to NOC.

BMcD/Modus prepares these reports for NOC as a continuous progression of the Project's status in which we identify areas for the DR Team to focus and monitor their efforts to recover or fill gaps. Throughout, we have identified both gaps for the DR Team to address and positive developments from which the NOC should draw a measure of confidence that the team is working toward the Project's ultimate goals. The following summarizes the topic areas and major findings from each of our reports to date.

BMcD/Modus Reports to NOC as of 2Q 2014	
Report Summary	**Major Findings**

Initial Assessment Report – August 13, 2013
• Finalized BMcD/Modus Work Plan
• Benchmarked the Status of Key Planning Activities
• Benchmarked the Status of Major Project Bundles
  ○ Retube and Feeder Replacement (RFR)
  ○ Balance of Plant (BOP)
  ○ Campus Plan
  ○ Turbine Generator
  ○ OPG Critical Path Activities
	The Refurbishment Project is appropriately advancing at the time of this assessment toward the goal of producing RQE by October 15, 2015

4Q 2013 NOC Report – November 12, 2013 • Assessed RFR project's procurement and estimate development • Presented assessment of the 4c Cost Estimate presented to Board • Reviewed scope definition and planning assumptions • Addressed BOP procurement model changes • Assessed Campus Plan Project risks	DR Team's development of the 4c Cost Estimate meets appropriate level of definition; future cost estimates will require increased definition to match the Refurbishment Project's anticipated maturity growth
1Q 2014 NOC Report – March 2, 2014 • Analyzed Project's conformance to goals set by Minister of Energy's Long Term Energy Plan (LTEP) • Updated RFR risks • Provided summary of Project Risk Management • Performed a commercial risk review • Continued Campus Plan Projects' risk assessment	The Refurbishment Project complies with the LTEP though there are some gaps that can be addressed over time; RFR procurement, planning and Class 3 Estimate fell behind schedule and is in recovery mode; Campus Plan Project cost and schedule experienced variances to baseline
2Q 2014 Report to NOC – May 13, 2014 • Performed detailed assessment of Campus Plan Projects' risk and assessment of cost/schedule variances • Reviewed and monitored RFR recovery plan • Provided commercial risk update • Assessed RQE preparation	Campus Plan Projects' variances were caused by initial poor cost and schedule estimates; P&M's management model was flawed; P&M and Refurbishment Projects are responding to challenges and lessons learned from early Campus Plan Projects; RFR is recovering from early delays

With each quarterly report, BMcD/Modus provides NOC and the DR Team with our general observations regarding the Project's top risk areas as well as specific recommendations, as required. In addition, with each report, we provide more granular focus on specific "drill down" issues that were the subject of our prior quarter's activities. From these reports, we provide the DR Team with a series of specific recommendations and observations for their use.

The DR Team has a complimentary process through which it is documenting our recommendations and providing the team's actions needed to close out those concerns. We meet weekly with DR Team's point of contact who updates the log of recommendations and actions, and meet periodically with the Project's leadership team (the "Refurbishment Project Executive Team" or "RPET") as a whole. To date, we have seen the DR Team take action on many of the items we have raised, including: (1) taking the recommendations as written as well as the prescriptive actions we may have identified; (2) finding a middle ground for response and action; or (3) identifying how the DR Team plans to address such recommendations in the future. In our reports, we identify the team's progress and monitor both the sufficiency and the speed of its responses. Thus far, we have been satisfied with the DR Team and P&M organization's actions or commitments to providing responses to our recommendations.

VI. Summary of BMcD/Modus Reports and Current Status Update – 3Q 2013 through 2Q 2014

A. Initial Project Assessment – August 13, 2013

In our August 2013 Initial Project Assessment Report, BMcD/Modus provided NOC with an overview of the Refurbishment Project's status at that time and identified a number of key recommendations for the DR Team to consider. The Initial Assessment Report was intended to form a benchmark for the Project's progress, so it is appropriate to revisit our key observations from one year ago and measure the team's progress:

BMcD/Modus Initial Assessment Report August 2013	Current Status
BMcD/Modus believes the Refurbishment Project was appropriately advanced to support its major goal of producing a Release Quality Estimate ("RQE") for final Board of Directors and Shareholder approval by October 15, 2015. However, we noted that the DR Team needs to effectively and efficiently manage a number of significant risks in order to achieve the necessary level of definition and project maturity required for the RQE.	The Refurbishment Project has made a number of key advancements in the last year and remains on pace with RQE preparation. However, the required effort increases with the passage of time. The team's effort for the 4d Cost Estimate will provide a good indicator of the Project's overall readiness.
The DR Team needs to mature, break down silos and operate as an integrated Project Team for the Execution Phase.	Some progress has been noted in this regard though there is more work ahead. Recent leadership changes will have to be monitored for effectiveness though the leadership remains committed to moving the organization to the Execution Phase. The Project Team should be further optimized in this regard by the award of significant work packages (Containment Isolation and Turbine Generator) [redacted]
The EPC contracting model presents a significant challenge, as this model is new to OPG and will require a number of process and management changes. We noted that the DR Team's current growing pains are commonly experienced by owners who engage in large EPC contracts for the first time.	The P&M Team for the Campus Plan Projects struggled with the initial application of a hands-off oversight model paired with largely cost reimbursable target price contracts with vendors. The DR Team has learned from these early lessons and is moving forward with more active management of the work.
OPG's oversight of the Detailed Engineering and Planning & Assessing phases poses perhaps the most significant near-term risks, as these functions have typically been performed in-house by OPG on past projects. We recommend OPG consider "shoulder to shoulder" work with the EPC design partners to expedite the	Development of Detailed Engineering by the May 2015 deadline remains a milestone at risk. Engineering has modified its approach to a collaborative design process in which the engineering work on-going at vendors' home offices is subjected to OPG's more immediate review and resolution of outstanding issues. The goals for the collaboration are appropriate, though some delays in awarding BOP work are placing the design completion

BMcD/Modus Initial Assessment Report August 2013	Current Status
start of detailed engineering and constructability reviews.	milestone at risk.
OPG's most vital role during the Execution Phase will be to manage and coordinate the work of the multiple EPC contractors, a condition that typically provides a ready source of change orders, delays and commercial disputes on projects of this type.	The DR Team has taken this issue head-on and has instituted a number of key issues and initiatives that assert OPG's role as the integrator and as general contractor. Most notably, OPG has taken control of the detailed Level 3 Project schedule integration and coordination.
The final scope for the Refurbishment Project needs to be fully vetted and properly narrowed to meet the Project's goals of (1) replacement of life-limiting components (such as pressure tubes) and (2) replacement of components most efficiently done in an extended outage.	The DR Team instituted a "Blue Ribbon Panel" to perform an independent review of the Project scope. The Blue Ribbon Panel made several recommendations to remove project scope resulting in less project complexity (as well as reducing project risk) and lower cost. On an ongoing basis, any scope changes are reviewed by the Scope Review Board.

B. 4Q 2013 Report

The focus of this report was to progress the status of the Project from the baseline established by our Initial Assessment Report. In particular, the 4Q 2013 Report looked at the progress and risks of RFR and Balance of Plant, the 4c Cost Estimate, the development of the Project's scope and schedule and Campus Plan. We also reported at that time that the DR Team's senior leadership had positively responded to the recommendations in our Initial Project Assessment that we presented to the NOC in 3Q 2013.

BMcD/Modus 4Q 2013 Report December 2013	Current Status
[redacted]	OPG's RFR Project Team required the RFR Contractor to develop a recovery plan to restore progress to plan. The RFR contractor's performance has since improved, and although it has not fully recovered the schedule, OPG is much more active in holding the contractor accountable to work its recovery plan and show improved progress.
[redacted]	The DR Team worked extensively with the RFR contractor to identify and communicate its expectations regarding its Class 3 estimate (which will be a significant input to OPG's own 4d release business plan) and is currently in the process of vetting the JV's estimate, but all indications are that the JV has met its contractual obligation.
The Facilities and Infrastructure Projects that are part of the Campus Plan remain a significant risk to the DR Project, particularly D20 Storage.	The DR Team's senior leadership is taking action to turn the performance around, including: • Additional focus on helping the ESMSA vendors' design partners' efforts by co-locating OPG resources as resident engineers; • Developing a plan to integrate all of the pre-requisite work into a master integrated schedule so that the ESMSA's can properly plan and resource load the work and OPG can manage the contractors' work load and performance. • Completion of work allocation to each of the vendors so that the ESMSA's can properly plan their work
Consider the 4d Cost Estimate that the DR Team will be presenting for next year's Business Plan a "dry run"	The DR Team has agreed with this recommendation and incorporated it into its 4d estimating plan. The 4d estimate

BMcD/Modus 4Q 2013 Report December 2013	Current Status
for RQE.	will be developed over the summer and will be submitted to the Board for approval in the November 2014 Board meeting. Additionally, the DR Team is focusing on improving traceability, sourcing, vetting and suitability of database information underlying the estimate.
Quality and consistency of the materials in Gate packages should be addressed. Gate review packages are often hastily assembled by the project teams and provided to the GRB only shortly before the gate review meetings.	The Refurbishment and P&M leadership have increased accountability by their respective project managers. Recent packages have been subjected to increased scrutiny and initial rejections. Management of both organizations has reiterated quality standards.
The development of the Level 3 schedule needs improvement. Since future contracts (most notably RFR and BOP) are based on target price arrangements, it is essential that the operative schedule is resource loaded; otherwise, the Project Team will lack an essential tool for holding the contractors accountable to their budgets. Project Controls will need management support to hold the work groups accountable for developing and utilizing the Master Schedule, including developing forums for discussion of the Execution Phase Master Schedule status and preparation.	The DR Team has made significant progress and adopted all of BMcD/Modus's recommendations for the development of the Project schedule. The Definition Phase schedule continues to mature and scheduling standards are being enforced with the contractors.
The next challenge for Engineering will be to morph into an organization that can manage the next phases of work, and here remains some concern. Engineering will have multiple roles, from design authority to reviewer of the various EPC contractors' work-product to developing the restart plan for the units. This will require a significant planning effort.	Meeting the May 2015 milestone for completion of detailed design is at risk, though OPG Engineering has taken significant steps by injecting increased front-end planning and collaboration with the vendors. The success of these efforts will be determined over the coming months.

C. 1Q 2014 Report

The issuance of our 1Q 2014 report coincided with the release of the Minister of Energy's December 2013 Long Term Energy Plan ("LTEP"). As a result, much of this report was dedicated to identifying any gaps or misalignment between the Project and the LTEP. Our report also identified recommendations for strengthening OPG's planning for completion of the Release Quality Estimate ("RQE").

BMcD/Modus 1Q 2014 Report March 2014	Current Status
RFR contract incentives and disincentives are based on 4 unit performance; the LTEP prioritizes the success of Unit 2 as a precursor for the other 3 units.	Refurbishment's senior management is committed to a thorough commercial review of the RFR contract's incentives and disincentives. Target price negotiations will provide a platform for negotiation of these essential provisions.
There is ambiguity in pricing risk for the RFR target price; the contract monetizes contingency as part of the target price, not before. This includes focusing on risk and contingency for the Project estimate to be included in the 2014-2015 Business Plan.	With the completion of its Class 3 Estimate, [redacted] has committed to providing input to OPG for modeling contingency for the 4d Cost Estimate. Nonetheless, monetizing the associated contingency for RFR will require substantial effort.

BMcD/Modus 1Q 2014 Report March 2014	Current Status
The DR Team has struggled with defining its "oversight" role of the contractors. OPG needs to embrace "active management" of its contractors and apply lessons learned from early Campus Plan and RFR work regarding benefits of active management vs. passive oversight.	The DR Team and P&M have each made essential changes to their respective management models that incorporated these lessons learned. These changes include: • Increased collaboration for estimating, scoping, scheduling and planning of the work; • Increased vendor surveillance; • Managing the interfaces in the integrated schedule; • Increased management meetings with vendors and senior management to review and resolve open issues.
The DR Team's project controls are in an early stage of development and require testing and validation, including: Continued action on the part of the DR Team to strengthen schedule and budget controls, and continued development of the integrated level 3 schedule.	As noted, this is underway.
With respect to the RFR Class 3 Estimate, OPG needs to hold the RFR contractor accountable for meeting the required schedule dates.	The OPG team held SNC/Aecon accountable for developing a quality product for the Class 3 Estimate. OPG's team challenged multiple aspects of the estimate and required SNC/Aecon to change or further explain multiple elements of the plan embedded in the estimate.
Several Campus Plan Projects may delay breaker open if the delays are not mitigated; the lack of an integrated and resource loaded Level 3 schedule has made it difficult for P&M to evaluate Campus Plan Projects' work priorities, ESMSA resource needs and determine potential delays to the project pre-Refurbishment critical path.	The maturity of the P&M schedules is increasing; there are currently 14 projects with updated level 3 schedules including all work on the critical path. These updated schedules are allowing P&M's management to make appropriate decisions.
Capture lessons learned from Campus Plan and incorporate into management of BOP work in real time.	As noted in our 2Q 2014 Report, this is currently occurring on both the Campus Plan Projects and Refurbishment.
Evidence of P&M mismanagement of EPC contract terms with ESMSA could impact Refurbishment.	Refurbishment immediately injected the lessons learned regarding ESMSA performance. Refurbishment has increased collaboration with the ESMSA vendors and has made decisions regarding scope assignments based on vendor readiness and capability.
Early indicators of scope/pricing for the ESMSA BOP work have been mixed with examples of misunderstood scope and engineering requirements.	The BOP estimates that were initially out of line have been reviewed and scope is being aligned. The Refurbishment Project initiated an Options Review Board ("ORB") that provided additional vetting of scope and planning. The ORB has already uncovered poor initial planning and scoping of three BOP projects.
The Risk Management Program has initiated some improvements but has additional work to do to increase effectiveness; the current Program Management Plan is lacking in detail and clarity.	Risk Management's profile within the Refurbishment and P&M teams still needs to be raised. The Refurbishment team launched an RQE risk session that should increase the teams' focus.

D. 2Q 2014 Report

On May 13, 2014, BMcD/Modus presented to the NOC our Quarterly Report for 2Q 2014 (the "2Q 2014 Report") in which we provide a summary of our investigation of the causes of the cost and schedule variances in the Refurbishment Project's key pre-requisite Campus Plan Projects. This assessment was not initially in our scope, though in early 2014, the DR Team's senior management requested that we provide an independent review of the causes of these cost variances. Our 2Q 2014 Report raised a number of concerns that both NOC and senior management have taken very seriously. During the May 13, 2014 meeting, the NOC requested both BMcD/Modus and the DR Team's executives to provide an update of the issues we each raised regarding the Campus Plan Projects' performance and cost and schedule variances at the next NOC meeting. As part of this update, OPG senior management has asked us to assess:

- The current impact and extent of condition of the variances found in the budget and schedule for the Campus Plan Projects;
- The extent to which changes in management personnel and approach implemented for the Campus Plan Projects have been effective;
- Whether Refurbishment has benefitted from lessons learned from the Campus Plan Projects, and specifically whether the EPC contracting model for Refurbishment and the method OPG has chosen to manage the EPC contractors suffer from the same flaws as seen in the early Campus Plan Projects;
- [redacted] are improving in their performance and incorporating lessons learned into their methods for planning, estimating, scheduling and executing the work; and
- Whether the Projects & Modifications ("P&M") and the Darlington Refurbishment organization ("DR Team") are committed to transparent reporting of the Refurbishment Project's progress.

The following is our analysis of these questions. We have been advised by the senior management of the DR Team and P&M that they intend to take into account our findings regarding the issues that impacted the early Campus Plan Projects, and are currently working to implement all of the lessons learned from these projects. We have been involved in several discussions with the DR Team and P&M with respect to their on-going and planned management actions and we have begun to see evidence of these efforts taking effect. Additionally, many of the issues that we identified with respect to the performance of the Campus Plan were the direct result of the fact that the P&M organization had not adopted many of the procedures developed by the DR Team for the Refurbishment Project. The legacy issues that caused the schedule and cost variances for the two key projects—D2O Storage and AHS—will continue to be a challenge, and will need to be closely monitored.

1. Extent of Condition – Budget and Schedule for the Campus Plan Projects

a. Management of the Work

As we have previously stated, the DR Team is responsible for planning and executing the bulk of the Refurbishment Project work. The Projects and Modifications organization is responsible for completing the Campus Plan and other prerequisite projects. It is important to note that Refurbishment and P&M are set up differently from both an organizational and process standpoint. Thus the issues impacting the prerequisite projects have manifested themselves differently and the necessary responses may also need to be different.

Each organization also exhibits a different level of maturity from a project management standpoint. As noted in our 2Q 2014 Report, P&M was an existing maintenance organization that handled minor modification work within the OPG stations. P&M's yearly volume was historically less than $300M. P&M was chosen to manage the Campus Plan Projects because the DR Team was in its embryonic stage. P&M negotiated the ESMSA contracts as generic commercial documents that could be assembled as EPC agreements as needed. In retrospect, had the Campus Plan Projects been in the same general size and complexity as the plant modification work, this plan may have had a greater chance of

success. However, the first of the Campus Plan Projects was D2O Storage, which is as technically and logistically complex as virtually any work on the DR Project, and this project was unfortunately used as a pilot project.

The Refurbishment Project has, from the start, proceeded with its major EPC contracts using a more direct management approach which has been further strengthened by internalizing the early lessons from D2O Storage and AHS and by changes in the senior management team. Since the inception of our engagement in late February 2013, we have witnessed a number of changes by the DR Team that incorporated lessons learned, notably the changes to the method for scheduling the work via a fully integrated Level 3 schedule, increased focus on necessary scope through a robust process with multiple checks and vetting, and adhering to the gate process for budget approval with greater rigor.

Moreover, the EPC contracting method selected for Refurbishment's major scopes of work—the RFR/Containment Isolation, Turbine Generator and Steam Generator projects—has been managed differently and much more effectively than the pilot Campus Plan Projects. Because of their timing, the pre-requisite Campus Plan Projects provided the DR Team with an opportunity to test its new EPC model and draw experience for the much larger Refurbishment effort. Thus, the Campus Plan Projects were intended to be a source of lessons learned. The area in Refurbishment where the lessons learned from D2O Storage and AHS are most salient is the Balance of Plant work: here too, Refurbishment has made essential changes to the procurement method, scope identification and instituted greater collaboration at a much earlier stage than seen from the Campus Plan Projects.

b. Overall Cost Impact

A critical aspect of our 2Q 2014 Report's examination was to identify the extent to which the early problems with D2O Storage and AHS spread and otherwise impacted the Refurbishment Project. From a budget standpoint, while the DR Team is still examining the extent of the cost impacts from each of the Campus Plan Projects, it would appear that approximately 67% of the overall variance from the 4c Cost Estimate approved by the Board in 2013 resides with these two troubled projects. The following chart illustrates the current budget status for the Campus Plan Projects:

Bundle	Project	Release 4C estimate	Current Forecast*
F&IP (Campus Plan)***	D_2O Storage	$110M	$276M**
	OSB Refurbishment	$45M	$53M
	Auxiliary Heating Steam	$46M	$85M
	Water and Sewer	$46M	$58M
	DEC	$87M	$87M
	R&FR Annex	$32M	$41M
	RPO	$89M	$100M
	Electrical Power Distribution	$14M	$13M
	Other F&IP Projects	$83M	$111M
Subtotal		**$552M**	**$824M**

* Current forecast amounts provided by the DR Team.
** The D2O estimate is currently being challenged and confirmed. This is an interim estimate that may not be reflective of the final Estimate at Completion.
*** Does not include SIO Projects

It is important to note that we believe that the majority of the cost increases with D2O Storage and AHS are due to maturation of these projects' scope definition, scope management, unforeseen subsurface conditions or flawed estimates. In other words, the increased budgets are simply reflective of the true project costs had they been estimated properly at the outset. Moreover, we have no issues with the project delivery approach (multiple-prime EPC, target price). We have seen the multiple-prime EPC approach employed successfully on other projects, and it is appropriate for OPG to act as the construction manager and design authority for a refurbishment project on an operating plant. Additionally, target pricing in this context is appropriate—particularly prior to the completion of detailed engineering—a

contractor would add a large premium to accept pricing risk. Our criticism in the 2Q 2014 Report stems mainly from the fact that the project management strategy originally employed by the P&M organization did not match the chosen commercial strategy, as both the multiple-prime delivery method and target pricing requires that OPG be fully engaged as the contract manager of the Refurbishment Project. As a result, P&M did not have the tools to determine the "true" costs of the project from the outset and communicate those costs to the Board of Directors. In particular, the P&M organization made several mistakes with respect to determining the projects' budgets, including:

- "Negotiation" of bid prices which gave a false sense of security regarding the accuracy of the cost estimates—too much emphasis was given to pricing during the bid evaluation phase rather than understanding the scope, execution plan and qualifications of the contractors;
- Assuming, without the proper vetting and review, that estimates provided by the contractors had a certain level of accuracy even though no design was complete and scope was still in flux – this resulted in significantly lower contingency than should have been applied to these estimates; and
- P&M's and the contractors' failure to regularly update the Estimate at Completion (EAC) once changes were known resulted in the budget shock occurring all at once with the presentation of revised Business Case Summaries ("BCSs").

Based on these practices, the budgets initially approved by the Board for D2O Storage ($108M) and AHS ($45.7M) were not sufficient for the planned scope of work. Moreover, had P&M appropriately classified these two project's cost estimates at a Class 5 (-50% to +100%) maturity level, it is very likely that these projects could have entirely avoided an overrun. At a minimum, under the current Refurbishment Project leadership, these cost estimates would not have been presented to the BOD for full funding release until reaching an appropriate level of maturity.

P&M has recognized the problems which caused these budget overruns to occur and is actively working to negate any repeated issues in the estimating of the remaining work. The BCS for AHS that underlies the authorization for additional funds approved by the Board at the May 2014 meeting was developed by ES Fox using sound estimating processes and vetted by OPG in an appropriate manner. [redacted] estimating effort for [redacted] is ongoing and this estimate is more problematic for reasons discussed herein. [redacted] Thus, at this time, P&M is proceeding with appropriate caution in how this estimate is being characterized.

c. Schedule Impacts – D2O Storage and AHS

Due to the extended time used for detailed engineering, and poor planning and scheduling practices deployed by P&M [redacted], there is much less contingency and schedule float available to complete the Campus Plan. While the Campus Plan Projects were initially helped by the one year change in Refurbishment's breaker open date (from October 2015 to October 2016), this additional time was not utilized in an effective manner. However, after the change in P&M's leadership in January 2014, detailed schedules have become a top priority for the Campus Plan Projects. As a result, P&M has more confidence in their time projections and is now able to evaluate ways to improve the schedule for the D2O and AHS buildings.

- The AHS project is currently projecting about 3 months behind schedule which could miss its completion milestone prior to the Vacuum Building Outage ("VBO"). Since our 2Q 2014 Report, P&M has taken action to try to improve these completion dates through:
  - Prioritizing the resolution of any remaining design issues;
  - Working double shifts on critical path work;

- Simplifying the design of the pipe chase to the plant by substituting a very difficult to construct underground pipe chase with an above-ground pipe rack, which should positively impact both the project's schedule and budget; and
- The DR Team is monitoring the schedule progress of AHS and is readying mitigation plans in the event that the VBO milestone cannot be met, including utilizing the existing construction boilers and/or procuring temporary back-up steam capacity if needed.

- D2O Storage remains the more challenging project from a schedule standpoint. The combination of underground utilities and poor soil conditions, significant design changes, engineering delays and contractor performance has pushed D2O Storage to a projected completion of April 15, 2016. This date has no float and is based on a mere 5 ½ months to erect and install the building's key piping systems. The P&M team is currently engaged on a number of fronts in attempts to reduce the complexity of this design and thus ease construction:
  - Value engineering of the piping design including rationalizing the aspects of the design to reduce work and potential productivity difficulties;
  - Elimination of the box drain below the foundation, which should improve the foundation work schedule by 4 weeks;
  - Review and rationalization of the design of the pipe chase to the existing TRF building;
  - Elimination of office space requested by the TRF personnel;
  - Elimination of the emergency back-up diesel generator.

As with the budget, these scope reduction initiatives and the schedule impacts are under review and are being assessed with increasing urgency.

The other Campus Plan Projects are being added to the integrated master schedule at this time. Currently 12 of the 28 pre-requisite projects have been added to the master schedule. Moreover, the projects that have shown potential for schedule variance are being given priority and mitigation plans have been developed to minimize impact. As an example, the Containment Filter Venting System ("CFVS") was initially scheduled to complete prior to the VBO, though, due to design issues, this work was delayed. Based on the schedule and the project's priorities, the team decided that completing this work at a later time posed no risk; thus the cost to accelerate the work was avoided. Similarly, P&M is looking to increase its understanding of the cost and schedule drivers for each project and work within projects to strategically accelerate only where the benefits are tangible.

2. Leadership Changes

The issues with respect to the Campus Plan Projects led to the departure of the VP of P&M in July of 2013. P&M's new leadership has put into place several important initiatives, and is intent on correcting the remaining issues around management and staff, including streamlining internal processes to enhance project performance. In addition, there has been increased accountability and integration between P&M and the Refurbishment Project, with P&M reporting and updating its project schedules and other metrics within the Refurbishment Project's reporting. In addition there has been increased sharing of resources between P&M and the Refurbishment Project: (1) the Refurbishment Engineering team is much more active in attempting to resolve the issues that have impacted design completion within the Campus Plan Projects; (2) a schedule "hit team" has been deployed by Refurbishment to help standardize the schedules for the Campus Plan Projects; and (3) there has been increased integration between the P&M and Refurbishment BOP teams. These measures have increased the DR Team's understanding of the importance of the Campus Plan Projects to Refurbishment and their likelihood of success.

3. Implementation of the Lessons Learned and Corrective Actions

As stated above, in order to put our 2Q 2014 report into the appropriate context, it is important to understand that the DR Team and P&M are two separate organizations within OPG. The DR Team is focused on planning for the successful

execution of the refurbishment and life extension of the four Darlington units. They are a single program organization that have implemented a very methodical approach to determining the Refurbishment Project's scope and implemented project management procedures and controls that meet our expectations for what we would typically see in the industry. P&M is a projects organization set up to manage a large portfolio of capital projects for both Pickering and Darlington. As such, the needs of the P&M organization are different to Refurbishment and it does not utilize the same procedures and controls developed for the Refurbishment Project. The P&M processes are geared towards multiple (hundreds) of small projects authorized within the OPG AIS-C funding stream. Due to the fact that the Campus Plan Projects had to start significantly ahead of the Refurbishment Project, and the fact that the DR Team did not have its construction execution organization in place, the Campus Plan Projects were handed over to the P&M organization to manage. Therefore, many of the issues experienced by P&M were never a threat to the Refurbishment Project, as appropriate controls had been developed.

As an example, one of the causes of the increased project estimates for Campus Plan is the increase and changes to scope. In contrast, our prior reports have documented the fact that the DR Team has taken a balanced approach to the development of the Refurbishment Project scope. The initial scope identification effort incorporated scope beyond that of refurbishment and life extension, potentially increasing the budget and project complexity. However, to even this out, the DR Team has continuously monitored and repeatedly tested the included scope through scope reviews and de-scoping exercises, including a detailed and intensive effort led by the Blue Ribbon Panel in 2013. Additionally, the DR Team has monitored scope definition through the Gate Review process and Health of Scope metrics. B&McD/Modus believes the DR Team has struck an important balance between overly limiting scope (and risking scope growth during execution) and being overly-inclusive (and risking excessive project budgets).

The Refurbishment Program has benefitted from the early start of the Campus Plan Projects because it has allowed Refurbishment to evaluate its management processes and procedures and make adjustments as necessary. It is not uncommon for an organization to have to adjust its commercial strategies, project delivery methodology, contractor incentive/disincentive structure, or other negotiated contractual provisions during the course of a long and complicated project to ensure that commercial considerations continue to drive the appropriate contractor behavior. Good project management organizations make such adjustments based upon the information that is known to them. As a result, we would expect that the DR Team would incorporate the lessons learned from the Campus Plan experience—and there is evidence that they are doing so—even before the issuance of our 2Q 2014 Report.

Below is an update as to the most significant issues raised in our 2Q 2014 Report. We have recorded the responses from both the DR Team and P&M, as there will necessarily be differences between the required planned management actions. For Refurbishment, the main actions are to implement the lessons learned and ensure its model will not be subjected to the same issues as seen with the Campus Plan Projects. For P&M, it will be to recover the on-going projects and to mitigate future risks.

BMcD/Modus D2O Storage and AHS Findings	Refurbishment Approach	P&M Recovery
Scope for the projects was based on a performance specification; P&M relied on the contractors to develop and progress the design.	Scope for the EPC contracts is based on thorough Modification Design Packages (MDPs) developed by OPG Engineering and its OSS vendors; MDPs advance the design beyond the conceptual stage and provide the EPC contractor with a defined scope of work.	P&M has also adopted the MDP as the basis for scope definition for its remaining projects. OPG Engineering is fully engaged in developing, vetting and approving design work.
Contracts were bid between the two ESMSA vendors and low price was deemed the primary consideration for	Major EPC contracts were openly bid and qualifications, technical ability and performance record trumped price; after considering the subcompete used	Most of P&M's work was subjected to the sub-competitive bidding process; however, the packages each ESMSA vendor received after the

BMcD/Modus D2O Storage and AHS Findings	Refurbishment Approach	P&M Recovery
award.	by P&M for the Balance of Plant work, the DR Team changed its process to directly assign the work packages based on vendor qualifications.	initial pilot projects were more reflective of each contractor's capability.
P&M negotiated the cost reimbursable prices resulting in reduction of the base cost estimate prior to full scope definition.	Vendor pricing for the EPC contracts is being determined from a progression of cost estimates at prescribed points in project definition; final negotiation of target price contracts will only occur once the scope is known and estimates have matured.	P&M has abandoned previous practices and is now working collaboratively to develop reasonable cost estimates.
P&M misclassified the D2O Storage and AHS initial bids as "Class 2" and "Class 3" caliber estimates prior to the start of design work, which resulted in severe underestimation of project contingency.	Refurbishment built the classification of the estimates into the process for weighing the EPC contractors' progress; as an example, the RFR contractor has yearly (from 2011 to 2015) prescribed deliverables of Class 5/4/3/2 estimates that accompany different levels of the project's maturity. Moreover, contingency development is occurring under a defined interactive process in which OPG and the vendor must agree on risks, opportunities and monetization of those potential events.	P&M is following the Refurbishment gate process.
P&M's team was instructed to be "hands-off" and allow the contractors to develop their designs, and only after full development would P&M and the OPG stakeholders provide comments, changes and design input; this led to scope creep and an attenuated design process that has eliminated construction float.	Refurbishment has increased management focus and collaboration on engineering solutions, and is moving up critical constructability and design review cycles. As an example, the final price for RFR will be negotiated on the basis of final construction work packages and proving-out of the critical tool and construction operations in a full scale mock-up that simulates actual conditions.	P&M is instituting a collaborative approach to engineering reviews.
P&M presented the cost estimates it received as part of business case summaries for full project funding release at a very early phase of design definition.	Refurbishment is incrementally releasing funds through a gate process that measures progress on the basis of objective criteria and will seek full funding release only when the scope is fully defined, execution planning is completed and all risks are well-known.	P&M is adopting the Refurbishment gate process and will not submit projects for full release until a reliable estimate is prepared. P&M has chosen to hold off presentation of the revised D2O Storage BCS until it has confidence in the underlying estimate's accuracy.

BMcD/Modus D2O Storage and AHS Findings	Refurbishment Approach	P&M Recovery
As design and project definition progressed, the contractors and P&M failed to timely update the projects' cost estimates at completion (EAC), and only provided such updates when additional funds were necessary.	Refurbishment's gates and the yearly Business Plan cycles require the projects to update EAC on a timely basis. In recognition of the issues with D2O Storage and AHS, Refurbishment is imposing additional controls to require constant evaluation of each projects' maturity.	P&M has abandoned this practice and its team has been instructed to update EAC when new information is available.
Scope creep into these projects caused the design to become more complicated and difficult to build.	Refurbishment has instituted an Options Review Board chaired by the SVP that evaluates whether the maturing design meets the Project's needs.	P&M is currently engaging in value engineering reviews of the major projects to determine whether scope reductions are possible.
P&M gave the contractors complete latitude to develop their Project schedules and did not adequately vet these schedules' quality.	After initially considering a siloed Project schedule, Refurbishment is adopting a much more rigorous method of vetting and integrating the projects' schedules into a single, detailed Level 3 schedule that, once fully developed, will represent all of the work in the Execution Phase; Refurbishment is enforcing quality standards from each of the vendors.	P&M is instilling rigor into the schedule process and requiring the vendors to develop Level 3 schedules that depict their plans for the work. These schedules are being integrated with the Refurbishment schedules and must meet the same quality standards.
As an artifact of the poor practices that established and updated project budgets, P&M's reporting was inaccurate and not fully updated to reflect project status.	Refurbishment is establishing processes for data fidelity in its reports and continues to improve the quality of the reporting.	P&M is revamping its entire suite of metrics to align with the requirements of Refurbishment.
P&M managed the work in "silos" and didn't regularly engage the contractors in meaningful dialogue intended to remove barriers and fix problems.	Refurbishment is establishing multiple forums for interaction with the contractors. Each major contract has a Steering Committee made up of project executives that meets monthly, and the major EPC contracts engage in CEO-level meetings each business quarter.	P&M has instituted Steering Committee meetings as well as a monthly ESMSA Summit in which OPG and the two contractors can air any issues in an open manner.

The P&M and Refurbishment organizations have taken action to acknowledge the Campus Plan Projects' issues and incorporate lessons learned into their planning activities. However, implementation of these lessons learned and the related actions will take an on-going concerted effort that will not happen overnight. In fact, as P&M is working through all of the Campus Plan Projects to develop and vet proper estimates and schedules, additional issues may be uncovered. This will also require a high level of monitoring to ensure that the recovery efforts are successful.

Exhibit 1

3Q 2013 Initial Project Assessment Report

Supplemental Report to
Nuclear Oversight Committee

2nd Quarter 2014

Darlington Nuclear Refurbishment Project

Initial Project Assessment

Darlington Nuclear Refurbishment Project

Burns & McDonnell
Modus Strategic Solutions

August 13, 2013

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I. Executive Summary

On February 25, 2013 Burns & McDonnell Canada Ltd. and Modus Strategic Solutions Canada Company ("BMcD/Modus") were retained by Ontario Power Generation ("OPG") to provide External Oversight of the Darlington Nuclear Generating Station's Refurbishment Project ("Project" or "DR Project"). As part of our services, BMcD/Modus provides the following Project Assessment of the DR Project in which we examine the DR Project's current status; evaluate the methodology the DR Project team ("DR Team") is employing for planning and executing the work; review and assess the DR Project's risks and challenges; and, provide certain recommendations where applicable for the DR Team and OPG's management to consider.

The DR Project is a complex undertaking for any utility. Fortunately, OPG is positioned to be the beneficiary of lessons learned from a number of critical past projects, most notably the Pickering A Unit 4/1 Return to Service ("PARTS"), as well as the prior CANDU life extension refurbishments that have been executed at Bruce Power, Point Lepreau and Wolsong. In fact, Wolsong provides the reference plant that is being utilized by the SNC-Lavalin Nuclear, Inc./AECON Construction Group, Inc. Joint Venture ("SNC/Aecon") for purposes of formulating its estimate for the retube and feeder replacement ("RFR") work. For these reasons, BMcD/Modus has focused significant attention in this Independent Project Assessment ("Project Assessment") on the DR Team's incorporation of appropriate lessons learned and operational experience ("OPEX") into the DR Project's plan. In any event, the DR Project has many "first of a kind" aspects which must be taken into account in the planning and execution phases.

Based on our observations to date, BMcD/Modus believes the DR Project is appropriately advanced at this time to support its major goal of producing a Release Quality Estimate ("RQE") for final Board of Directors and Shareholder approval by October 15, 2015. However, the DR Team needs to effectively and efficiently manage a number of significant risks in order to achieve the necessary level of definition and project maturity required for the RQE.

The following is a brief summary of our observations regarding the DR Project's current and most significant challenges and risks.

- **Project Management Roles, Responsibilities and Readiness:** Thus far in the DR Project's development, the team has been working on developing the component projects (RFR, Turbine Generator, Balance of Plant and the like) as separate, individual projects. This approach is appropriate during the planning phase in order to ready each Project Bundle for execution. However, the challenge for the DR Team will be to shift from the "silo" mentality to operating as an integrated Project. Moreover, the choice of using a significantly different project delivery method (multiple Engineer, Procure and Construct ("EPC") contractors) than OPG has utilized on past capital projects means the DR Team has to define the processes, level of staffing and qualifications necessary for effectively managing the work.

  The DR Team may experience some challenges in integrating and operating as a single, integrated, oversight management team. In our experience, the DR Team's current growing pains are commonly experienced by owners who engage in large EPC contracts for the first time. OPG's oversight of the Detailed Engineering and Planning & Assessing phases pose perhaps the most significant near-term risks, as these functions have typically been performed in-house by OPG on past projects. Moreover, OPG's most vital role during the Execution Phase will be to manage and coordinate the work of the multiple EPC contractors, a condition that typically provides a ready

source of change orders, delays and commercial disputes on projects of this type. Now that the scoping work is nearly complete, the challenge for the DR Team will be to migrate toward integration of the work into one unified Program—and such integration should occur as soon as possible.

The DR Team also needs to ensure that it has individuals with the expertise to manage the Execution Phase. Thus the DR Team should be looking to add those individuals who will be responsible for the construction of the DR Project sooner rather than later and integrate them into the Project planning process. It is important that the DR Team require the EPC Contractors do this as well.

- **Scope Definition and Budget/Schedule Status:** On March 5, 2010, Management identified the following DR Project's goals to the Board: (1) replacement of life-limiting components (such as pressure tubes) to allow OPG to operate the units for an additional 30 years, and; (2) replacement of components most effectively done in an extended outage.[1] Management assured the OPG Board of Directors Nuclear Oversight Committee ("NOC") that the DR Project had processes in place to control scope growth via the Project's Scope Review Board, which will "ensure that appropriate reviews (technical and financial) are being performed to ensure that scope is appropriate and minimized to the extent feasible to avoid increasing the complexity of the project and impacting the project's critical path."[2]

  The DR Project's scope was derived from a deliberate process that included review of over 1400 separate Darlington Scope Requests ("DSRs") that were generated primarily by the Station and Project Engineering. These DSRs were reviewed and vetted, and ultimately were presented to the Project's Scope Review Board for disposition. The Project Team was mindful of OPEX from PARTS and intentionally took an expansive view of project scope, with the later intention of reducing that scope through a series of critical challenges, all of which were anticipated by the DR Project's processes.

  In 2009, the DR Project's point estimate was [redacted] with a publically-announced range of $6B to $10B.[3] The DR Project's most current budget assessment, the 2013 Business Plan (as of 3rd Quarter 2012), identified a projected Project cost of [redacted], reflecting growth of [redacted], or [redacted].[4] Direct work scope considerations within the Project's bundles accounted for [redacted] of this growth although the largest overall cost growth contributor is OPG's indirect management costs, which increased by [redacted], or [redacted] over the 2009 budget. A driver for the increase in overhead cost was a decision by OPG to have the DR Project carry the costs for the Operations & Maintenance workers associated with the units being refurbished for the duration of the DR Project. In addition, there has been some ongoing internal debate regarding the scope of the DR Project in light of the Station's high standing with WANO, which may has driven some of the desire to increase scope.

  Coinciding with the start of BMcD/Modus's engagement and changes in the DR Project's executive leadership, the DR Team recognized that the velocity of the scope additions and other management costs had the potential to adversely impact the DR Team's ability to execute the Project within the

[1] Update on Darlington Refurbishment Project (March 5, 2010) at p. 1 ("Background").
[2] Update on Darlington Refurbishment Project (May 18, 2010) at p. 2.
[3] DGNS Refurbishment Estimate Analysis (April 25, 2013) at p. 3.
[4] *Id.*

anticipated schedule and budget estimates. Key members of the DR Team were assigned to revisit the DR Project's approved scope with the intent of optimizing the Project's size. These reviews are ongoing at this time with decisions by the Scope Review Board and executive management pending. This "scrubbing" of the scope is timely, appropriate and necessary, and should result in greater confidence in the execution schedule and overall project costs. However, the DR Team must also take appropriate care to ensure that items not included in the Project's scope but are nevertheless needed (in some manner) for the DNGS stations' future operation and performance are captured in future O&M and Capital planning and are not dropped. Moreover, the DR Team must take a critical look at the Project's indirect costs in order to ensure that the associated management team has the proper skill-sets and is right-sized for its role on the Project.

The DR Team is also preparing different planning scenarios intended to achieve greater schedule certainty with less overall risk. The DR Team has adopted new planning assumptions for the 2014 Business Plan budget forecast that model elimination of the scheduled overlap of the execution phase of each unit, and in particular, isolating the performance of Unit 2. Given the past history of CANDU mid-life refurbishments, this appears to be a reasonable strategic decision.

- **Engineering Status:** Engineering for the RFR and Turbine Generator Projects are under EPC contracts that are each advancing with the contractors performing the detailed design work. The remainder of the engineering effort is currently focused on developing the requirements needed for procuring the rest of the DR Project's scope, and in particular, the Balance of Plant ("BOP"). In order for the RQE to be reliable, detailed engineering must be sufficiently progressed by the 2nd Quarter of 2015 for the DR Team to develop Class 2 cost estimates (cost estimates that are deemed to meet the criterion of the Association for the Advancement of Cost Engineering ("AACE") cost estimating standards).[5] Per the AACE standards[6], to achieve a high quality Class 2 Estimate, detailed engineering needs to be between 30% and 75% complete overall in order to realistically determine contingency. The DR Team is mindful of the need to complete sufficient detailed engineering and Planning & Assessing prior to RQE. This goal will require significant work and some changes to procurement method, as discussed below.

  The DR Project is currently developing engineering packages known as Modification Design Packages ("MDPs") for work not yet contracted (mostly for BOP work) that are precursors to detailed design. OPG has contracted with two external Owner Support Services ("OSS") vendors, AMEC and WorleyParsons, to augment its staff and develop the MDPs. OPG's engineering team has recognized the potential schedule problems and is attempting to expedite and optimize the efficiency of the MDP preparations as well as start the EPC contractors on detailed design packages. Additional modifications to the procurement process, such as earlier releases of smaller scoping packages, will be required to optimize the schedule and accelerate the beginning of detailed engineering.

  As a part of its initial assessment of the DR Project's engineering capabilities, BMcD/Modus has also reviewed: the structure and depth of the OPG engineering organization; processes and procedures;

[5] AACE Class estimates, Class 5 through Class 2, are referred to herein as the "Class X Estimate".
[6] AACE International Recommended Practice No. 17R-97, Cost Estimate Classification System (November 29, 2011) at p. 2; AACE International Recommended Practice No. 18R-97 Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries (November 29, 2011) at p.2.

metrics for tracking work; and proposed methods for managing the OSS vendors. We have provided some comments and observations directly to the DR Engineering Team regarding optimizing the work flows and the development of Project metrics, and we have witnessed some improvements since the start of our engagement. There has been proper management focus on the issues that are unique to engineering. We will continue to monitor this critical work from a program management perspective as the engineering functions migrate from supporting procurement to project execution.

- **Project Controls:** The primary and associated subset of controls that the DR Team is establishing for tracking the planning and execution of the work are each in various stages of development. The following is a brief summary of the primary performance measurement tools the DR Team is currently developing:
    - Budget Development: The DR Team has a reasonably detailed game plan developed for achieving RQE and is generally following that plan. The current operative budget (2013 Business Plan) was developed on the basis of embryonic project definition and the range of uncertainty associated with that estimate was at no better than Class 5 level. The DR Team is currently in the process of developing its 2014 Business Plan, which is due to be released in the 4th Quarter 2013. There are a number of moving parts that could influence cost and schedule development over the next several months, including final determination of scope, optimization of the contracting strategy, the potential "unlapping" of Unit 2, staffing needs, and the like. The Project Controls Team is attempting to increase the level of rigor in the 2014 Business Plan development and this is a work in progress. We would expect the team to significantly ramp-up the level and quality of effort in conjunction with next year's 2015 Business Plan, as more knowledge about the Project develops. Ramping up the effort will provide higher confidence in the Project prior to RQE.
    - Project Schedule Development and Methodology: The OPG Project Controls team has developed a "Coordination & Control Schedule" ("C&C Schedule") that tracks the schedule activities at a milestone-based level. Although this tool should be sufficient for the Definition Phase, it is our understanding that the current process indicates that the C&C Schedule will be used through the completion of the Project. We believe that the C&C Schedule may prove to be too cumbersome once the Project moves to the Execution Phase. It is our opinion that the DR Project will ultimately be best served by a single, integrated Level 3 schedule that includes all activities for daily, weekly and monthly project management.
    - Cost and Earned Value Tracking: The DR Project is establishing new systems for tracking and projecting costs as well as tracking earned value (Proliance). The Project Controls Team planned to have these systems in place by spring of 2013 but implementation has proven more difficult than initially planned. In our experience, implementing such systems is frequently problematic, and OPG is doing so at a time when the DR Project is rapidly maturing. Until Proliance is functioning, the DR Team will continue to utilize manually-based controls for tracking costs. BMcD/Modus will continue to monitor the development of these systems and provide input and observations in regard to selected and reasonable "dipstick" checks concerning data fidelity and the like.

- Risk Management: The DR Team is in the process of improving its risk management program. The existing program with some contemplated modifications is generally consistent with what we have seen in the industry at-large. The Project's risk database has been populated by the individual Project and Functional groups and the DR Team has established certain forums (i.e. the Risk Oversight Committee) for evaluating related inputs. However, while the work to date represents a good start, there is significant development work remaining for the DR Team so as to be in a position to ultimately and reasonably address risk and risk mitigation:
  - Risk identification and associated scoring needs to be consistent on how individual risks are identified, evaluated, mitigated and monetized;
  - Per OPG internal procedures,[7] project contingency is to be based in large part on the project risk register. Therefore, it is critical that the risk team properly manage the risk register so as to ensure contingency is properly quantified;
  - The risk database is currently populated with large numbers of items that within the industry at large would ordinarily be viewed as management concerns as opposed to innate risks associated with the work;
  - The RADAR system that the DR Team uses to collect risks is cumbersome and does not interface with other databases—efforts to streamline the above have been very slow;
  - There needs to be some focus on the identification of potential "opportunities" that can be managed within the Risk Program.
  - Management should review its staffing and leadership of the Risk team to ensure that an effective, world class, sufficiently staffed and properly experienced team is in place.
- Electronic Data Management System ("EDMS"): Similar to Proliance, development of the EDMS is lagging behind the DR Team's intended implementation schedule. This, too, is not unexpected, but nevertheless must be cured as soon as possible. The EDMS is supposed to be available in the 3rd Quarter 2013. This system is a critical tool for managing the work of the contractors on-site and dealing with the considerable volume of information that is typically generated by a project of this magnitude.

Going-forward, BMcD/Modus recommends OPG consider re-unifying the Project Controls team under one umbrella. In order to maintain the necessary independence, Project Controls personnel should have a direct and singular reporting line to a central Director, and that individual should report directly to the SVP of Darlington Refurbishment.

- **Commercial Development**: OPG has entered into an EPC contract for the Definition Phase of the RFR Project (this includes Project Planning, construction of the Mock-Up facility, and engineering of the Tooling), Engineering and Supply of the Turbine Generator equipment, and intends to enter into several more EPC contracts for much of the remaining work. OPG's intended methodology for contracting the work is one that shifts certain performance risks to multiple EPC vendors for

[7] Nuclear Refurbishment Contingency Development and Management, N-MAN-00120-10001-RISK-05-R000 (July 19, 2012) at p. 4.

individual scopes of work that nonetheless leaves OPG as the overall manager and coordinator of these multiple EPCs. There are no contractual terms that serve to relieve all of the owner's risk, and no contractual penalties intent on causing contractors pain for a failed project that can ever fully compensate an owner for the consequences of such failure. As a result, the DR Team needs to embrace the proactive management of the contractors, which requires the team to effectively and transparently engage the contractors and hold them accountable for their performance, and to manage the interfaces between the various contractors so as to minimize potential disruption, all on an active nuclear site. While OPG has in place a good oversight plan, the key will be the actual execution. As a result, this item bears continuing and close monitoring.

- **Retube and Reactor Feeder Replacement**: The DR Team has devoted significant focus and financial investment in the RFR work, which comprises the DR Project's single-most important evolution and its most significant risk. The commercial agreement with SNC/Aecon establishes a methodology for developing a high-confidence performance schedule and cost estimate for the RFR work's performance that anticipates the submission and acceptance of four iterations of the Project's cost estimate, each with an increasing level of detail and certainty. The first two (Class 4 and 5 estimates) iterations focused on developing a Basis of Estimate that considers OPEX from prior refurbishment projects, and establishes Wolsong as its reference plant in regard to establishing work durations and sequencing. The remaining cost estimate iterations (Class 3 and 2 Estimates) will focus on SNC/Aecon's estimate specifically for Darlington. The Class 3 Estimate is intended to reflect SNC/Aecon's detailed work packages for the DR Project and the Class 2 Estimate will represent the final target price agreement with all risk/reward contingency identified.

  However, progress to date in adequately preparing and vetting the RFR estimates has been mixed.

  - SNC/Aecon's Class 5 Estimate approval was [redacted] The team worked to recover the time lost by advancing the successor Class 4 Estimate, which OPG approved 1 month early on March 21, 2013. From our review of SNC/Aecon's Class 4 Estimate, it appears that the team has optimized the estimate of an as-built reference plant. However, the current estimate does [redacted] related to the quality of costs carried in the Class 4 Estimate as compared to that in the Class 5 Estimate upon which it was based.
  - Moreover, the current RFR Class 4 Estimate is not commensurate with AACE's Standards of Practice. In some ways, the RFR Class 4 Estimate exceeds what is normally considered at Class 4 although the RFR Class 4 does not account for the DR Project's engineering definition or contingency. Per its contract with OPG, SNC/Aecon is not required to monetize risk until it prepares and submits the Class 2 cost iteration in May 2015. As a result, until RQE is derived, the overall DR Project cost estimate's largest component is progressing on a separate definition path which is not best practice in nature.

  Significant work remains for SNC/Aecon to complete its work plan and associated cost estimate so as to meet the DR Project's standards. Additionally, there is very little room for lost time in the development of the Class 3 Estimate. The DR Team is advised to consider revisiting the method of identifying and monetizing RFR's risks as the overall cost estimate progresses so as to increase confidence in SNC/Aecon's cost estimate and reduce the potential for last-minute surprises emanating from the contractor.

- **Balance of Plant:** The work that comprises the DR Project's BOP scope is varied and split roughly in half between NSSS and conventional plant work. As of the 2013 Business Plan, this scope consists of ~200 DSRs that have been estimated to cost approximately [redacted]. These include Core Scope, Non-Core Scope and all contingent items. By its nature, BOP work carries significant risk because it includes work on multiple systems in myriad locations and requires a wide range of craft workers. BOP work coordination is frequently a significant management challenge on a refurbishment project such as this one.

  From the outset of our engagement, we have been concerned that the DR Team's intended plan for procuring the BOP was time-challenged, had too many different and unnecessary steps, and could ultimately over-complicate the DR Project if the scope and scale were not right-sized. As noted, Engineering, with the help of seconded staff from the OSS vendors, is developing MDRs for procurement of the BOP work. The DR Team's original plan was to package-up the MDRs into two large bundles (NSSS and Conventional) and put those out for bid between the two Extended Services Master Services Agreement ("ESMSA") vendors, ES Fox and Black & McDonald. Because of the pace of the MDR preparation, these bundles would not be aggregated for this bidding process until well into 2014. As a result, the vendors could not start detailed design and preparation of construction work packages to complete this work in time for OPG to develop a mature, detailed Class 2 Estimate relating to BOP cost in time for derivation of the RQE. The consequence of this would be that the RQE would either be late, or would be of a lower-quality than promised, with the cost estimates, schedules and execution plans for the work having less certainty. This in turn would, obviously, require greater contingency and present significant risk to the actual execution of the work.

  The DR Team's leadership is currently examining an alternate method for procuring the BOP work. Since the ESMSA vendors' contracts have already been procured under a competitive process and each is qualified for the work, competitively bidding this work would likely not yield a significant price difference and would, in our view, cost the Project 6-12 months of valuable schedule time. The DR Team is investigating methods to flow work the to the ESMSA contractors in smaller packages, in order to eliminate the time originally planned for bundling these packages together and for procurement, bid evaluation, selection and contract negotiation. This would allow the ESMSA vendors to get started now on detailed design instead of waiting until 2014. The DR Team is also looking at practical ways to integrate the ESMSA's design partners in the process as early as possible in order to begin detailed design. Our experience shows that this is the most prudent approach to the BOP work on a project of this type.

  Finally, the team is evaluating the current BOP scope review to ensure that what is included in the DR Project meets the intent of the DR Team's commitments, and will be eliminating certain work that does not have to be performed in the DR Project. Each of these measures will help get BOP on track, and all of the above will be needed so as to keep the BOP detailed design off the critical path and improve the chance that the team will have a solid plan and estimate for BOP work in time for adoption of the RQE. In our experience, the method of releasing smaller bundles of BOP work as they become ready is the most prudent and effective means of reducing the risks inherent with BOP work, and in this case, because the ESMSA agreements are in place, would likely be the lowest cost option due to the schedule savings and risk avoidance.

- **OPG Critical Path Activities:** OPG is responsible for planning, directing and executing the work leading up to and after the completion of the RFR work. During the Vault Preparation period (from breaker open to the start of SNC/Aecon's work), OPG is responsible for defuelling and draining all of the systems, and OPG regains the lead in critical path activities in the start-up and commissioning phases. In all, the DR Team estimates that OPG will control the critical path 25% of the time (243 of 968 total days) of the breaker-to-breaker unit duration[8]. Many of the work items in OPG's scope have been performed before; however, some of the work, like defuelling, have never been performed at DNGS or by OPG and will be on the critical path. In addition, DNGS has unique challenges due to the fact the fueling machines that are needed to support the DR Project are also needed to maintain operations of the operating units. The DR Team is very aware of these risks and has made adjustments to the plan, most notably with refurbishment of the fueling machines prior to the opening of the Unit 2 breaker. The team is planning to continue to refine its schedule and sequence of events.

II. Work Plan And Methodology

In accordance with Schedule 1.1(x) - Scope of Services to the Agreement between Ontario Power Generation ("OPG") and BMcD/Modus for Independent External Oversight Services for the DR Project dated February 25, 2013 (the "Agreement"), BMcD/Modus has developed a recommended Work Plan for the term of its two-year engagement. This plan was presented to the Nuclear Oversight Committee on May 14, 2013. At that time, BMcD/Modus was given authority to proceed with the development of an Initial Project Assessment of the DR Project. BMcD/Modus's Project Assessment is intended to address significant aspects of the DR Project planning and set-up and provide a status baseline as of the time of the report that BMcD/Modus will use to measure the DR Team's progress in future reports. This report will provide the results of our Project Assessment.

In order to develop our Project Assessment, BMcD/Modus has reviewed key project documents, interviewed OPG's key personnel and attended regular and special meetings, including the following:

- **Project Planning**: BMcD/Modus has embedded within the DR Team and has:
  - Attended both regular and special meetings with the DR Team to determine status of project's planning, development and integration of processes and tools, schedule development, contracting strategy and assess prominent risks specific to each project;
  - Reviewed key planning materials and summaries.
- **Processes and Procedures:** We have reviewed the Project Execution Plan and associated Project Management Processes and Procedures regarding their application to the DR Project and how they would be viewed in light of industry best practices.
- **Engineering: BMcD/Modus attended and initiated meetings with the Engineering team to determine their approach, status, standards and plan for completing both short term (procurement focused activities) and long term (support of the Execution Phase). In addition, BMcD/Modus:**
  - Assessed the DR Team's methods for tracking and documenting the status of critical design evolutions to ensure that selected metrics are providing an accurate gauge of engineering progress;

[8] DNGS RFR – Execution Phase Estimate Progression (June 21, 2013).

- Reviewed metrics for tracking engineering deliverables;
- Reviewed management of external OSS vendors;
- Provided suggestions, as necessary, to streamline the management of engineering, planning, assessing and procurement;
- Evaluated whether the DR Team has actually incorporated lessons learned and OPEX into its project scope, and suggest other lessons learned from our team's experience that may be applicable;
- Sampled general quality of engineering deliverables submitted by EPC Contractors and reviewed OPG's review and approval process;
- Reviewed the plan to complete detailed engineering supportive of the adoption date of the RQE, which is essential to reducing the potential vulnerability to changes in price and schedule during the Execution Phase.

- **Determined Status/Progress of Scoping Activities:** BMcD/Modus has reviewed the DR Team's process for tracking and maturing scope, including:
  - Reviewing the DR Team's activities and results of scope definition and reviews, including observing and vetting of Gate Review processes.
  - Sampling of work product to determine methodology for scope rationalization;
  - Review of key documents in support of project scope definition, including commitments to BOD and variance reporting.

- **<u>Reviewed and Assessed OPG's Cost Control Systems and the Program Budget</u>:**
  - Project Estimating
    - Reviewed and assessed the Gate Processes and related estimating of work orders;
    - Reviewed project estimating approach and sampled estimating work product from a form, format and process perspective;
    - Reviewed RFR vendor estimates for work for compliance to OPG's standards and best industry practices.
  - Reviewed and assessed the contracts, systems, processes and procedures the DR Team has in place for commercial conduct, including:
    - Change Management;
    - Notice and Notification of Changes in Scope;
    - Contract Change Orders;
    - Contract Payments.
  - Program Budget:
    - Reviewed the DR Team's processes and methodology for phased development of cost estimates and project schedule leading to the RQE.
    - Evaluated the DR Team's approach to preparing and maintaining the Baseline Schedule and Project Budget, and identified any approaches that might depart from industry-best practice and offer suggestions, as appropriate, regarding the tools and techniques that might be available to improve the overall process.
    - Reviewed and assessed the DR Team's current methodology for determining contingency for the Project.
    - Performed detailed review and vetting of aspects of the DR Project's 2013 Business Plan budget, including a "deep dive" into the details of the RFR Project's estimate.

- Assessed development of project earned value system (Proliance)

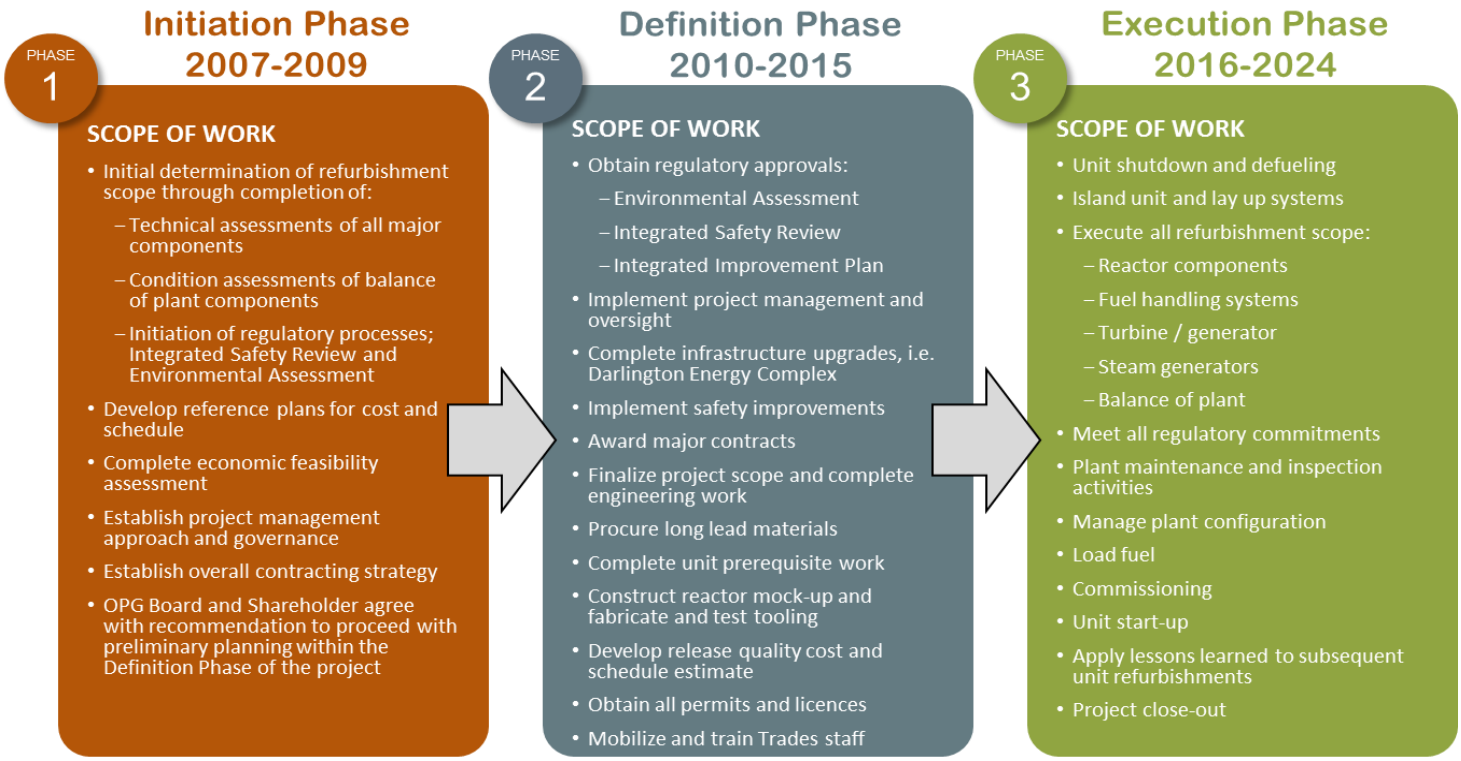
- **Schedule Assessment:** BMcD/Modus reviewed the DR Team's utilization of scheduling techniques and "rules" in order to evaluate whether there is:
  - Clarity of critical path(s) and sub-critical path(s) for monitoring performance;
  - Proper alignment within the cost system and documented support of the Project estimate;
  - Adherence to proper scheduling practices for integration of P6 enterprise schedule as well as contractors' submission of baseline and updates to the Project Schedule;
  - Proper schedule integration among all projects and subprojects.
  - Review of current status of the DR Team's C&C Schedule.
- **Organization**: BMcD/Modus has identified the risk associated with the role OPG is playing on the DR Project.
  - Reviewed and assessed OPG's ability to provide the appropriate level of project oversight to the Project's EPC contractors without directing the contractors' means, methods and procedures;
  - Reviewed the current and planned staffing levels and generally assessed the team's capabilities;
  - Assessed OPG's ongoing challenges in adapting to a construction project environment and utilizing an integrated P6 schedule instead of using Passport for work management.
- **Contracting Strategy and Contract Terms**:
  - Reviewed Commercial Strategy to determine whether OPG is proceeding on a reasonable path based upon industry experience and practice.
  - Reviewed the RFP process and recommend ways in which the RFP development process can be streamlined, particularly with the BOP Scope.
  - Reviewed Contracts as they are negotiated to determine if OPG has adequately assessed contracting risks.
  - Observed Gate process to identify how commercial risks are being presented and understanding process for allocation of budget/contingency.
- **OPEX and Risk Management:**
  - Assessed the DR Team's processes for establishing and updating the risk management system and reporting emanating from that system:
  - Risk scoring and identification;
  - Risk mitigation and avoidance strategies;
  - Related strategies for same;
  - Contingency development and,
  - Training of DR Team on use of Risk Management tools.
  - OPEX:
    - Reviewed timing and method of OPEX incorporation;
    - Determined whether OPEX is being reasonably incorporated during the planning stage of contractor work by OPG and contractors prior to RQE;
    - Inspected SNC/Aecon Plan on implementation OPEX.

Attachment "A" is listing of the documents BMcD/Modus reviewed in preparation of this Project Assessment.

III. Project Overview

A. Project History

The Darlington Nuclear units are currently predicted to reach their nominal end of service lives in 2019 to 2020. However, various factors from Darlington operations could result in the units reaching the end of life earlier or later than the present predictions indicate. In June 2006, the Ontario Government directed OPG to begin feasibility studies regarding the refurbishment of the Darlington Nuclear plants in order to extend their service lives. In late 2007, OPG commenced "Phase I" of the DR Project called the "Initiation Phase" in order to determine the preliminary scope of work for the Darlington Refurbishment project and to perform an economic feasibility assessment. Phase I was completed in 2009. OPG is currently in "Phase 2", or the "Definition Phase", which will continue until "Phase 3" called the "Execution Phase" begins in 2016. The three phases are detailed as follows:



Source: DR Project Team

OPG has chosen to manage the Darlington Refurbishment as a "Program". According to Project Management Institute ("PMI"), "A Program is a group of related projects managed in a coordinated manner to obtain benefits and control NOT available from managing them individually."[9] OPG's stated overall commercial strategy for the Program is premised on OPG acting as the General Contractor and Program Manager for the full Program. Within the Program, there are seven discrete Projects, each with its own project management team (including functions that are matrixed, such as engineers, commercial managers and project controls leads). The seven Projects (also known as "Project Bundles") encompass the following scopes of work:

- Retube and Feeder Replacement

[9] The Standard for Program Management, 2nd Ed.

- Islanding
- Fuel Handling/Defuelling
- Turbine Generator Maintenance and Controls Upgrade
- Boiler and Auxiliary Systems (Steam Generator Lancing)
- Shutdown, Layup and Services
- Balance of Plant

As of the date of this Project Assessment, the DR Team's major activities revolve around: (1) overseeing SNC/Aecon's development of the RFR Mock-up, detailed engineering and the Execution Phase plan and RQE project estimate; (2) completing procurement of the remaining scopes of work, including the BOP and Fuel Handling, which constitute a significant portion of the work; (3) identifying, and in some cases paring down, the scope of the work that will be performed within the DR Project; (4) preparing for the outages that will proceed the start of Unit 2's refurbishment; (5) developing the Project's schedule and budget for the RQE deadline. In this Project Assessment, BMcD/Modus has focused on these and other areas of risk.

B. Project Management Development

OPG's ability to successfully plan and execute the DR Project will be due in large part on the DR Team. Therefore, our Project Assessment must necessarily include some preliminary observations regarding the DR Team. As of the date of this Project Assessment, the DR Team has 233 individuals in the following areas[10]:

OPG Staff	Headcount
SVP – NR	2
Engineering	107
Planning & Controls	42
Management Systems Oversight	7
Execution and Construction Planning	41
Operations & Maintenance	34

In addition, there is ongoing involvement and assistance provided from the Projects & Modifications and Station organizations as well as staff from other business units (OBUs) that are matrixed into the DR Project. The DR Team has been established with the responsibility of assessing, making recommendations to OPG's Senior Management with respect to the feasibility of refurbishing the Darlington units, developing the scope, schedule and estimate for the Refurbishment Program, and providing overall program oversight on the execution of all activities associated with refurbishment, including:

- Assessing the technical feasibility of refurbishing Darlington and operating it for an additional 30 years of post-refurbishment operations;
- Making recommendations as to the lead time required to be prepared to refurbish each unit,
- Defining the refurbishment scope;

[10] Program Status Report for Period Ending June 2013 at p. 16.

- Executing project planning including the development of contract management strategies, cost estimates, schedules, a full risk assessment, and a release quality estimate for the Project;
- Managing the refurbishment pre-outage planning and preparation activities;
- Provision of overall program oversight on all execution and commissioning activities; and
- Performing Project Closeout.[11]

The DR Team's focus to date has been on the planning of the DR Project. We recommend the DR Team accelerate its plans to staff its construction and execution organization and integrate those individuals into the DR Team. At this point in the Project's maturity (and in particular the RFR project), constructability reviews will be essential for further development of the Project's Schedule, comprehensive work packages and detailed engineering. Additionally, it is likely that changes will emerge based on the constructability reviews, and the longer the DR Team has to adjust, the better. Getting the right personnel involved with reviewing and developing plans and processes up-front can prevent most (but certainly not all) of the late, high impact issues. OPG needs to insist that the EPC contractors build their Execution Phase organization as well.

1. OPG's Oversight Role

OPG's current contracting strategy, which will be discussed in more detail below, is dependent on the use of several Engineer, Procure and Construct, or "EPC", contractors. OPG will take on the role of General Contractor and Program Manager, with the responsibility of contractor oversight and coordination. This is a risk laden role. This contracting strategy represents a considerable change in approach from OPG's prior Large Capital Projects. The following matrix identifies how this approach differs from OPG's approach to PARTS Unit 1:

Project Component	Responsible Party	
	PARTS Unit 1	DR Project
Scope Definition	OPG	OPG with assistance from external vendors
Procurement Engineering	OPG	OPG managing outside vendors
Detailed Engineering	OPG	EPC Contractors
Planning & Assessing	OPG	EPC Contractors
Construction	Contractors managed by OPG Construction Management	EPC Contractors with OPG as the Construction/Program Manager
Start-up and Commissioning	OPG	OPG

While the use of the EPC model for large capital projects is common in the industry at-large, it is more prevalent for owners to use a single contractor to perform all of the work. Here, OPG will have several EPC contractors performing discrete scopes of work that will require management and coordination by the DR Team. Furthermore, in our experience, the EPC model can have significant challenges for any organization. Our team has observed some of the typical growing pains on the DR Project that come with such a transition. It will require time for the DR Team to adapt to its roles and responsibilities under this new governance.

There is a "sweet spot" that all owners must find when engaged in EPC contracting for large capital expansion or refurbishing projects. Owners frequently assume that EPC contracts by their nature distribute all of the risk

[11] *See* Darlington Refurbishment Project Charter, D-PCH-09701-10000 R001 (June 15, 2009) at p.1.

to the contractors and therefore the owner proceeds to only passively engaged in the work. At the other extreme, there are owners who micromanage the work to the point that their invasiveness is tantamount to dictating means and methods to the contractors which usually ends in nothing short of disaster. Both of the above management styles have significant cost and schedule risks for owners, and generally lead to disappointing outcomes – finding the right balance is crucial. Additionally, the DR Project has an added layer of complexity since DR Team will be responsible for managing and coordinating several EPC contractors at the same time—all of which will be competing for the same space, labor and the owner's time and attention. The DR Team has recognized that its new "oversight" role will be a challenge and its performance in the Definition and Execution Phases will have to be carefully and continuously monitored. We will continue to review the DR Team's performance on this issue as more contracts are executed.

2. DR Team Leadership

Shortly after beginning our role on the Project in late February 2013, OPG announced that Albert Sweetnam, the EVP of the Refurbishment Project had left the company. Through May 2013, interim management of the Project was assumed by Wayne Robbins, the Chief Nuclear Officer. There were no other changes to the DR Team during this time. BMcD/Modus observed no measurable ill effects from the former EVP's departure.

In late May 2013, Bill Robinson rejoined the DR Project as the Sr. Vice President of Nuclear Projects after a short term as a project consultant. Robinson's experience includes: leading the rescue of the Pickering A Return to Service of Unit 4 from significant cost and schedule overruns; management of the successful PARTS Unit 1 Project; leading a seconded team from OPG at Point Lepreau; and early development of the DR Project. His leadership should prove beneficial in the planning stages of the DR Project.

Dietmar Reiner is currently the SVP of Nuclear Refurbishment. Mr. Reiner has an excellent grasp of the Project's strategy and accomplishments, and is keenly aware of the amount of work in front of the DR Team. He also appears to have the support of his team of direct reports and has instituted goals within the team related to transparency and effective communication.

3. Processes

The DR Team continues to develop and refine the management processes necessary for the Project, many of which are discussed herein. The DR Team has developed, and continues to develop a plethora of process and procedure documents and guidelines—perhaps too many. The risks of having too many processes include needlessly creating work (which requires more people that add cost) and conditions for non-adherence. Additionally, it is our observation that many of the procedures are not fully integrated (within a particular group itself or to other groups within the DR Project), with accurate annotations to reference documents. Currently, the DR Team does not have a matrix or even a complete list of all of the processes, procedures, standards, guidelines, manuals and the like that have been developed for the DR Project. The DR Team has recently embarked on cataloging and re-doing some of the procedures and this, presumably, may clear the air, correct what needs to be corrected and impart clarity to the remaining. The existing Management Systems Oversight group should be able to provide necessary support in this regard. Throughout this Project Assessment we will provide our view of the development of the Project management processes to date and their relative effectiveness, given the current status of the DR Project.

C. Scope Definition

An important early indicator of continued success is the DR Team's adaptability to right-size and control project scope in order to meet the commitments to the Board of Directors ("BOD"), the Shareholder and the

public. Between the years 2009 to 2012, the DR Project's overall budget has grown by [redacted] (2012 dollars) which is equivalent to [redacted] of initial budget. The current point-estimate of [redacted] ($2012 dollars) in the 2013 Business Plan [redacted] latest approved by the BOD. This total increase represents in large part scope growth of the DR Project. There are many reasons for this growth, including:

- OPEX, in particular from PARTS, which had significant cost overruns and schedule delays due to lack of scope definition at that project's outset has led the DR Team to conservatively identify a broad range of potential refurbishment scope;
- In the scope identification process, there appears to have been a tendency to increase scope to maintain the Station's WANO standing as well as over-commit to regulatory-driven modifications;
- As the scope of the Project has become more in-focus, the size of the Project Team has grown to match the effort represented;
- OPG decided to shift the OPS & Maintenance cost for each unit's operators to the DR Project while under refurbishment, which further added to the overhead costs.

The DR Team's SVPs have a firm understanding that, going forward, if scope is not effectively managed (and in some cases significantly reduced), OPG's management will be hard-pressed to deliver the DR Project at an acceptable cost. Below we discuss the progression of the DR Project's cost estimate, assess the current DR Team effort to examine and vet scope, and provide other recommendations for OPG to consider.

1. Budget and Scope History

BMcD/Modus's starting point in reviewing the DR Project's scope was to review the evolution of Management's representations to the BOD. The following summarizes the presentations that Management has given to the BOD regarding the evolution of the DR Project's budget and associated scope:

- On November 18, 2008, the BOD was presented an initial "medium confidence" cost estimate of [redacted] including a [redacted] contingency. At that time, the basis of the cost estimate included a 2007 Pickering B Assessment; industry studies; and considerations emanating from OPG's own operating experience (OPEX).[12]
- In year 2009, Rev 3 of the cost estimate was developed by the Project Control Team which totaled [redacted][13].
- On March 5, 2010, Management committed to the BOD that the DR Project's scope would be limited to: (1) replace life-limiting components (such as pressure tubes) to allow OPG to operate the units for an additional 30 years, and; (2) replacement of components most effectively done in an extended outage. Management assured the NOC that the DR Project had processes in place to control scope growth via the Scope Review Board, which will "ensure that appropriate reviews (technical and financial) are being performed to ensure that scope is appropriate and minimized to the extent feasible to avoid increasing the complexity of the project and impacting the project's critical path."[14]

[12] Report for Submission to Nuclear Generation Projects Committee (November 18, 2008) at p. 8.
[13] Report for Submission to Nuclear Generation Projects Committee (November 17, 2009) at p. 1.
[14] Update on Darlington Refurbishment Project (March 5, 2010) at p. 1.

- On November 17, 2011, the BOD was presented with a cost estimate that was characterized as remaining in the range of ~$6.3B to ~$10.5B[15] Additionally, the DR Team's 2012 Business Plan estimate was [redacted].
- On November 15, 2012 management presented its 2013 Business Plan cost estimate with a high confidence amount of [redacted] in 2012 dollars, thus including escalation, which remained less than $10B in 2009$. There were additional details and explanation of variances within the materials presented with the 2013 Business Plan.[16]

Based on files made available, variances and explanations of overall Program scope growth between 2009 and 2012 are summarized below:[17]

[redacted]

- Operations Support grew by $386M or 76% based on required human resource profile considerations, all as prepared by Operations and Maintenance Organization.
- OPG project management projections grew by $443M or 69% based on enhanced definitions and refined organizational characteristics of each department. Currently, the project management estimate is [redacted] of total direct costs.
- Regulatory expenses grew by $71M or 65%, primarily due to CNSC fees.
- Facility Support grew by $86M or 716%. Projected costs were reflective of corporate real estate (CRED) support costs at the Darlington Energy Center (DEC) along with business trade union (BTU) costs to maintain site facilities.
- Operation Training grew by $27M or 100%.
- Project Bundles grew by [redacted] or [redacted] overall, resulting from enhanced work definition; increased maturity; increased scope of the Turbine Generator Project and addition of safety improvement opportunity (SIO) projects.
- Campus Plan costs decreased by $146M or 22% due to improved scope clarity.
- New fuel and Waste work decreased by $34M or 10% due also to improved scope clarity.

The variances between the 2012 and 2013 Business Plans for the Project Bundles which comprise the bulk of direct costs are summarized below:

[15] Update on the Darlington Refurbishment Project Economics (November 17, 2011) at p. B-1.
[16] Update on the Darlington Refurbishment Project Economics (November 15, 2012) at p. 3.
[17] See DNGS Refurbishment Estimate Analysis (April 25, 2013) at p. 4.

- The RFR scope grew by [redacted] or [redacted] via improved definition and development of a more refined cost estimate.
- The Fuel Handling scope increased by [redacted] or [redacted] based on detailed review of Fuel Handling – Component Condition Assessment and continued scope clarification.
- The Steam Generator scope grew by [redacted] or [redacted] due to a revised cost estimate.

[redacted]

- The Turbine Generator scope grew by [redacted] or [redacted] due to the addition of the turbine control system and general scope finalization.
- BOP work reduced by [redacted] or [redacted] due to significant validation of work scope placed elsewhere in the program.
- Safety Improvement work increased by [redacted] or [redacted] due to the addition of SIO's.
- Islanding work grew by [redacted] or [redacted] due to scope clarification and the development of associated cost estimates.

Overall, a variance review indicates that the larger cost increases as measured between the 2012 and 2013 Business Plans resided in the Functional groups, not the Project Bundles. This suggests that any attempt by the DR Team or Management to reduce scope must also involve a re-look of the corresponding Functional group costs as well.

2. Scope Review Process by DR Team

As noted, the DR Team is currently vetting the approved project scope. The following summarizes the process the team is using to rationalize the scope and right-size the DR Project.

a. Process for Scope Determination

The DR Project's governance for scope review establishes the following Primary Objectives:

- Successful refurbishment of Darlington Station life-limiting components in order to allow Darlington to operate for 30 years beyond the current predicted end of service life.
- The Refurbishment Project will maintain and return the unit in the condition in which it is turned over.
- A successful refurbishment project requires delivery of all core and approved non-core scope within the high confidence timeline and budget established in the RQE and as documented in the Project Business Case Summary.
- Project cost and schedule as well as post-refurbishment performance will come under extreme scrutiny due to the high profile nature of this project and its impact on OPG's reputation.

- Where scope is approved by Scope Review Board, Nuclear Refurbishment may recommend inclusion of the scope and execution in a pre-refurbishment station outage.

The stated goal of this process is to "ensure that the proposed additions and/or deletions have undergone a thorough assessment based on the return on investment, impacts on plant safety, reliability, project schedule and cost, program resourcing, regulatory requirements and environmental impacts."[18]

The DR Project's scope was developed from review and vetting of 1,409 DSRs that were generated by the Station and Refurbishment Engineering. Based on OPEX from past refurbishments, including PARTS Unit 4, the team adopted an intentionally expansive view of potential scope inclusion so as to consider all options and avoid later surprises and/or scope additions that could adversely impact the DR Project's success.

The process used to date for defining scope was based in part on accepting and classifying "Core" versus "Non-Core" scope. "Core Scope" is "work that must be done to achieve the Primary Objective" including (1) Regulatory; (2) Station Life Limiting Components; (3) Component Upgrades that can only be done in an extended outage; (4) Programmatic Work necessary to maintain the plant's license; (5) Pre-requisites; and (6) Facilities and Infrastructure to support the DR Project. Non-core scope is defined as work that "Will be performed in the refurbishment period if it has no impact on the Projects Core Scope critical path, does not add risk to the successful completion of core scope, and where cost or resource efficiencies and station priority warrant the work to be executed in the refurbishment period."[19] The Scope Review Board has been given the role of approving, deferring or rejecting the scope items based on multiple criteria.

b. Scope Status as of the 2013 Business Plan

The 2013 Business Plan's scope definition and maturity level within each Bundle varies considerably. The following summarizes the monetized value of the DR Project's DSRs for each of the Bundle in the 2013 Business Plan.[20]

Project Bundle	Number of DSRs	2013 Business Plan ($000)
BOP	208	[redacted]
Campus Plan Infrastructure	23	
Campus Plan Inside	10	
Campus Plan Outside	17	
Engineering Projects	42	
Fuel Handling	76	
In-Station Infrastructure	14	
RFR	17	
Safety Improvement Opportunities	3	
Steam Generators	12	
Shut Down/Layup	26	
Turbine Generator	79	
Unit Islanding	29	

[18] Darlington Nuclear Refurbishment Program-Scope Control NK38-INS-09701-10001-R004 (December 12, 2012) at p. 4.
[19] *Id.,* p.8
[20] Scope Review as of June 20, 2013 at Table 1.

Project Bundle	Number of DSRs	2013 Business Plan ($000)
Other	3	[redacted]
Total	**559**	

The DR Team anticipates that it will generate additional DSRs that will need to be dispositioned and may add to the total end scope. Outside of discovery work that cannot be anticipated until the unit is under construction, the DR Team expects that additional DSRs will largely come from three sources:

- Component Condition Assessments ("CCA's"): The DR Team determined that many of the condition assessments performed in the developing the DSRs were incomplete. Project Engineering is currently re-evaluating the CCAs that appear to have shortcomings. It is not currently expected that these CCAs will yield a significant number of additional DSRs although this process needs to be continuously and closely monitored, and the interim results need visibility.
- Regulatory Requirements: There are certain regulatory issues that will require additional DSRs and/or modifications to existing DSRs. Most notable are additional requirements for fire protection work that was not initially anticipated. These additions are being assessed at this time.
- Scope Defining Inspections: The DR Project will be performing ~40 separate scope defining inspections during the upcoming pre-project outages. While the plan for the Project includes contingent scope and associated budget, there is a risk regarding the work scope that could be generated until these inspections are completed.

Based on our review of the development of the scope, it appears that OPG's methodology has cast a wide net for identifying all of the possible scope that could be included in the Project. The DR Team has developed effective metrics for bringing focus and attention to scope identification status and maturity via its "Health of Scope" ("HOS") reporting. These HOS reports highlight the life of a DSR until it is dispositioned. These metrics have been very helpful in bringing focus to the scope that lacks maturity and requires action.

The challenge for the DR Team now is to weed out the work scope that is not essentially done in refurbishment and ultimately define scope that is balanced to the original commitments to the BOD, the Shareholder and CNSC. Adding unnecessary work not only increases the Project's cost but aggravates complexity and risk. Reasonably balancing the scope with complexity, risk, schedule and budget concerns has the added benefit of allowing the DR Team to focus on the critical path RFR work which has been problematic in prior mid-life refurbishments.

As a result, the DR Team is currently reviewing the previously approved DSRs and bucketing them into one of three categories:

Must Refurbish in DR Project	Possible Deferral to Station for Life-cycle Management	Remove from Scope
•Life limited components •Regulatory commitments •Drained/Defuel State •Refurbishment Support •Sustaining scope – 30 year replacements	•Station improvements with positive payback •Sustaining Scope that can be done outside of DR Project •Sustaining Scope – Manage as part of Life-Cycle Management •Sustaining Scope – Service Equipment, can be done online or during normal station outage •Station Support •Station Improvements – Likely payback	•Work not needed for ISR •Inspections determine scope is unnecessary •Work should be done under functional work program •DSR is for purchase of Capital Spares •Work with no relationship to Refurbishment •Work that must be done in VBO •Station Improvements – Payback Unlikely •Clean-up – work superseded

In our experience, removing scope that was once nominally "in" a project is often a difficult proposition. The DR Team has engaged in two separate reviews, one conducted by key members of the team using the above considerations and a second "cold eye" review by Paul Pasquet, who is reviewing the scope in light of the necessary regulatory commitments. As of the time of this Report, these reviews are ongoing with the intent to present separate recommendations to the Scope Review Board for final review and disposition prior to the DR Team's 2014 Business Plan presentation. BMcD/Modus has examined these ongoing processes, reviewed interim conclusions (to the extent those are available) and interviewed the principals involved, from which we can conclude that this effort is robust and likely to produce significant recommendations in reducing the Project's scope.

3. Conclusions – Scope Status and Review

Since the inception of our engagement, BMcD/Modus has observed the DR Team's increased focus on scope and all the related considerations. We have noted the direction and increased focus provided by the DR Team's leadership. Assuming that the result of this effort is supported by a favorable economic analysis, BMcD/Modus believes these efforts are likely to result in a more achievable project plan with reduced overall risk. The following considerations should be kept in mind as the DR Team prepares its recommendations:

- Cost controls that the DR Team has put in place need to be followed in the future or scope creep will again threaten the success of the DR Project.
- Decisions regarding scope of the DR Project should be made as quickly as practicable so as to avoid the team expending effort on scope that will not be performed in the Project. Currently, Project Engineering is under stress to complete the procurement engineering work associated with undefined DSRs. If the DR Team can winnow down the scope as intended, such changes will reduce this pressure and make the final scoping effort more manageable and increased the likelihood of timely preparation of these packages.
- The remaining scope risks, including those resulting from future scope-defining inspections, need to be tracked in a transparent manner for the BOD so that there are no surprises.
- The results of this review need to be recorded in the AIDA database for future reference for rate proceedings and configuration management.

IV. Functional Group Status

A. Engineering

At the outset of our engagement, BMcD/Modus found the DR Project's engineering in a state of flux. The OPG Engineering Team was in the process of instituting new procedures and developing the organization needed to fulfill all of its necessary functions, its metrics and tracking methods of engineering product were in the embryonic stage, and it appeared that engineering was significantly stressed and behind schedule. However, the Engineering Team's performance indicators did not reflect this stress. Over the last several months, we have noted improvements in both reporting and production, though there are many challenges remaining in both areas. In this assessment, we have focused on defining the roles OPG's engineering will play, the current areas of focus, and recommendations for improvements for upcoming phases.

1. Overview of Engineering Roles and Responsibilities

The Engineering Team (with its sub-parts Nuclear Safety, Design Engineering, Component Engineering, Engineering Projects and Reactor Engineering) is the largest of the DR Project's Functional Groups and fulfills a number of significant and evolving functions during the Project's lifecycle. Because OPG has chosen an EPC model, detailed engineering will be provided by the EPC contractors. However, OPG's Engineering Team retains responsibility for:

- Defining project requirements and design elements through development of the Design Modification Packages ("MDP");
- Identification of owner supplied long lead materials;
- Design authority approvals;
- Design completion assurance;
- Construction Completion Declaration
- Commissioning;
- Available for Service;
- DSR Closure.[21]

Currently, the Engineering Team's focus is on preparing procurement-related MDPs that are essential for defining OPG's requirements for the remaining scopes of work. This is an OPG-led function, though the Engineering Team is supplementing its efforts with the OSS Vendors, WorleyParsons and AMEC, in order to achieve a higher level of throughput. Once this phase completes, the Engineering Team will retreat into an oversight role in which its primary function will be to review and approve EPC design documents. OPG will take the lead again as the work moves out of the Execution Phase and into Commissioning. These myriad functions will require the Engineering Team to constantly review the mix of people and their specialties within the team. Management is currently evaluating the structure of the Engineering Team to meet these challenges.

Because OPG and the various EPC vendors each have responsibility for aspects of the design at various stages, answering the seemingly straightforward question of the DR Project's engineering status is a very complex equation. Nonetheless, as discussed below, the Engineering Team should endeavor to improve its reporting

[21] Darlington Refurbishment Project Unit 2 Major Work Streams (undated).

and metrics so that management and the BOD have a better and more precise handle on the status of the DR Project's engineering definition as the DR Project progresses.

2. Procurement Engineering - MDP Process

Since the majority of the Engineering Team's current efforts revolve around the MDP activities, BMcD/Modus has reviewed this process, progress and issues. The OPEX that the Engineering Team has gathered from the MDR/MDP process needs to be considered as the DR Project's design advances.

a. Developing MDRs

As noted, the DR Project's scope was assessed based on a wide variety of plant CCAs, life cycle management reports, system health reports, engineering backlogs and regulatory requirements in order to develop approximately 1400 DSRs. These DSRs were then evaluated to determine if the resulting scope of work would be a Maintenance Work Order, an equivalency evaluation, a Non-Identical Component Replacement or a Modification. If the disposition requires a modification, a Modification Design Requirement ("MDR"), Modification Outline and Conceptual Design Report are developed in accordance with the existing Engineering Change Control ("ECC") process. These evaluations of the DSRs netted 117 MDRs for engineering evaluation.[22]

According to OPG procedures, Engineering must prepare MDRs for the following purposes:

- New or existing Structures, Systems and Components;
- Engineered tooling;
- Permanent or temporary additions to existing facilities; and
- Permanently or temporarily re-defining a system design basis.[23]

In accordance with OPG's ECC process, the actual development of each MDR requires Engineering to review and account for such elements as:

- Nuclear Safety Design, Functional and Performance Requirements
- Interfacing Systems
- Design Limits and Strengths and Seismic Requirements
- Design Constraints and Constructability
- Environmental Qualification/Aging Considerations and Reliability Requirements
- Maintainability/Operability/Human Factor Requirements
- Periodic Inspection Requirements
- Safety Requirements
- Commissioning Requirements
- Standards and Codes
- Comparison with Similar Systems at Other Generating Stations

Initially, OPG planned to prepare the MDR packages with in-house, internal resources. However, OPG could not complete the volume of work and the number of MDRs required without additional engineering help. The

[22] Preparation of Needs Document N-GUID-00700-10002-R001 (2013) at p. 13; Modification Process N-PROC-MP-0090-R009 (2013)at p. 41 , Engineering Change Control, N·PROG-MP-0001 (2013).
[23] Preparation of Modification Design Requirements, N-INS-00700-10007-R001 (2013) at p.3.

Engineering Team therefore contracted with the OSS vendors to complete the MDP development as augmented staff workers under OPG to support the RQE milestone. This, however, has led to increased costs for the development of the MDRs.[24]

b. MDR/MDP Status and Metrics

Despite the fact that the OSS vendors have now been engaged, Engineering is still struggling to meet the schedule for MDP development. In June 2013, OPG's Nuclear Oversight ("NO") group conducted a performance-based audit of the MDR/MDP and Design Quality Oversight process, the objective of which was to determine if the development of MDRs and associated MDP documents comply with governance, and to audit the Engineering team's organization. NO identified the schedule instability for the OSS Vendors work, noting that compliance with the MDR completion dates was "difficult to determine" because of the changing dates and metrics used for tracking engineering work.[25] While the then-current schedule showed engineering essentially on track, NO determined that the OSS vendors were trending well behind in the development of the MDR packages based on a December 31, 2012 schedule labelled as the "baseline." In all, of the 37 remaining MDRs, 19 were scheduled to be complete by June 30, 2013 per the original baseline schedule; though as of the end of June, only one MDR was complete. NO also found additional quality and accountability issues in the OPG Engineering Team's management of the vendor. These audit findings are being addressed by Engineering.

Engineering has ramped up its efforts in developing metrics, though these are still in the embryonic stage. The weekly engineering meeting with the team and the OSS vendors has increasingly focused on schedule performance and project "need" dates. There have been improvements in the reporting by the OSS vendors, though there is still noise within the earned value rules and counting of design products.

3. Engineering Quality Programs

The Engineering quality program is currently focused on oversight of the EPC vendor in-line with the original implementation model. Since very few of the projects have progressed past the procurement phase, the effectiveness of the quality oversight model implementation has yet to be proven.

OPEX from early implementation of the EPC model on the Campus Plan modification activities has led the Engineering Quality group to look into its methods of oversight activities of the OSS vendors and the MDP development process. Recent actions to address these quality issues include: a Self-Assessment,[26] a Nuclear Oversight Audit Report,[27] and a Common Cause Analysis regarding the quality of design engineering deliverables received from the OSS vendors.[28]

As part of the Common Cause Analysis, fifty-five SCRs were reviewed to determine the bases of the quality issues. The results were broken down into the following categories:

[24] *See* SCR N-2013-01589.
[25] Nuclear Oversight Audit Report – Darlington Refurbishment – Modification Design Requirements and Design Quality Oversight, OPGN NO-2013-005 T6.
[26] *See* SA NO13-00005.
[27] *See* OPGN NO-2013-005 T6.
[28] *See* Common Cause Analysis SCR N-2013-02294 (June 21, 2013) at p. 6.

SCR Category	# of SCRs	Findings
Quality of Product	27	Human performance error Issues; Lack of rigor during verification; Staff not sufficiently trained/qualified
Delays in Deliverables	16	Original schedule errors; resource availability
Procedure Adherence	13	Lack of understanding; Execution Mistakes
Expectations	5	Poor Communications

The conclusion from this Common Cause Analysis identified two themes related to MDP quality:[29]

- Human performance issues during the preparation and issuance of the design products; and
- Communication issues between OPG staff and the OSS Vendors.

Actions being taken to address the issues identified above are:

- Pursue opportunities to co-locate OPG and OSS vendor engineers at either the DEC or vendor facilities to improve communications;
- Get vendor engineering staff registered in the OPG TIMS system as qualified engineers;
- Refresher training for OSS staff with regard to OPG's ECC process; and
- Team building activities[30]

These issues are indicative of a team that is getting organized on the fly and under duress. The Engineering Team's leadership is taking this OPEX into account and is reshaping the organization, which should result in improvements. The BMcD/Modus team will continue to monitor the OSS and EPC vendors engineering services in these areas as additional MDP packages and EPC detailed design work products become available for review. In addition, we will monitor the Engineering Team's quality processes at the Program level to assess the DR Team's ability to ensure adequate oversight of the upcoming detailed engineering phase.

4. Additional Observations and Recommendations

However its progress is measured, the DR Project's engineering effort is still in a very early phase. Engineering's current activities in developing the procurement packages are projected to continue well into 2014, and the team will have to adapt to monitoring the EPC's detailed design work that is underway. The current rationalization of scope and potential scope expansion from CCAs and regulatory scope will have an impact (both positive and negative) on the Engineering Team's work effort. Moreover, OPG will need to settle into an essentially new role of providing oversight of the detailed design process performed entirely by others.

For these reasons, BMcD/Modus believes it is essential for the Engineering Team to continue to refine its metrics, including earned value and schedule adherence. The reliability and quality of RQE will depend on the DR Team's ability to understand with confidence the Project's underlying level of engineering maturity. Currently, in part due to the fragmented distribution of the engineering activities between OPG, the OSS vendors and the EPC vendors, there is no metric that measures the integrated engineering effort (OPG + OSS

[29] *Id.* at p. 6.
[30] *Id.*at pp.8-10.

Vendor + EPC Vendor) such that the true status of the overall engineering effort is visible and can be understood.

There have been improvements over the last several weeks in the Engineering Team's metrics because the team is relying less on showing progress via work-down curves tracking completion milestones and more on interim key performance indicators such as SPI/CPI. In addition, the metrics better reflect the "need" dates from the various projects. There are still improvements needed and noise to wring out of the data, though the metrics are much accurate now than at the outset of our engagement. As the Project's C&C Schedule matures, we would expect that all of teams' metrics will be schedule-focused.

We have some additional high-level observations:

- As noted and discussed at length in the BOP section, OPG needs to examine a different delivery method for BOP work, one that allows the EPC vendors to begin detailed design as soon as possible. In conjunction with this change, the Engineering Team should review its processes to eliminate or reduce redundancy and the burdensome nature of elements of the MDR package development. One potential solution would be to limit the work by the OSS vendors and transfer some of these requirements to the EPC, so long as OPG's requirements are robustly detailed and established in accordance with ECC.
- The Engineering Team needs to review its and the other OPG groups' turn-around time for design approvals. There have been OPG-caused delays in approval of the OSS vendors' work, and the team needs to eliminate such constrictions where possible. The team should consider expanding its ball-in-court metrics to incorporate more granularity and visibility of the choke points in the chain.
- On the subject of engineering quality, BMcD/Modus recommends that an audit program be utilized to confirm that the EPC engineering vendors are adhering to their own QA/QC programs and that specific OPG quality requirements have been incorporated into the engineering practices utilized by these vendors (e.g.: Requirements Traceability Matrix).
- The Engineering Team should continue to evaluate the methods it will use for overseeing the development of detailed engineering by the EPC vendors. The OPEX from the Campus Plan work is informative in this regard and should be studied carefully.
- Developing comprehensive work packages is another function that has been exported to the EPC vendors. The Engineering Team will need to have sufficient resources available to handle questions and Requests for Information ("RFIs") from these vendors.

As the engineering effort continues, BMcD/Modus will provide both status updates and additional recommendations.

B. Commercial/Contracting Strategy

1. Process

OPG has chosen to use a combination of the multiple-prime and EPC project delivery methods. Here, each EPC "prime" contract equates to a Project within the DR Program. Each EPC prime contractor is responsible for coordinating and delivering the work covered by its particular scope of work (i.e. a Project or some portion

of a Project), but is not responsible for the entire Program.[31] Instead, OPG will take on the role of the Program Manager.

Under OPG's procedures, the Nuclear Commercial Development ("NCD") group coordinates an analysis with each Project Team and relevant stakeholders to develop a "Contracting Strategy" for each major work package. "A comprehensive contracting strategy takes into consideration factors such as the nature and scope of the work, the Supplier marketplace, potential longer term or broader commercial arrangements and results in a recommendation of the procurement approach, contract structure, pricing mechanism and the style and type of management to be adopted for the subsequent contract."[32]

Although each Project Team must perform a separate evaluation to determine the best contracting strategy, OPG has stated a strong preference for the EPC or hybrid versions of the EPC project delivery model, whereby a single contractor will perform the detailed engineering, equipment procurement and construction and installation work for a particular scope of work. OPG's key rationales for this choice are:

- This model gives OPG one point of contact (i.e. fewer interfaces and hand-offs for which the owner would be responsible to coordinate) and is "easier" to monitor and coordinate. From OPG's perspective, this also gives "one point of accountability" for complete delivery.
- This model can provide cost and schedule certainty to the owner prior to commencement of the execution/construction phase. This aligns with the DR Project's goal of having a high-level of definition for RQE.
- This model will enable OPG to concentrate its resources and efforts on rigorous project management and contractor oversight, which will be crucial to the DR Project's success.
- This model aligns with OPG's core business and overall future business direction, including staffing. [33]

Where applicable and relevant, we will discuss individual Project contracting strategies below. At this time, only contracts for the engineering and supply for Defuelling, RFR Definition Phase work (including development of the Tooling, construction of the Mock-Up and pre-construction estimate and schedule development), and the equipment supply and technical services contract for the Turbine Generators have been awarded and fully negotiated. The Execution Phase agreement for the RFR work has technically not yet been awarded (though it is anticipated that this work will be awarded to SNC/AECON upon agreement of the Target Price); and the final Target Price for this agreement will be subject to the ongoing RFR estimate development required by the Definition Phase contract.

Additionally, the ESMSA Contracts for the two intended BOP contractors have been negotiated and pre-Refurbishment work under these agreements is ongoing, although no Execution Phase work has been awarded to date. These contracts were awarded on the basis of competitive bid process, and the terms and conditions of these agreements were established for the purpose of simplifying future awards of the BOP work. The BOP section of this report provides additional detail regarding the commercial considerations in these contracts.

[31] The Campus Plan Projects have been excluded from the scope of the DR Commercial Strategy since they are being managed by Projects & Modifications, rather than the DR Team.
[32] See Program Contract Management Plan, NK38-PLAN-09701-1067- R000 (January 31, 2013) at p.5.
[33] See Darlington Refurbishment Program Commercial Strategy, NK38-REP-00150-10001-R001 (October 1, 2012) at p.11.

2. Additional Observations and Recommendations

As with any commercial strategy for a large capital project, there are risks associated with the multi-prime EPC model chosen by OPG for the DR Project. Many of these risks have been recognized and are being monitored by OPG, though they must be discussed on an ongoing basis as realization of some of these risks will impact the success or failure of the DR Project.

- With the multi-prime management approach, Owner's traditionally hire construction managers or program managers to coordinate the EPC contractors' work, and owner's engineers to review program compliance. OPG has chosen to fill these roles, and its success will be dependent its ability to employ a strong, capable and experienced construction management team that is able to effectively coordinate and track the work of such a large, complex project. We would also recommend that the DR Team integrate key construction management individuals into the DR Project Team as early as possible in the Definition Phase.
- OPG's preferred EPC contracting strategy is a new project delivery model introduced for the DR Project. It is also different from that used by OPG's vendors on past projects. Business cultural differences between OPG and vendors' management philosophies will have to be closely managed.
- The RFR contract dwarfs the other major project scopes, and there is a tendency to think of SNC/Aecon as the Project's full-wrap EPC contractor. This is not the case, and management needs to devote attention to the other projects to optimize adjacent project coordination and minimize interferences.
- [redacted] and OPG's management of the vendors' work on the current Campus Plan scope [redacted]. OPEX from the D20 Storage Facility includes evidence of failures on [redacted] OPG's [redacted] part to recognize that key details were missing from that project's definition which led to unrealistic schedule and readiness expectations[34]. The DR Team should examine these lessons learned going forward.
- The Program/Project approach has the risk of creating "silos" between the Project teams. Although each of the major Project Bundles are self-contained units, the Program must be managed by OPG as a whole, with a single, integrated schedule, cost control system and risk management approach.

Developing a contracting strategy for such a large project has to include a number of key variables. Some contracting approaches are more risky for the owner than others. Some are unsuitable for certain situations. Some strategies work for some owner organizations but do not work for others because the strategy depends on the owner's strengths. There is evidence that OPG took these major considerations into account in deciding on the contracting strategy it is following. However, this strategy will require some significant changes to OPG's prior large capital project mindset, and while growing pains are expected, the Project's success will be largely determined by OPG's willingness to embrace the role and recognize and control the risks associated with the chosen method.

C. Project Controls

OPG's Project Controls team is responsible for essential functions of Schedule, Budget, Risk Management and Document Control. The following is our assessment of the development of each of these key elements to date.

[34] D20 Storage and Drum Handling Project: Modification Planning Lessons Learned Report, D-LLD-38000-1001 (March 4, 2013)

1. Project Controls Team and Structure

After Engineering, the DR Project's Project Controls team is the next largest functional group on the Project, and given the broad range of responsibilities the team has been given, this appears to be entirely appropriate. Project Controls is supporting the project-led approach with a core functional team and matrixed resources that have been embedded within the various Project Bundles. This was done to assist the Bundles in developing their respective schedules and budgets, though the efficacy of this model will likely wane as the Project continues to mature.

Going-forward, BMcD/Modus recommends OPG clarify the reporting lines of authority for Project Controls matrixed staff. Project Controls as essentially an independent function and those charged with that function are tasked with holding project managers accountable to integrated schedule, budget and risk standards. As an example, in the budget process, it is expected that certain puts and takes will occur between the Project Bundles. Project Controls needs to be the first-line-of-defense of the budget and broker these budget shifts with only the Project's overall best interests in mind. The matrixed Project Controls staff could be put in an uncomfortable position, having to work essentially for two bosses. In order to maintain the necessary independence, Project Controls personnel should have a direct and singular reporting line to a central Director, and that individual should report directly to the project's executive.

2. Schedule Development

a. Process and Methodology

The DR Team has chosen a method for developing the Project's schedule that is unique in the industry at large. In accordance with the Program Schedule Management Plan[35]:

> The (C&C Schedule) level 2 schedule covers the scope of work by Phase, Unit USI, and Type of work and contains full Critical Path Method (CPM) logic. It is referred to as the C&C schedule, or, Control and Co-ordination schedule, as this is the schedule which will be used, at the Phase and Unit level, to track the overall schedule status of the Program. It will be updated and controlled by OPG and based on the Contractors detailed Level 3 Schedules.[36]

In essence, the DR Team intends to use the Level 2 C&C Schedule as an integrated "look" of the schedule using Level 2 detail that mirrors (or hammocks) the level 3 detail that the contractors are developing for work execution. In order to update and further develop the C&C Schedule, OPG's Schedule Team intends to summarize the contractors' level 3 schedule into a separate level 2 that contains an adequate number of activities with realistic activity durations to clearly show the sequence and logic in performing all projects, within the Program, at the Phase and Unit level, in a systematic manner. It will include all interfaces between OPG and contractor, and/or between contractors."[37] Notably, under this plan, the Level 3 detailed schedules from the contractors and respective work groups will not be integrated but only summarized at the milestone level. The eight[38] project bundles will each develop, maintain and update eight separate schedules with no interface logic ties between areas or bundles. The DR Team currently anticipates the C&C Schedule will

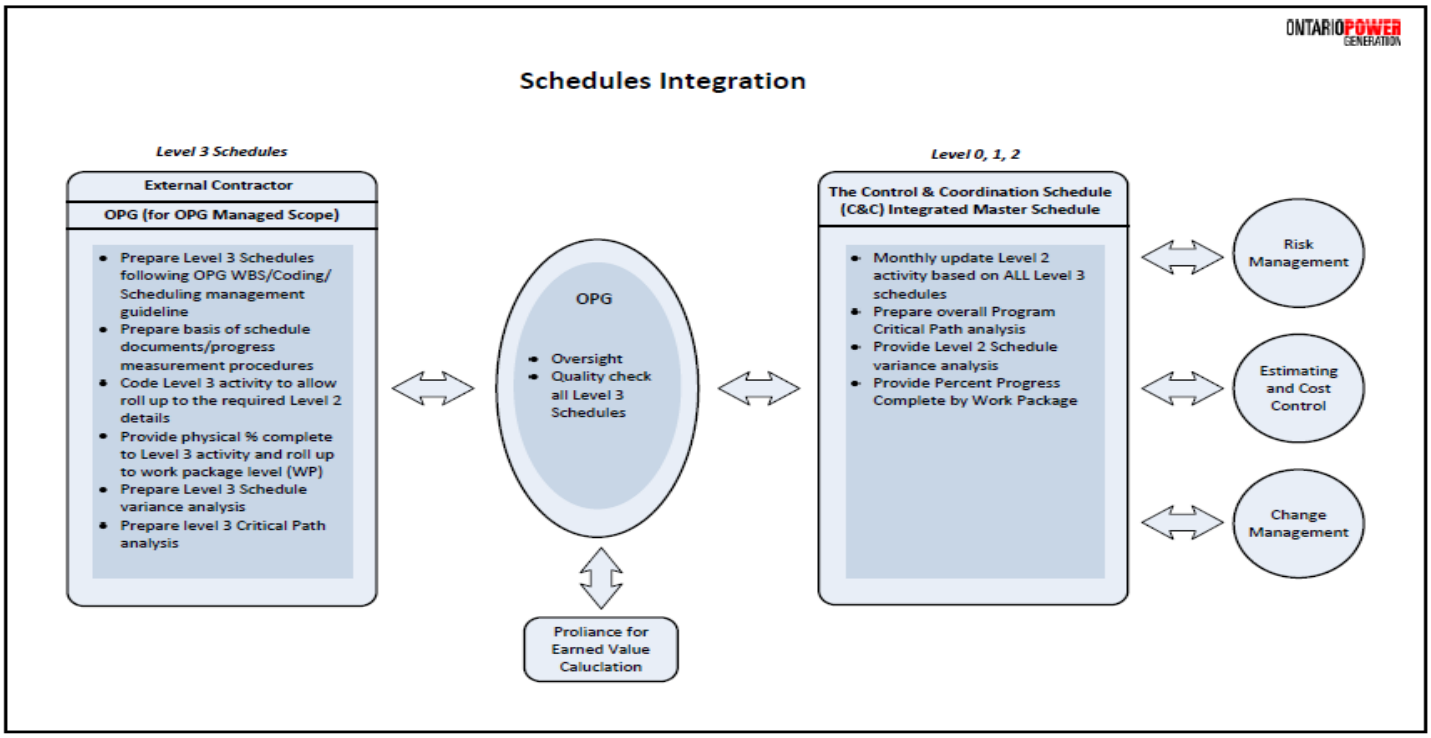
[35] NK38-PLAN-09701-10067 (January 31, 2013).
[36] Program Schedule Management Plan, NK38-PLAN-09701-10067-0004-R001 (March 27, 2013) at p.4.
[37] *Id.*
[38] For scheduling purposes, some of the SIO work is in a separate bundle.

consist of 5,000 tasks/activities in the Level 2 format, whereas the level 3 schedule, when developed, will consist of ~50,000 tasks/activities.

As articulated by the Project Team, the key drivers behind this unique methodology are:

- To allow for coordination of schedule activities at the summary milestone level. This is based on the Project Team's preference to manage the interfaces between the contractors and work groups at a higher, less granular level;
- To address OPEX from prior capital projects suggesting that the Project Team needs to manage the Project in a manner different from a conventional maintenance outage;
- To support OPG's desire for the exclusive ability to manage both overall and individual milestones that determine the contractors' schedule start dates, finish dates and float using the C&C Schedule.

OPG's *Program Schedule Management Plan* provides the procedure for developing the C&C Schedule from the Level 3 detailed schedule.[39] The diagram below identifies the flow of information from the Level 3 detailed schedules to the Level 2, C&C Schedule:



Some of OPG's processes follow typical scheduling practices: each bundle will have and update individual detailed Level 3 schedules with integrated Work Breakdown Structures ("WBS"); and assessment of critical paths and status updates will be based on an assessment of physical percent completion. These processes generally conform to frequent industry practices. Moreover, each Project Bundle will be responsible for updating its schedule to show its progress, and OPG will receive and coordinate the interfaces between the

[39] *Id.* at pp. 4-5.

Project Bundles through establishing and maintaining project milestones and touch points contained in the Level 3 Schedule.

While the C&C Schedule will work for the Definition Phase, it is our understanding that the DR Team intends to use the C&C Schedule as its prime schedule management tool through the Execution Phase. However, OPG's intended approach varies from what is typically seen in the industry for project execution in several important respects. By the Project Team's design, there will be no single integrated Level 3 schedule on the Project during the Planning or Execution Phases. Under this plan, instead of enmeshing these eight Project Bundle schedules, OPG has created the Level 2 C&C Schedule which "covers the scope of work by Phase, Unit USI, and Type of work and contains the full Critical Path Method (CPM) logic" and interface points. The DR Team's intent is that the C&C Schedule "will be updated and controlled by OPG and **based on** the Contractors detailed Level 3 Schedules." As shown in the diagram above, in order to monitor schedule progress, BMcD/Modus believes that this will cause OPG to monitor the eight separate Level 3 schedules and summarize the information into the C&C Schedule, as well as capture and record any changes to each bundle's schedule durations, adjacencies and logic (including the critical path). Typically, this level of integration is done electronically via an agreed automated roll-up of the schedule's Level 3 activities into a higher level 2 format. Such a Level 2 Schedule is typically not a stand-alone, calculating schedule, but merely a roll-up of the detailed Level 3 integrated, calculating schedule.

Maintaining a single Level 3 integrated, calculating detailed schedule network in P6 is standard in the industry because it readily provides the level of information needed for day-to-day management of the projects' work. The AACE's Recommended Practice 37R-06, which OPG's Schedule Management Plan uses as a reference document, states that Level 3 is the "first level that a meaningful critical path network can be displayed and the CPM schedule can be used to monitor and manage (control) the overall project work. Level 3 is a good level for the overall project control schedule since it is neither too summarized nor too detailed."[40] AACE recommends that the Level 3 schedule network "reflect the interfaces between key workgroups, disciplines, or crafts involved in the execution of the stage." BMcD/Modus agrees with and endorses AACE's conclusions. In our experience, a schedule for a project of this complexity needs a detailed logic network that is unconstrained and able to freely and readily calculate the critical path and sub-critical paths. As a result of our experience and widespread industry practice, we are skeptical that OPG's efforts at maintaining, updating and administrating the level 2 C&C Schedule will provide the management tool necessary for successfully coordinating and controlling the Execution Phase of the work.

b. Status of Schedule Development

The DR Team is currently developing the C&C Schedule by populating the detailed schedule network. The Project Information Management System ("PIMS") milestones for schedule development are: (1) Level 3 Schedule, "Revision A", April 15, 2014; (2) Level 3 Schedule, "Revision B", which will form the basis for the RQE, is scheduled to be completed in May 15, 2015; and (3) Final Level 3 Integrated Schedule, April 15, 2016.

The interim C&C Schedule was the basis of the presentation to the Refurbishment Project Executive Team ("RPET") on July 19, 2013. The following is an assessment of the current status of each of the Bundle components of the schedule, based on a review of the materials that were prepared for that presentation:

[40] AACE International Recommended Practice No. 37R-06 Schedule Levels of Detail—As Applied in Engineering, Procurement and Construction (March 20, 2010) at p.2.

C&C Schedule Status as of July 19, 2013	
Project Bundle	**Current Status**
RFR	Level 3 is resource loaded with contractor staff needs, though there is a concern with contractor staffing to meet the work load in the Fall 2013. Program milestones for 'mock-up construction complete' are misaligned with the contract (by 61 days), with a CCF to be processed. RFR is currently evaluating inter-project ties and inserting outage milestones into the schedule. The RFR team was challenged to evaluate the number of activities with excessive float (600+ days) though the RFR team believes this float is realistic due to early performance of certain work. In addition, RFR will need to examine multiple activities with 500+ days of duration.
BOP	The schedule is currently reflecting pressure from MDR's for scoping, which are showing 89 days late. This may be due to logic ties rather than lack of progress and if so, will be corrected. However, as will be discussed in the BOP section, there is a significant risk that the current schedule logic will not support on-time completion of BOP detailed engineering. In addition, the schedule currently reflects that several inspection preparations are running behind schedule, though the BOP team assures that recovery plans are in place and as-planned completion dates are expected to be maintained.
Fuel Handling	The schedule for Fuel Handling is being revised to reflect the award of the Defuelling contract as well as certain changes that management has directed to move work forward, before the start of the DR Project's Execution Phase.
Turbine Generator	This bundle's schedule is not well developed at this time, as activity definition, sequencing and interface ties all require work. The current preliminary engineering activities are riding the data date with no rationale. The team reported that the RFP negotiations are impacting the schedule at this time.
Steam Generators	This schedule reflects the current maturity level, which is in the pre-contract phase.
Shutdown/Layup	New level 2 schedule was completed at the end of July and will be used as the target. The strategy is to use the existing ESMSA contracts and vendors for the work. The plans to support this procurement strategy are reflected in the target schedule.
Functional Group	**Current Status**
Operations & Maintenance	Much of the current work is to support project needs yet the activities are not tied (integrated) with the downstream project activities, consequently large amounts of float are shown. Significant O&M work that is required for the projects does not show up on the O&M C&C Schedule, which reflects an interface issue with coding and layout at level 2.
Licensing	Licensing schedule is organized by each project, activities are supposed to be extracted from the project schedules. This schedule needs further refinement from presentation layout to the definition of licensing activities for it to be a usable C&C schedule.

C&C Schedule Status as of July 19, 2013	
Nuclear Safety	There were a number of flaws noted with activity dates, % complete, float, descriptions, among other things. The activities are very short term focused, level of effort type activities. This schedule also needs further refinement for it to be a usable C&C schedule.

In the C&C Schedule meetings held during the week of July 15 2013, the Project Controls Team identified that schedule adherence and variance will be monitored against this version (July) of the level 2 schedule. There was a concern noted that the schedule fragnets from OPEX on other projects are not being used to guide the logic and durations of schedule activities, the schedules are being developed from scratch. We noted a distinct difference between Functional and Project groups with the approach and degree of schedule development. The Functional groups in general have much more work ahead in their schedule development, with the Project Bundles being much further along. The current iteration of the Project schedule will be used to drive and measure the Definition Phase for the next 10 months. All schedule performance metrics will use this schedule as the interim baseline for measurement at the milestone level. As the Project Bundles mature, the schedule will continue to be populated with additional Level 3 schedules.

c. Summary of Risks

Whereas the C&C Schedule is an adequate tool for the Definition Phase of the Project, BMcD/Modus is concerned with the schedule development plan that OPG is pursuing for the DR Project's Execution Phase. The following are some of these concerns:

- OPG intends that its C&C Schedule be its depiction of the interfaces between the eight Level 3 Project Bundle schedules, as described. At a minimum, this approach appears to shift significant burden onto OPG's Project Controls department to update the C&C Schedule to match the Level 3 schedules received from the contractors. This approach creates a risk that the C&C Schedule and the eight Level 3 schedules will not be fully aligned and manipulation of data will most likely be a daily issue as between OPG and its contractors. Moreover, the contractors may not accept the C&C Schedule as the Project's baseline schedule, which would create difficult issues when analyzing potential impacts and mitigation of delays and coordination problems.
- OPG's intent with the C&C Schedule is to give the contractors sufficient latitude to develop and "own" their respective schedules, and reduce the amount of interference (unintentional or otherwise) from OPG. However, in our view, the contracts executed to date do not present clear and unambiguous rules to hold contractors accountable in schedule development. The contracts rely on the parties reaching mutual agreement on the schedule which is a concept fraught with risk and difficult to achieve under the best of circumstances, and one which could ultimately result in the DR Project never having a baseline schedule. The contracts also reference AACE standards rather than identify specific requirements; however, there is a potential for confusion regarding OPG's exact requirements, as not all sections of these AACE standards are applicable and these standards are intended to be used as guidelines in the first place not requirements or obligations that OPG can enforce as the per OPG's Schedule Plan. OPG should consider revisiting its scheduling requirements for the contractors and clearly spell those out in all (current and future) contracts so that these standards are understood and dispositioned upfront and not held over for later mutual agreement.

- OPG's ability to obtain a sufficiently detailed Level 3 schedule from each contractor will depend on the amount of oversight the OPG team applies at a very early stage of development. As an example, the RFR contract requires SNC/Aecon and OPG to have a meeting of the minds on the schedule before it is accepted. OPG will have to similarly engage each contractor and police the schedule updates to ensure none are using techniques that could give OPG's management a false read of the Project's progress.
- As noted, OPG plans to limit the transparency of an integrated schedule in order to manage contractor float. While we recognize the importance of an owner maintaining proper float management when multiple prime contractors are working side-by-side, we do not believe that this is a sufficient reason for not having a fully integrated Level 3 schedule tool for coordinating and controlling the work. As an example, OPG will not be able to hold a "Plan of the Day" meeting with all contractors present because OPG intends to restrict viewing of the overall schedule. Moreover, to the extent that there are touch points between the contractors, and there will be many, OPG will have a difficult management task of communicating separately and individually with each party – even the best in the industry avoid this scenario. In our experience, limiting the transparency of the schedule risks the value of the schedule as an essential planning and communication tool needed to hold the contractors accountable.
- The level of resources OPG needs to maintain the C&C Schedule may be significantly underestimated. Our concern is that OPG will be utilizing resources in summarizing the detailed schedule that would be better focused on vetting of the contractors' schedule input.
- In the event a Project delay occurs in one of the eight bundles requiring a delay mitigation analysis, such analysis would need to use the Level 3 Detailed Schedule. However, if the Level 3 Schedule is not updated with interface logic, such an analysis would prove problematic at best. It would be very difficult if not impossible to perform an effective and convincing delay analysis using the Level 2 Summary Schedule, which was not developed by the contractors but is an owner controlled and developed document, all for the purposes to prove or disprove a delay claim.

In summary, BMcD/Modus sees significant risks associated with the plan for tracking the schedule using the currently adopted process, and we are skeptical that the end-product OPG intends to create will be a useful tool, let alone offset these potential risks.

d. Summary of Recommendations—Schedule

Based on the above observations, BMcD/Modus recommends the Project Team consider the following path forward with respect to the schedule:

- OPG's Project Controls team should continue populating the Level 2 C&C Schedule in the same manner with each Project Bundle submitting progressively more detailed Level 3 Schedules through RQE;
- OPG's Project Controls team should develop distinct rules for contractors to follow in the development of their level 3 schedules and have these rules clearly imbedded in all of the contracts;
- Continue using the C&C Schedule as a planning tool and as a tool for OPG management to measure the DR Project's status, critical path, and forecasted completion dates, through the current phase of project development until the Level 3 Detailed Schedule is completed;
- Continue developing the touch-points and milestones at Level 2 as the basis for the planning process;

- Once the detailed Level 3 schedule inputs from the contractors are sufficiently mature, OPG should revisit the issue of integrating the schedules from each Project Bundle into a single CPM network using the Level 3 Detailed Schedule;
- OPG should vet the internal resource requirement and model the amount of such that it will need for tracking and managing the schedule under both scenarios. The upcoming 2014 Business Planning review will be important for establishing the level of effort and resources needed for schedule development and maintenance; and
- OPG may choose to continue updating of the C&C Schedule, both as an interim Level 2 Schedule and as tool for OPG management to measure the Project's status, critical path, and forecasted completion dates if doing so provides OPG's management with a useful tool.

In summary, we are of the view that OPG is needlessly exposing itself to extra time, cost and management difficulties in proceeding along its contemplated course of scheduling after RQE. In this deviation from widespread industry practice, we doubt that the action will result in the Project Control tool necessary for tracking the work during the Execution Phase of the DR Project. We recommend that OPG consider developing a fully integrated level 3 schedule using progressive elaboration of the detail as the contractors' plans mature and automatically roll-up of the level 3 detail to the level 2 and summary schedules for management and reporting.

3. Budget Process and Status

a. Processes and Methodology for Cost Management

BMcD/Modus has reviewed the primary processes, procedures, manuals and guidelines for budgeting and cost controls and found that the intent of these processes to generally comport with industry standards. However, the DR Team should review these documents for consistency and integration. The following summarizes our review of the more significant concerns related to the DR Project's cost control processes.

i. Contingency

On June 26, 2013, the DR Team issued a "major" revision to its Contingency Development and Management Guide.[41] The revision was issued as work was starting on the 2014 Business Plan Business Plan estimate so that proper guidance could be provided to the Project Teams in developing each of their contingencies. According to the DR Team, Contingency Development and Management should be guided by the following principles:

a) Uncertainty and risks in projects is a certainty – project managers are expected to identify discrete risks and be provided with the budgets to manage risks.

b) There should be at least two classifications of funds to manage executive expectations, uncertainty and risks: One to manage identified and documented "known unknowns", and one to manage "unknown unknowns".

c) Risk management must be a living and iterative process requiring frequent monitoring and control as project circumstances are always changing

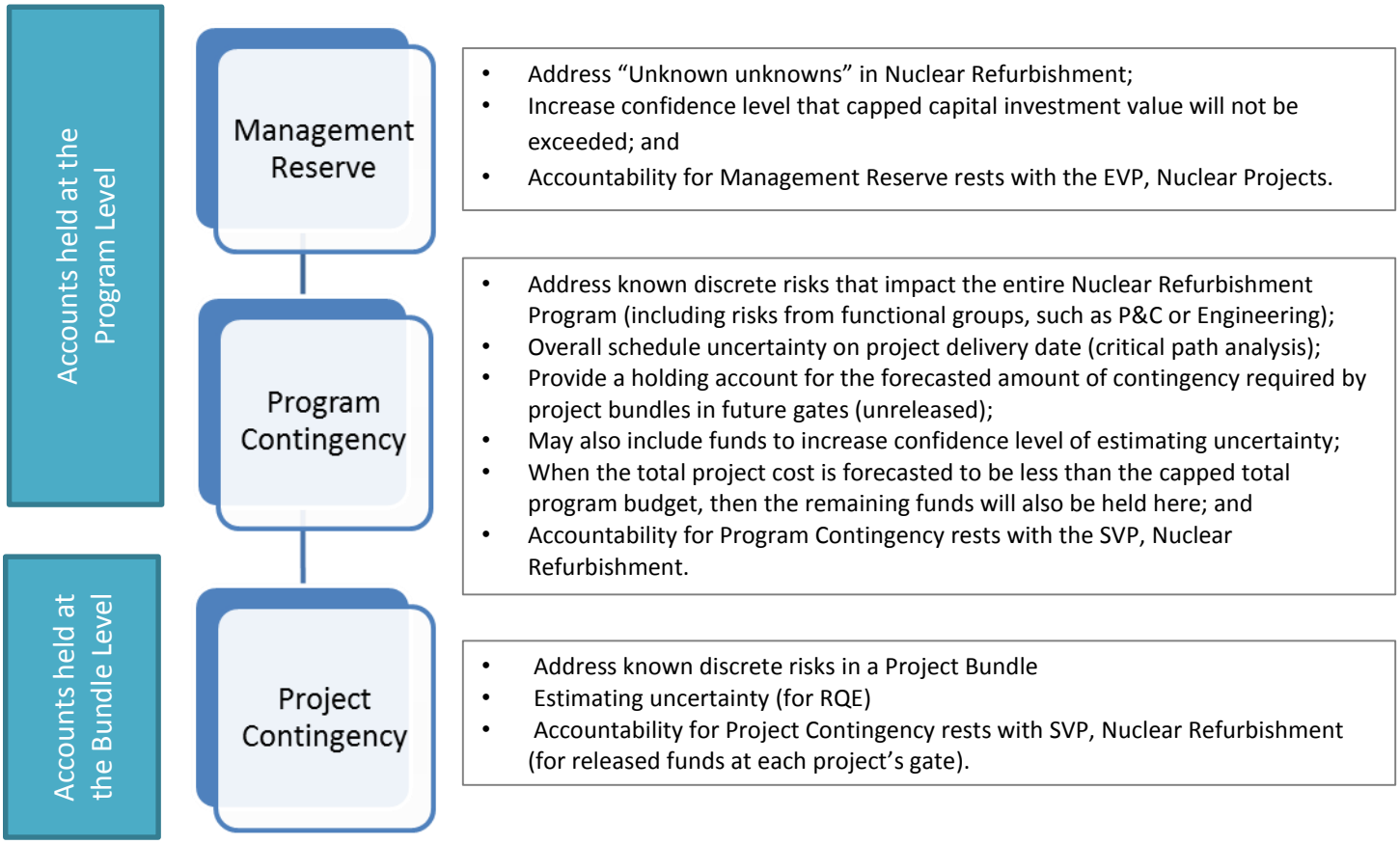
[41] Nuclear Refurbishment – Contingency Development and Management Guide, N-MAN-00120-10001 Risk-05 R001 (June 26, 2013).

d) Contingency development should be based on a justifiable risks, properly documented and determined using an approved process

e) Contingency usage must be justifiable, properly documented, and requested via an approved process that allows for proper reviews and levels of approval

f) Contingency or Management Reserve approvers must understand the impact of this usage on the remaining risks on the Project and as well on the overall program.[42]

Based upon these principles, the DR Team has established three contingency pools from which contingency funds may be drawn: 1) Project Contingency; 2) Program Contingency; and 3) Management Reserve. Below is an illustration of the purpose, scope and accountability for each type of contingency:



In determining the appropriate amount of contingency, the guideline recommends the use of a probabilistic approach, or Monte Carlo simulation method, which is the industry standard for mega projects. However, a probabilistic approach depends upon the organization having a comprehensive and reliable risk assessment and risk management program. As a result, the quality and effectiveness of OPG's Risk Management Program is very important for overall cost control.

As we will discuss in more detail below, based upon our review of the operative procedures and guidelines as well as interviews with the Project Managers and the Risk Section Manager, the Risk Management Program is

[42] Gary Rose, "Strategic Direction for Nuclear Refurbishment Contingency Development and Management" (undated).

comprehensive and well within industry standard. However, we have concerns regarding its execution, including risk identification and the updating, scoring, maintenance and management of the risk register, all of which need to be closely integrated. Making OPG's risk register the foundation of the Project contingency analysis potentially transfers quantifying risk and the exercise of estimating contingency not only away from the cost estimating function, but from the contractor to the owner. As yet, we have not had a chance to fully review how the items in the risk register are monetized and how contingency is actually calculated; the opportunity to do so will come with our vetting of the 2014 Business Plan budget process.

ii. Gate Review Process

The Gate Review process is intended to ensure that all work is rigorously defined and adequately vetted at a series of gates which correspond to relative maturity of that sub-project.[43] The ultimate goal, as described by the DR Team, is for all work to meet the standards of Gate 3 prior to approval of funding for execution; further, that all work on the DR Project will be at the requisite level for Gate 3 approval by the RQE date.[44]

Based on our review of the estimating, contingency and gate review processes, the Gate Reviews appears to be adequate for use if all associated paradigms are identified and adhered to. As an example, the Gate Review Board has continuously rejected the Gate 2 submission from the Turbine Generator Team for its lack of completeness and failure to meet the Project's standards. We would recommend RPET to use this as a living example for holding the DR Team accountable as the requirements of the gate reviews increase and more projects will be advancing to Gate 3.

The Gate Review process is consistent with that seen in the industry at large. Nonetheless, as noted in this report, BMcD/Modus has particular concerns regarding the BOP scope's readiness for Gate 3 by October 2015. This has less to do with the gate process than the current schedule and pace of scope definition evident within the BOP work.

iii. Cost Management and Project Reporting

The implementation of Proliance, which the DR Team intends to be the primary tool for reporting earned value, has been delayed and is currently only in the embryonic stages of its development. As a result, we have not yet been able to evaluate it as an effective project tool. Only one Project Bundle RFR, has an earned value process that is up and running and system bugs are still being worked out. Three other projects—BOP, Defuelling, and Turbine Generator—have reportedly been readied for import into the earned value system. However, there is evidence that the Turbine Generator team is not on board with or committed to the earned value process or, more basically, even to Proliance.

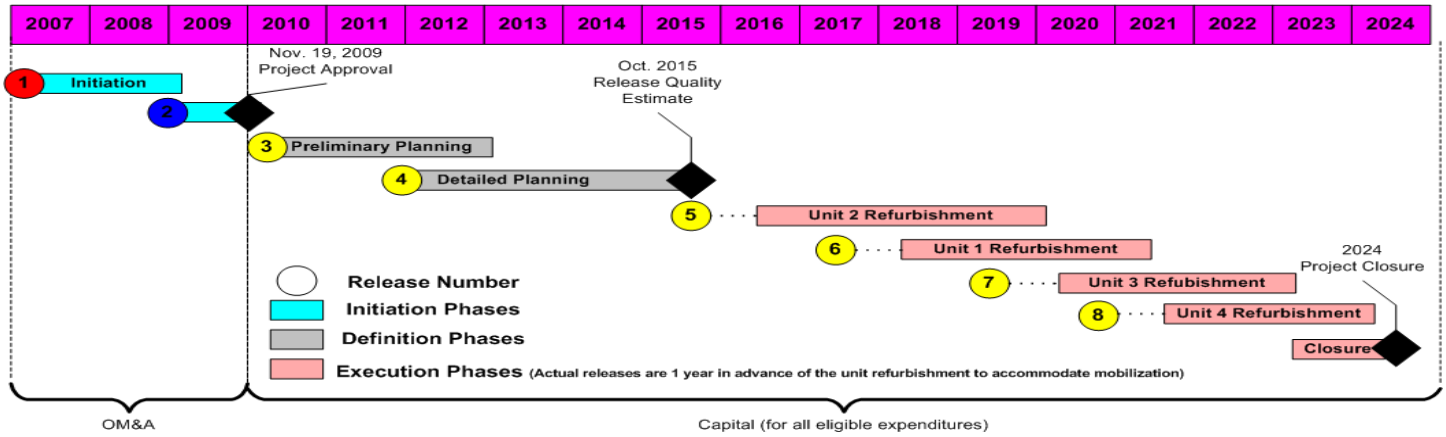
It should also be noted that based on our industry experience with clients employing similar systems to Proliance, it will most likely take months or quarters to get the earned value system up, running and purged of reporting noise. Therefore, it could be some time before OPG receives any meaningful data out of Proliance.

b. Review of 2013 Business Plan

The current DR Project cost estimate is in the form of the 2013 Business Plan which the DR Team presented to the BOD for approval in the 4th Quarter of 2012. This Business Plan was the most recent in a series of yearly

[43] Nuclear Projects Gated Process, N-MAN-00120-10001-GRB-R000 (November 28, 2012).
[44] Darlington Program Update, February 27, 2013, at p. 71.

funding requests, the purpose of which is to provide the Board with an update on the status on the DR Project and to request approval of the revised overall release strategy and funding to proceed to Detailed Planning within the Definition Phase of the Project as identified below:



This release strategy provides the BOD with built-in "off ramps" in the event the DR Project's economics cannot be supported, and requires the DR Team to provide the BOD with yearly requests for Definition Phase funding.

The base assumptions embedded in the 2013 Business Plan are as follows[45]:

- First unit Refurbishment Start date – October 2016
- Duration of Refurbishment (4 units) – 36 months each, 88 months total
- Estimate shown is in overnight $2012M (excluding interest and escalation)
- Estimate is based on scope approved by the Scope Review Board, contractor cost, and OPG costs
- As contracts are awarded and contractor estimates are refined, the Project estimate is updated
- Contingency is based on an assessment of cost estimate uncertainty (price, quantity, productivity) as well as an assessment of discrete project risks
- Refurbishment will perform oversight of EPC vendors and will operate the unit during the refurbishment period.

The Project Bundle estimates underlying the 2013 Business Plan (exclusive of BOP) were characterized as Class 5, and there is evidence of scope (and scope bucketing) uncertainty in the comments adjoining the estimate's line items. The estimates for the Functional Groups were drawn from high-to-medium level staffing plans for each of these groups. As noted in the earlier discussion of Scope, the Functional Groups' plans changed from the 2012 to the 2013 Business Plan, reflecting a larger Execution Team with greater External Oversight, Project Controls and Engineering costs[46].

[45] *Id*. at p. 18.
[46] Id. at p. 17.

c. 2014 Business Plan

i. Revised Planning Assumptions

On June 4, 2013 OPG's Senior Management determined that the DR Team needed to analyze for planning purposes a potential alternative schedule scenario in which:

- Unit 2's Execution Phase would begin as originally planned October 2016
- Unit 1's Execution Phase would begin after the commencement of Unit 2
- Units 1, 3 and 4 construction would overlap by 19 and 17 months
- The total Refurbishment Project window would be 108 months

The drivers behind this new set of planning assumptions include reducing the complexity and risk of performance in as many ways as reasonable and allowing OPG to fully integrate lessons learned from the first Unit into the execution of the remaining Units. As of the time of this Report, the DR Team is engaged in its 2014 Business Plan review in which the team plans to reflect the result of this evaluation. It is our understanding that this work will continue into the 3rd Quarter of 2013 and culminate in a recommendation to the BOD to be presented during the October 2013 BOD meeting. We will continue to monitor this effort to its conclusion.

BMcD/Modus recommends the following in tandem and/or support of this decision:

- When presenting information to the BOD, OPG management must adequately document, present and otherwise explain the nature of its cost estimates and appropriately characterize the same before the BOD, all in a transparent manner. The BOD would benefit from the DR Team developing new and meaningful metrics that trace and meaningfully report on scope, cost and planning variances going-forward.
- It is our understanding that the DR Team intends to segregate the estimated variances in the 2014 Business Plan estimate that were caused by scope increase/decrease from those emanating from the revised planning assumptions. This will be helpful but the Project Teams and Functional groups must be supportive.
- In keeping with the revised planning assumptions, the DR Team is training a critical eye on BOP scope. As discussed elsewhere in this Report, the DR Team should examine a different project delivery method than originally planned in order to optimize the BOP schedule, in particular the schedule for developing detailed engineering and construction work packages that will form the basis of Class 2 estimates needed for RQE.
- It is likely that if approved, the revised planning assumptions will result in some commercial reworking of the JV Agreement with SNC/Aecon. If Unit 2 is performed as a stand-alone without overlap, there will be some budgetary puts and takes that will likely impact the target price. BMcD/Modus recommends that OPG use this opportunity to consider amending the JV Agreement to incorporate other changes that could result in greater transparency, cooperation and risk reduction in the RFR project.

ii. Basis of Estimate

BMcD/Modus has sampled some of the preliminary materials that are currently being assembled in support of the 2014 Business Plan reviews. Based on this in-flight review, it appears that the vast majority (64%) of the individual estimates that will make-up the 2014 Business Plan are still characterized as Class 5, while 19% are at Class 4 including RFR, which we discuss in detail in the related section. Seventeen percent (17%) of the DSRs have not been estimated to date. Based on this information, it would not appear that the level of maturity has greatly increased from the 2013 Business Plan to the 2014 Business Plan.

iii. Process

The 2014 Business Plan assessment will not be a full re-examination of the DR Project's underlying cost estimates. While at this stage, given the DR Project's overall maturity, this refresh of costs is appropriate, we nevertheless recommend that the DR Team engage in more rigorous effort in connection with next year's 2015 Business Plan cost assessment as a pre-cursor to release of the RQE. Because of the expected leap in clarity in regard to project definition over the next several months, the DR Team should be tasked with considerably narrowing the uncertainty cost band around project cost – there is no reason to delay this to the timing of the of the RQE release.

d. Recommendations—Estimating and Budgeting

In summary, while the DR Team has made reasonably good strides toward establishing cost controls and driving compliance and accountability from a process perspective, there are some areas (scope definition, contingency development and management) where improvements can be made. The following are selected recommendations in this regard:

- The DR Project's estimating process needs to more closely adhere to AACE guidelines, and do so with greater uniformity. Since RFR is the test case for the other project cost estimates, the team needs to ensure that adequate vetting of the RFR estimate is accomplished as the cost estimate moves toward the RFR Class 3.
- The Risk Register needs to be streamlined and otherwise vetted including how and why some categories of risks are translated into contingency.
- Estimating and risk management functions need to be better aligned with regard to deriving contingency.
- Proliance needs to be implemented as soon as possible to ensure the cost and schedule management systems and reporting are aligned and in sync. This is critical to ensure data fidelity as the bundles move through the gate review process and move toward RQE and execution.
- The number, mapping and consistency of the various cost control processes and procedures should be reviewed by the DR Team, with an eye toward simplifying and streamlining such procedures.

In developing and characterizing its cost estimates and contingency, management reserves and allowances, OPG needs to adhere to unified and consistent definitions. In the absence of clarity, the organization will almost certainly continue to use the terms in interchangeable manners and thus run afoul of good practice. OPG has chosen AACE for reference guidelines and it needs to align to them in all cases, both internally and in contractor operations. As we discuss in the section related to RFR, inconsistent application of processes can

lead to unnecessary confusion and thus a misunderstanding at the management level with respect to the rigor behind the cost estimates presented to it.

4. Risk Management/Lessons Learned/OPEX/AIDA

a. Status of the Programs

The DR Team has established its Risk Management Program which is generally consistent with those commonly encountered on other projects and complies with published literature such as the Project Management Book of Knowledge ("PMBOK")[47]. The Risk Management Program focuses on the key elements of: (1) Risk identification; (2) Likelihood of Occurrence; (3) Impact; (4) Mitigation and (5) Monitoring. To date, the DR Team has focused on the following activities:

- Developing written procedures[48] derived from corporate documents[49] and establishing a risk management organization infrastructure;
- Creating a central risk register to assemble and document identified risks, results of assessments, response plans (mitigation activities) and status. The risk register is an Access database called RADAR (**R**isk **A**ssessment **D**atabase and **R**egister), which is maintained by a small Risk Group that is part of the Project Infrastructure section of the Refurbishment Planning and Controls organization;

- Initiating a Risk Oversight Committee ("ROC") comprised of RPET and various subject-matter experts that meets at least quarterly to provide oversight of program and project risk management activities.

On a separate path, SNC/Aecon and the OPG RFR Project Team are developing and vetting their own risk register as part of the RFR estimating process. Development of this RFR risk register is required under the specific terms of the JV Agreement and is based in large part on the OPEX and lessons learned from prior refurbishments. It will be used for monetizing a component of SNC/Aecon's target price for the Work.

OPEX and lessons learned are key sources of input for identifying risks within the Risk Management Program. To make full use of the OPEX from past refurbishments, the DR Project has established a formal process and procedure[50] to capture and communicate OPEX and lessons learned that assist in identifying and managing the risks.

In addition to the Risk, OPEX and lessons learned programs, the DR Team also has established a formal program for ensuring that assumptions, actions and decisions associated with the refurbishment are properly

[47] PMBOK is published by the Project Management Institute.
[48] Nuclear Refurbishment Risk Management, N-MAN-00120-10001-RISK-04-R000 (July 25, 2012), Nuclear Projects Risk Management Process, N-MAN-00120-10001-RISK-R001 (November 22, 2012).
[49] Darlington Refurbishment Risk Management Plan NK38-PLAN-09701-10067; Project Risk Management Standard, OPG-STD-0062.
[50] Darlington Refurbishment Lessons Learned And OPEX Management, N-MAN-00120-10001- RISK-06 (July 19, 2012).

assessed and that follow-up actions are documented and managed[51]. This information is collected and recorded in the Assumptions, Issues, Decisions and Actions ("AIDA") database, which is maintained by the Risk Group. The purposes for recording significant assumptions and decisions include: "To Exhibit prudence and oversight in the decision making process and in the validation of key assumptions impacting NR"; and "To maintain an auditable trail for future review and reference."[52]

To mitigate cost and schedule risks, the DR Team has established a Contingency Program[53] which provides for developing contingency from quantitative and qualitative analysis of risks residing in the Risk Registers and in functional area business planning. A more detailed analysis of the Contingency Program is discussed in Section IV.C.2.a.i.

b. Processes and Methodology

The process that the DR Team is using for developing the source data, analysis and presentation of risks is generally consistent with that observed in the industry at large although there are some issues with the quality of the information that DR Team needs to correct. Below we describe the component parts of the Risk Management Program.

i. Risk Scoring Process

The DR Team has populated the Risk Management Program's databases through facilitated brainstorming sessions, individual input and review of OPEX and lessons learned from other projects. The Risk Group aggregates and reports specific risks in individual projects or department RADAR files. High level "global" risks that have the potential to impact the viability of the whole Refurbishment Program are included in a Program Risk Register. Each Program risk is "scored" by assigning a number to reflect the probability of occurrence based upon the following rating system:

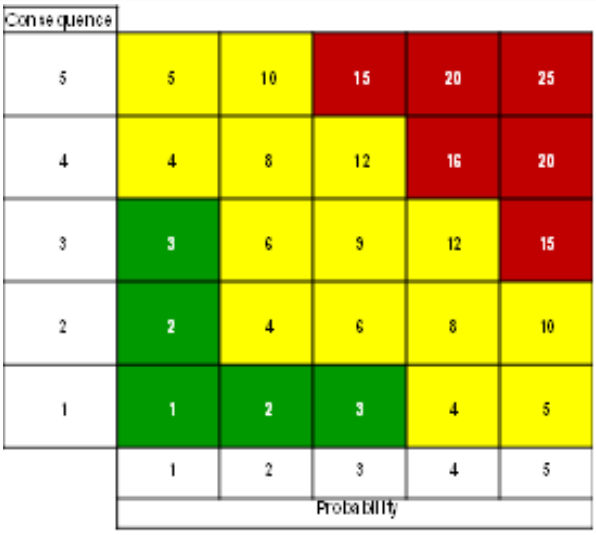
Probability Rating ->	1	2	3	4	5
Qualitative	Improbable	Unlikely	Possible	Likely	Probable
Quantitative	< 10%	10% - 30%	30% - 70%	70% - 90%	>90%

In addition, the consequence of each risk is "scored" relative to its potential impact on cost as depicted in the table below.

Impact Rating ->	1	2	3	4	5
Qualitative	Minimal	Minor	Notable	Substantial	Major
Quantitative (Cost)	< $5M	$5M - $50M	$50M - $200M	$200M - $500M	>$500M

Similar ratings are developed for schedule impact and risk manageability (i.e. ability to mitigate or control the risks). Different rating scales may apply to the individual Project Bundles and Functional groups. The final individual Risk score is determined by multiplying the probability of occurrence by the highest of the impact ratings for cost, schedule or manageability. The "heat map" below is a graphical representation of the probability and impact combinations that yield a risk score. The color coding depicts the severity of the risk relative to likelihood and impact.

[51] Nuclear Refurbishment Assumptions and Decisions Management, N-MAN-00120-10001 RISK-07 (March 5, 2013).
[52] *Id.*
[53] Nuclear Refurbishment – Contingency Development and Management, N-MAN-00120-10001 RISK-05 R001 (June 26, 2012).



EPC contractors supporting the DR Project must also prepare a Risk Management Plan for identifying and managing contractor related risks. Scoring of risks can be somewhat subjective as risk tolerance can vary from person to person. In our review of the various Project risk registers, we have observed wide variances in scoring practices. This may lead to difficulty by the management team to accurately identify and assign the proper amount of contingency necessary to cover these risks.

ii. RADAR and OPEX Databases

The DR Team developed the RADAR database to be the central depository of OPEX and lessons learned from external sources to OPG (e.g. the CANDU Owners Group, Bruce, the Institute for Nuclear Power Operations ("INPO")) or within OPG (e.g. Pickering, Operations & Maintenance, and the DR Project itself). A refurbishment OPEX management database is maintained by the DR Project's Program OPEX Single Point of Contact ("SPOC") in the Refurbishment Planning and Controls Risk Group. The OPEX SPOC gathers and screens OPEX and lessons learned items, enters the information into the database and distributes the new entries to the local departments and projects. Responsible departments and projects then assess applicability and respond to the OPEX SPOC regarding how the item will be addressed. The OPEX SPOC issues a quarterly OPEX/Lessons Learned Summary Report to document quarterly Lessons Learned and actions planned or taken to address significant items.

iii. AIDA Database

The DR Team has established the AIDA database as storehouse of all of the DR Project's major assumptions and decisions. This database is intended to support OPG's future rate proceedings as well as be an adjunct to the plant's configuration management.

All of the DR Project's significant assumptions are supposed to be entered into the AIDA database by submittal of a prescribed form to the DR Project Planning & Controls Risk Group. A similar process is used for significant decisions. However, the decision entry process ("Decision Record and Analysis Summary" – DRAS) requires a benefit-cost analysis and progressive approvals based on the potential impact of the decision. The DR Project Planning & Controls Risk Group is responsible for providing oversight and support throughout the assumption and decision management program. Action items that arise from meetings or individual submittals are entered in the actions database, which is also processed and maintained by the DR Project Planning & Controls

Risk Group. As noted below, the DR Team has not fully updated AIDA, which compromises its overall usefulness for its intended purposes.

c. Summary of Observations

A sound Risk Management Program is critical to the success of a complex project such as the DR Project. The DR Project intends its Risk Management Program to function along such lines. The DR Project's reporting to the BOD and management has been focused on risk identification. While there are good aspects of the DR Project's Risk Management and associated programs, they have not yet been developed to reach their full potential for supporting project objectives. In part, this is due to the maturity level of the DR Project program. A number of the concerns raised herein have been recognized by the DR Project Risk Group and selected action is underway. However, curative actions need attention at this time. The following issues are presented:

- **Risk Identification and Scoring Issues**: Many of the identified risks are really "concerns" stemming from potential inadequate management and thus serve to only clutter the Risk Register – contingency should not be added for poor management, rather, better management should be added. For example, Program Risk No. 300: "The risk is that the Campus Plan schedule may not be fully integrated with the Refurb schedule". Within the industry, the above would only be seen as a risk resulting from poor management, and not an innate work risk. Cluttering the register with false risks is energy consuming and serves no productive purpose. In addition, there is evidence of wide ranging ambiguity and inconsistency in the risk titles and descriptions which leads to uncertainty in understanding the risk that may in turn lead to misplaced mitigations.

  Moreover, the rules that the DR Team are using exhibit a broad range of probability (30% - 70%) and could mask serious differences in likelihood of occurrence scoring. A risk with a probability of 31% is given the same score as one with a probability of 69%. While the risk analysis process in not precise, the opportunity exists to inappropriately score a risk in this broad range.

- **Tools for Risk Management Program**: The software systems used for Risk Management and related programs (i.e. RADAR, AIDA, OPEX) are cumbersome with limited capabilities and do not interface well or cross reference with each other. This limits effectiveness as a management tool and causes inefficient use of personnel time. Efforts by the IT group to improve this critical system are essential at this time.

  There are a number of shortcomings in the various databases that the Risk Group is tasked with maintaining. For example, the AIDA database is conceptually an excellent tool that should help OPG immeasurably in future rate proceedings. However, our pulsing of AIDA's content identified a number of significant gaps in the information that has been stored within the database. In addition, we noted a number of entries of questionable value (e.g. numerous entries state "the assumption is that identified criteria with regards to (an event) will be met"). Also, many of the entries border on events that should be considered "risks;" however, there is no indication that a corresponding risk was created in the Risk Register.

  The OPEX and Lessons Learned program is good, but the OPEX database is not fully integrated with RADAR and AIDA database. This disconnect could cause important OPEX and lessons learned issues to be lost or ineffectively tracked. The DR Project Risk Group's plan for creating an integrated, user friendly and accessible system will remedy this.

- **Opportunities**: A good Risk Management Program also attempts to identify "opportunities" and provide for a proactive response to improve the likelihood of the "opportunity" occurring. No such opportunities have been observed in the DR Project RM Program, suggesting that latent opportunities may be out there.
- **Contingency**: The DR Team is currently implementing a revised contingency process. However, properly implementing and managing the program will be a challenge, considering the above concerns regarding resources in the DR Project Risk Group, training, risk definition ambiguity and RADAR database capabilities. Performing stochastic analyses to calculate contingency is appropriate. However, it is a complex process that could yield inconsistent results. The issues identified herein need resolution in order for the stochastic modeling that will form contingency recommendations to be accurate and consistent.
- **Lack of Metrics**: The Risk Management and associated programs have a less than desirable number of meaningful metrics to provide management with a sense of the maturity or fidelity of the underlying the data and the DR Project's performance.
- **Staffing and Leadership:** The Refurbishment Planning and Controls Risk Group is lean and staffed with capable but relatively inexperienced individuals - several staff are Co-ops or interns. The DR Project's philosophy appears to be for the individual projects and departments to perform the majority of Risk Management duties and related work, while the central Risk Group serves only an administrative, support and oversight role. This creates a condition that at the end of the day, risk management is viewed as a collateral duty of project or department personnel which dilutes and diminishes the attention focused on risk management efforts, given other duties of such entities. A recent self-assessment of the DR Project Risk Management program concluded that *"Darlington lacks the resources to achieve the desired dynamic risk culture"*. Despite that conclusion, the accompanying recommendation advocates no curative action.

  In a related note, training for Risk Management and related programs is occurring in an ad hoc manner, and the resultant issues addressed in this report reflect its ineffectiveness.

d. BMcD/Modus Recommendations—Risk Management Program

Based on the above observations, BMcD/Modus recommends that the Project Team consider the following with respect to the Risk Management and associated programs:

- ***Provide Direction on Risk Scoring and Evaluation***: The DR Team should decide whether all Risk Registers "concerns" that rely on existing management processes should be considered innate "risks" with associated analyses, mitigation actions and tracking. The team should also consider whether the definition of risk should include a phrase such as: "…for which there is no management structure of process to address". The team should vet all DR Project's Risk Registers and identify those entries which fail to rise to the level of a true risk and consider removing such items as appropriate by closing the risk or transferring it to an action item list.

  The team should seek to eliminate ambiguity in risk descriptions, prepare and distribute a short instruction for responsible risk owners to review and revise their risk descriptions. Alternatively, the team should consider assigning several technical writers to review risk descriptions and interface with the responsible risk owners to clarify the descriptions. Also, to avoid inconsistencies and to preclude "gaming", contingency derivations should be performed across all areas by a qualified centralized

group with adequate resources and detailed procedural requirements. Finally, the team should consider revising probability scoring to include specific points rather than ranges (e.g. 10%, 30%, 50%, 70% and 90%).

- ***Address Leadership Issues***: Many of the concerns raised in this section of the report would likely be addressed by appointing or hiring a strong, experienced, and assertive central Risk Program Coordinator with an established track record of success, endorsed by senior management. The risk manager should have well-defined responsibilities (e.g. oversee RM, OPEX, AIDA activities on a day-to-day basis, proactively advocate the documentation of decisions, assumptions, lessons learned, etc., eliminate ambiguity and inaccuracies of database entries, facilitate consistency in risk analysis/scoring and in contingency development, conduct training, etc.). Also, the DR Team should consider performing a staffing analysis to ensure that the Risk Group is right-sized with the appropriate skill sets.

  OPG should also consider elevating the Risk Group in the DR Project organization to give it more stature and to demonstrate that senior management considers Risk Management, OPEX Management, Decision and Assumption Programs to be serious and extremely important elements of a successful Nuclear Refurbishment.

- ***Expedite the IT organization's efforts with the Various Databases:*** The DR Project needs IT support to develop the needed Risk/OPEX/AIDA software systems pursuant to the recommendations of the Risk Group.

- ***Address AIDA Database Gaps:*** The DR Team should clearly define the requirements of the AIDA Database, review the existing database for conformance with such requirements, and revise the database as required.

- ***Training Gaps***: The DR Team should consider developing and executing a comprehensive Risk, OPEX and AIDA training program. This training would foster an understanding and acceptance of the importance of these programs, stimulate proactive participation and encourage the identification of opportunities in the Risk Registers. Once effective training is initiated, consideration should be given to establishing an internal communication program to keep people informed and to sustain appropriate employee interest and participation.

- ***Metrics and Trend Charts:*** The DR Team should review (and develop or re-develop) appropriate metrics to effectively track various elements of the risk management program.

V. Major Project Bundles

A. Retube and Feeder Replacement

The DR Project's largest single cost component is the Retube and Feeder Replacement ("RFR") project, which comprises the Project's critical path and represents the largest risk to the Project's overall execution. OPG is the fourth utility to perform a mid-life refurbishment of CANDU reactors, and all of the prior unit refurbishments have experienced a number of significant delays, cost overruns and/or performance issues. Thus, understanding the risks and lessons learned from these prior projects is an essential part of developing the RFR cost estimates.

The RFR project is organized into three phases:

(1) Definition Phase: pre-outage work beginning February 1, 2012 and to be completed before the first plant outage in 2016. It also includes the development of specialized tooling and the design and construction of a reactor mock-up for training purposes, prior to refurbishment.

(2) Execution Phase: actual specialized fieldwork associated with each of the station's four reactors, including the removal and replacement of 480 pressure tubes, calandria tubes, 960 end fittings; and 960 feeder pipes the reactor components and includes training and tool maintenance for each of the four DNGS units; and

(3) *Commissioning Phase*: plant commissioning and support as required and directed by OPG.

On March 1, 2012, OPG awarded the RFR contract to SNC/ Aecon (the "JV Agreement"). The JV Agreement is for the Definition Phase of the RFR Project that will be performed from 2013 to mid-2016. The current value of the SNL/Aecon contract is estimated at over $600 million. Once the Definition Phase is completed, OPG and SNC/Aecon will determine the cost to complete the Execution and Commissioning Phase work and if such cost is acceptable, OPG will award the remaining contract work for the Execution Phase.

1. RFR Cost Estimates

The JV Agreement requires SNC/Aecon to develop a series of progressive cost estimates based on AACE *cost estimate Classification System* for the Execution Phase. Per the JV Agreement, the timeline for developing and submitting the progressive cost estimates spans a period of about three years beginning on August 1, 2012. Submission of each progressively classed cost estimate (i.e., Class 4, 3 and 2) is contractually due on June 15 of each year, starting in 2013. The final Class 2 Estimate is intended to form the basis of SNC/Aecon's Parget Price for the Execution Phase.

The intent for the progressively classed cost estimates is to absorb all lessons learned through mining-out OPEX along with other information developed during the Project's Definition Phase, all as it becomes available, validated and approved by OPG. The JV Agreement established as part of this progression of estimates a process whereby the successive classes of estimates proceeding to the final Class 2 Estimate specifically exclude consideration of contingency. The JV Agreement at 3.5 states, "Every Execution Phase cost estimate prepared in accordance with this Agreement will not include any contingency amount." However, the JV Agreement also states that the estimates at every level will follow AACE guidelines, and those guidelines include calculation of contingency.

The parties' intent in the JV Agreement is to use the risk register to help develop and manage the Target Cost. OPG and SNC/Aecon will mutually determine and agree on the risks to be included on the risk register. [redacted]

Nonetheless, as with all cost estimates for the DR Project, as the knowledge that forms the basis of the estimate matures, the RFR Team must present the resulting revised estimate under the DR Project's Gate Process. The intent of this process is to ensure that all important aspects of the estimate under scrutiny have been adequately vetted before proceeding further.

2. BMcD/Modus Review of RFR Cost Estimates

BMcD/Modus has examined the two RFR estimates to date to evaluate: (1) the efficacy of the vetting process for the DR Project's most significant scope of work; (2) the status of the RFR's estimate and how it should viewed by OPG's Management; and, (3) draw broader conclusions regarding the methodology the DR Team has established for review, vetting and challenging estimates in general. To more fully understand the methodology and procedures used for development of the Class 5 and Class 4 Estimates, BMcD/Modus has met with the key members of the OPG RFR estimating team.

In conjunction with its oversight responsibilities, BMcD/Modus has reviewed various OPG's procedural and process documents, certain PowerPoint presentations and the cost estimates. A list of these documents appears in Exhibit A.

a. Basis of Estimate – Class 5

SNC/Aecon's Class 5 Estimate was initially submitted on August 1, 2012 in accordance with its Project Estimating Plan.[54] [redacted]

As identified in the Estimating Plan, which reflects the current understanding between the parties for the development of the estimates, the root causes of the disconnect between SNC/Aecon and OPG were:

- The detailed basis of estimate were not agreed upon before SNC/Aecon started;
- The original Estimating Plan was too high level;
- [redacted] the basis for OPG's intended estimating process;
- [redacted]
- Inadequate and untimely collaboration over details in the estimate.[55]

The remedy for these early process failures was the parties agreed that "schedule and estimate [for the successive estimating packages] to be prepared as ***ideal without risks, contingency & factors per the Agreement***."[56] The basis for the next iteration of the Class 5 Estimate was a Process Flow Diagram ("PFD") that was derived entirely from OPEX and largely from Wolsong, which was then reviewed and monetized based on the associated level of effort. "In the Class 5 Estimate the critical path activity durations were established on adjusted OPEX durations, based on a percentage average adjustment representing 'ideal' productivity for all [Direct Field Labor or "DFL"] activities equally applied, without contingencies or allowances."[57] The only adjustments to the DFL categories were to adjust the size, scale and to some extent the work rules that represented the difference between Wolsong and Darlington at a very high level.

SNC/Aecon submitted the revised Class 5 Estimate on December 21, 2012. The revised Class 5 was [redacted] Within the industry, the approved Class 5 Estimate would be considered appropriate in defining the reference

[54] DNGS RFR Project—Project Estimating Plan 509407-0000-00000-33IM-0001 R3 (March 21, 2013).
[55] *Id.* at p. 18.
[56] *Id.*
[57] *Id.* at p. 17.

plant for an estimate of this type. The modifications to the process produced what was intended by the JV Agreement—a jumping off point for estimating this work, based on OPEX and in consideration of process improvements that should come from the repetitive nature of this work.

b. Basis of Cost Estimate – Class 4

The goal for the Class 4 Estimate was for SNC/Aecon to state and OPG to validate the primary costs consisting of vault DFL and the Owner Specified Materials ("OSM"). SNC/Aecon presented an estimate based on "individual OPEX validations" with "100% of all DFL activities on the PFD critical path series. . .analyzed and validated assuming ideal productivity without contingencies or allowances for unforeseen disruptions."[58] In other words, the Class 4 Estimate was intended to be a validated, perfect-world reference plant with all risks wrung-out. Each DFL activity on the Project's critical path for the Class 4 Estimate was individually validated, as opposed to the Class 5 Estimate procedure wherein only an average adjustment factor was used, based on OPEX sampling. The vetting of the above described activities was memorialized in specific estimating reports called *Mini-Estimate Reports*.

As stated, each of the Class 5 and Class 4 Estimates utilized information from previous OPG projects (OPEX), *looking backwards*. The primary outside referenced project used for the Basis of Estimate ("BOE") was Wolsong Unit 1 (2009-2011) OPEX. Below are select estimate considerations:

- OPEX information has been adjusted for quantities and assumed optimum shift work hours and other patterns.
- In the estimate, all work is deemed executed under *ideal* conditions and thus actual *poor productivity* has been excised (based on a review of OPEX information).
- All contingencies and risks have been removed from the estimate.
- OPEX data from the Bruce Restart project and Point Lepreau has been used, as appropriate, when no other data is available.
- OPEX information has been adjusted to reflect existing Ontario Labor Agreements.
- Generally, DFL parallel path activities (i.e., non-critical) have not been robustly re-assessed but have been minimally reviewed so as to determine if they have *gone critical* as a result of CP duration changes made when moving to Class 4 from Class 3.
- Percentage allocation for support services, training and Project Management Team ("PMT") labor have been carried forward based on the Class 5 Estimate.

Utilization of the above methodology has resulted in a project estimate modeled under *best theoretical* performance conditions. However, the Class 4 Estimate was essentially devoid of more refined cost estimates specifically for Darlington that include productivity factors and contingency identification.

[58] *Id.*

c. BMcD/Modus's Analysis of SNC/Aecon's Cost Estimates

i. Cost Estimate Variance Analysis

The monetary changes noted from the approved Class 5 to Class 4 Estimate were minor: these variances total [redacted] or [redacted] growth from the Class 5 Estimate amount. The most significant difference from Class 5 to Class 4 Estimate were changes to the work day ("WD") durations for critical path work activities in the vault, as summarized below in Table A:

Table A - Critical Path Summary and Variance

Vault Summary Series	Class 5 Durations (WD)	Class 4 Durations (WD)	Variance (WD)	Basis for Variance
Pre-Requirements	32	92	60	40 WDs added to SNC/Aecon schedule for bulkhead installation; 6 WDs added for PHT work; 14 WDs reconciliation of critical path
Feeder Removal	44	55	11	13 WD added for one parallel task (Feeder Cabinet Removal) changed to critical path; 3 WD added for a new critical path task - Feeder Monorail; -5 WD deleted for reduction of Feeder Removal activity.
Fuel Channel Removal	219	223.5	4.5	Re-evaluation of OPEX related to critical path activities.
Inspection	75	82	7	Re-evaluation of OPEX related to critical path activities
Feeder Installation	97	79	-18	Re-evaluation of OPEX related to critical path activities
Fuel Channel Installation	138	138	0	No changes
Post-Requirements	18	63	45	20 WD added due to the addition of bulkhead removal. 26 WD added due to new execution strategies for four critical activities. -1 WD reduced due to re-evaluation of OPEX related to critical path activities.
TOTAL	623	732.5	109.5	

From a cost perspective, the impacts of these revisions were as follows:

- Bulkhead activities and associated cost in both the Pre-Requirement phase and Post-Requirement phase are now included in Class 4 Estimate whereas these costs were not included as scope in the Class 5 cost estimate ([redacted] or [redacted]). OPG has shifted this scope from the Islanding Project to RFR, and thus does not represent a major impact to the overall DR Project's budget.
- Escalation to 2013 dollars is included in the Class 4 Estimate ([redacted] or [redacted]) per the JV Agreement.
- Other miscellaneous changes ([redacted] or [redacted]):
  - OSM decreased based on actual vendor feedback and quotations.
  - Feeder installation duration/hours were significantly reduced as a result of more detailed analysis when compared to the Class 5 Estimate.
  - Tool decontamination and packaging increased in Class 4 level
  - Non-Destructive Examination, Phased Array Testing and Shielding scope was added to the Class 5 Estimate.
  - Letter of Credit costs increased due to a calculation error in the Class 5 Estimate.

The relatively minor change to the cost estimate from Class 5 to Class 4 reflects the parties' goal to perform "100% validation" of the critical path PFD activities that are the foundation of the estimate. It is not clear as to why this work was deferred to the Class 4 Estimate, and the production of the estimates one-after-the-other indicates that this was a continuous effort that may not have justified two separate deliverables or classifications. The variance between the estimates is not reflective of any real increased level of project definition, at least according to AACE Recommended Practices. The most significant change between the two estimates, the bulkhead scope [redacted], was a part of the DR Project, but the scope was shifted to SNC/Aecon after release of the Class 5 Estimate.

BMcD/Modus does not question that SNC/Aecon's estimate is nevertheless better as a result of this validation. However, both OPG and SNC/Aecon should seek to define and classify future estimates with greater precision and traceability to the established processes for the DR Project. If the parties proceed as anticipated in the JV Agreement, this issue will be cured with the Class 3 Estimate, which will be premised more on the specific definition of SNC/Aecon's DR Project Execution Plan and less on the theoretical model that is the heart of the Class 4 Estimate.

ii. Estimate Quality Assurance

The Class 4 Estimate was developed in accordance with SNC/Aecon's Project Quality Assurance Plan. The OPG Estimate Quality Assurance process includes selection of qualified estimating team members who have hands-on experience with CANDU RFR refurbishment beyond available OPEX information. From our review, it appears that the team included or otherwise drew upon Subject Matter Experts with relevant expertise for the purposes of consulting with and advising the OPG estimators. Another level of oversight was provided by SNC/Aecon's Review Team for the purposes of validation of OPEX information and also to ensure complete in-depth scope coverage in the estimates. The cost estimate was also reviewed by a cold-eye Peer Review Team to catch any errors or omissions that SNC/Aecon's Team members may have over looked.

In our view, the OPG cost estimate team exhibits a reasonable composition of talents including experience mix. However, as is true with most nuclear refurbishments, the DR Team will be constantly challenged as the Project progresses.

In order to test the quality of the estimate, BMcD/Modus randomly sampled several line items of cost in the Class 4 Estimate. As a result of this sampling, we found some minor inconsistencies, such that the OPG team should consider assigning a quality resource to scrub estimate sheets for errant inclusions or exclusions, as well as perform quality checks on spreadsheet formulae and the like so as to end up with the most reliable work product reasonable. This is industry best practice particularly on projects involving repetitive work.

iii. Observations Regarding the RFR Estimates

[redacted]

- ***The development of a "perfect" reference plant comes freighted with ambiguity.*** To the uninformed observer, SNC/Aecon's Class 4 Estimate could appear to represent a model for the best possible

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

outcome (aka optimal performance) for the DR Project. However, the current Class 4 Estimate actually represents a model of "perfect" performance that the DR Team believes is unrealistic to expect in the real world at any location, even perhaps Wolsong. Further, the "reference plant" is actually not Wolsong (which, to date, represents the most successful RFR project from a schedule standpoint) but a modified Wolsong absent approximately 19% of its as-built durations, then scaled-up to match the Darlington parameters. Thus, OPG may well be subject to managing the Project to a wholly unrealistic mile post.

- ***Ultimately, BMcD/Modus recommends that OPG focus on the value derived from the Class 4 Estimates not on whether it meets AACE's definition of a Class 4 Estimate***. The RFR work is different from many major construction scopes whereas the AACE classification is ordinarily applied to work that is largely repetitive and akin to a manufacturing process in which tooling, reliability and assembly-line precision is required. Developing an estimate that summarizes the best possible performance of such an operation has significant value.

OPG should be extremely cautious in regard to characterizing its current estimate as being anything other than *current best efforts toward compliance with the AACE estimate classification scheme*. The current estimate nevertheless has great value and should be viewed as a useful benchmark as OPG progresses to an AACE Class 3 Estimate where the cost estimating work product must shine, no excuses allowed.

d. Class 3 Estimate Progression

The starting point for development of the Class 3 Estimate is the Class 4 Estimate and the Project Estimating Plan. From this point forward, the Class 3 Estimate will be *looking forward* utilizing well-defined Process Flow Diagrams (PFDs), preliminary Construction Work Packages and applicable N-Procedures that are unique to the DR Project and based on SNC/Aecon's view of constructability. This methodology change could result in task-based duration and man-hours variances; indeed, it could result in improvements from greater knowledge and improvements to the tooling that will be tested in the mock-up. The Class 3 estimate's efficacy will determined by the completeness and availability of detail within the design, procurement, mock-up facility and tool testing work efforts, all of which will facilitate progress to the requisite depth and accuracy.

Any developing variances (to the extent existing) will be logged and vetted within the Class 3 Estimate progression cycle. The Class 3 Estimate will be structured as an integrated program to allow for further progression to Class 2 Estimate. OPG expects that the Class 3 Estimate will reflect the SNC/Aecon's estimate of 100% "wrench time" based on the maturation of the DR Project's design and the proving-out of the tool set in the mock-up. SNC/Aecon and OPG will further review certain mitigation strategies and actions to reduce risks in the Execution Phase which will be monetized in the Class 2 Estimate.

As stated previously, the Class 3 Estimate will use the Class 4 Estimate as the basis for further development and some important activities and aspects of that effort will include:

- The establishment and maturation of key inputs that will drive the estimate (e.g., Process Flow Diagrams, Engineering and Construction Work Package development and Risk Register).
- A review of the experience and OPEX during the Class 5 and Class 4 Estimate work effort and adjustment of processes and methodology, as appropriate, for continued development of the Class 3 Estimate.

- Compliance with the next level of AACE estimate-classification-requirements as further underscored by OPG procedural documents.
- Identification of major variances as between the Class 4 and Class 3 Estimates.
- Examination, reassessment and refinement of the Risk Register associated with the Class 3 Estimate.

These steps are anticipated by the JV Agreement and should result in a further-refined estimate.

3. Risk Program and Contingency Development for Target Cost

The Risk Register plays a very important role in the development of the Target Cost for the Execution Phase of the Project. As discussed above, it is not anticipated that the RFR Contractor's Execution Phase estimate will include contingency until submission of the Class 2 Estimate. The contingency amount will be determined using a probabilistic approach based in large part upon identification of risks on the contractor's risk register.

[redacted]

[60] RFR EPC Contract at Exhibit 3.5, Section 14.

SNC/Aecon is progressively refining its Risk Register as the EPC cost estimate progresses through the various AACE estimate classifications. As of May 1, 2013, the Risk Register contained some 329 identified risks. In the further development from Class 5 to Class 4, SNC/Aecon and OPG analyzed 169 (51%) of these initial risks, while 44 (13%) were not analyzed. In addition, the parties agreed to add 116 (31%) additional risks to the register. Of significance, the Risk Register contains non-productive work activities that SNC/Aecon identified from OPEX and stripped from the Reference Plant in Class 4. SNC/Aecon has not fully developed its Risk Register (nor does it have an obligation to do so at this time) to allow OPG to begin vetting the necessary contingency. OPG should consider accelerating the pace at which SNC/Aecon monetizes the Risk Register so that OPG can apply appropriate contingency at the project level sooner than the JV Agreement anticipates.

4. Recommendations – RFR Cost Estimate

Based on our review of the progression of RFR estimates to date and our understanding of the DR Project's next steps, BMcD/Modus has drawn the following conclusions:

- AACE Classifications: Going forward, OPG should seek to clarify the guidelines used for establishing the RFR's BOE which are inconsistent with the terms of the JV Agreement. The primary estimating guidance for SNC/Aecon consists of:
  - AACE Recommended Practice Number 34R-05 - Basis of Estimate with an accuracy band of -30% to +50%.
  - OPG Instruction N-INS-00400-10001 R01 "Estimate Developing"
  - Exhibit 3.5 of the SNC JV Agreement

  However, as defined by the JV Agreement, the Class 3 Estimate will not include contingency of any sort and as a result, the associated AACE accuracy bands will not be applicable. From a process standpoint, OPG should seek to clarify the application and appropriate use of these various standards and guidelines in the Class 3 Estimate so as to avoid potential confusion, inconsistency and communication problems during the next phase of the RFR estimate development.

- Metrics for Estimating Progress: The DR Team should strongly consider implementing meaningful metrics that are simple and user-friendly in order to effectively and realistically monitor progression of SNC/Aecon's Class 4 to Class 3 estimate during the next 12 months. Such metrics can track the progression of the estimate in lock-step with the overall maturation of the RFR project, which will have the associated benefit of providing management with key health indicators. One example would be to measure engineering progress by using planned vs. completed drawings in various categories (e.g., P&IDs) on a monthly basis. Another example might be to use work down curves for Engineering and Construction Work Package development.

- Monetizing SNC/Aecon's Project Management Costs: A major outlying cost to be determined in the Class 3 Estimate is SNC/Aecon's management and overhead costs. In Section 1.1.3 of Appendix D-10 of the Class 4 Estimate, the Specific Cost Estimating Report indicates that the percentage cost add-on for foremen management and supervising foreman management and PMT remained unchanged from the Class 5 Estimate. No new information was presented, such as monetization of an organizational chart to support a progression to a Class 4 Estimate. As SNC/Aecon most likely has historical experience suitable for use in meaningfully quantifying these cost items, the earlier the look at it, the better. With respect to SNC/Aecon's Support Services, in Section 1.1.2 of Appendix D-11, of the Class 4 Estimate, the Specific Cost Estimating Report shows that the percentage cost add-on for Support Services (SS)

remained unchanged from Class 5 Estimate. [redacted]

- RFR Risk Register: Considerable work remains in identifying and monetizing risks in the Risk Register specific to the RFR work.
    - The OPG estimating group should be used as a resource to help vet the monetizing of risks as performed by SNC/Aecon. By comparing the SNC/Aecon's assessments to its own, the OPG team will be better equipped to make informed decisions on the reliability of the SNC/Aecon contingency work product.
    - The Execution Phase Risk Register for the Class 4 Estimate contains 329 identified risks at various levels such as low, medium, high and very high. The list is too long and appears redundant yet will most likely grow with the passage of time. As stated elsewhere, for a project of this complexity and importance, OPG should consider bringing on board an experienced risk manager with a solid construction background so as to best manage the Risk Register.
    - As noted, OPG should consider revisiting the contractual scheme that currently prevents SNC/Aecon from monetizing risks until the creation of the Class 2 Estimate and the target price.

5. RFR Schedule and Plan Optimization

a. RFR Schedule Status

RFR's overall schedule development is significantly ahead of the other Project Bundle Teams, particularly in the evolution of the detailed level 3 schedule. The RFR team is involved daily with SNC/Aecon's detailed schedule and monitors development and update progress against the milestones and level 2 activities weekly. Nonetheless, as noted, there are some issues with the RFR's status in the schedule that need to be addressed, including a number of activities with excessive float (600+ days) though the RFR team believes this float is realistic due to early performance of certain work. In addition, RFR will need to examine multiple activities with 500+ days of duration.

Since RFR is on the critical path, it is good that its schedule is farther ahead so that the bugs can be worked out well in advance. Because this team is so far ahead of the others in the planning and schedule development area, the RFR team has encountered technical schedule formation issues that the other teams have not yet encountered. In some cases, Project Controls has not been made aware of some of these issues and is busy establishing rules and criteria for overall project planning and schedule development. These rules do not always address the problems encountered early by the RFR team and are sometimes contradictory to the direction already chosen by this team. As a result the RFR team has to rework previously developed schedules, formats and/or codes. The most affected area of development thus far has been the summary level 2 schedule for RFR. More attention needs to be given to the RFR schedule team's handling of these issues as they are true indications of future project issues.

Some conflict has developed between the RFR Bundle Team and the OPG Project Management Team (and potentially some of the other Bundle Teams) due to this misalignment of progress and not just in the area of scheduling. This conflict is mainly due to the somewhat isolated nature of the teams in the area of project management and schedule development. This is not unusual early in the life of mega-projects like the DR

Project. Because the individual scopes of work are so large and unique that they warrant individual bundle teams, it is the nature of these groups to focus on and attack their scopes somewhat independently. However, we see the issues that have developed with the schedule maturation as further evidence that the DR Team needs to break down silos and move to a unified Program approach.

b. Planning Opportunities

Now that SNC/Aecon has developed the reference plant work plan that forms the basis of its estimate, the team's attention will be focused on developing the specific plan for the DR Project. In doing so, SNC/Aecon and the OPG RFR team should maintain one eye on the OPEX from Wolsong and Lepreau while looking for ways to optimize the plan to move the planning assumptions from *best achieved* to *best achievable* plan. As an example, in our review of the Wolsong OPEX and how it was used in formulating the Class 4 Estimate's BOE, [redacted]

From our team's OPEX (Wolsong, Pickering and other relatable plants), there are certain improvements that we believe the team should consider, including:

- In the fuel channel removal, SNC/Aecon should consider a process improvement over Wolsong and remove channels from both sides of the reactor. Doing so could improve the critical path by as much 8-9 days and could lessen overall dose.
- There are certain tool fixes that CANDU Energy made due to performance issues at Wolsong; we will be interested in seeing how these fixes result in better tool performance from the start of the work.
- Distinguishing the Wolsong OPEX from volume reduction from the newly minted plan from SNC/Aecon to see if adequate time and risk has been squeezed from the plan.

As SNC/Aecon's plan is further fleshed-out, we will examine the revised plan for time duration, manpower and manhours for the individual components of the work against the as-built from past refurbishments. In addition, BMcD/Modus has other recommendations for OPG to consider, including:

- Requiring SNC/Aecon to add CANDU Energy personnel who were particularly helpful and effective in the Wolsong project.
- Having a team from OPG working shoulder-to-shoulder with CANDU Energy and tool supply subcontractors in learning the operation of the tools, which we believe will aid OPG in decision-making during the Execution Phase.
- Obtain and rationalize the complete set of Wolsong and other stations' OPEX through the CANDU Owners' Group.
- Begin challenging SNC/Aecon regarding its bandwidth to support multiple refurbishments at once in light of its past performance and likelihood of Bruce Power deciding to go forward.

B. Balance of Plant

Balance of Plant ("BOP") scope for the DR Project consists of DSR's for plant modifications of the following plant areas and systems:

- Pre-refurbishment Work

- Safety & Control Systems
- Reactor Component Systems
- Conventional Systems
- Common Systems
- Special Programs.

For the Execution Phase, the BOP team is working to combine DSRs into these systems to the extent possible. In addition, much of this work is considered "contingent scope" and the necessity of its performance will depend on the outcome of scope defining inspections that will be carried out during upcoming outages. Therefore, as is often the case in refurbishment projects, the scope that comprises the BOP is the most difficult to plan, which can lead to problematic schedule and cost estimate issues.

The DR Team attempted to anticipate the typical issues with BOP in its contracting model, though some of the initial assumptions it made are not materializing. There is a significant risk that absent changes, the BOP work—and in particular, detailed engineering work performed by the EPC contractors—will not advance quickly enough to provide management with a high-quality estimate at RQE.

As a result, the DR Team is currently investigating methods for improving the schedule for BOP scope definition, which in turn should yield a higher quality plan and RQE. However, doing so may require a significant change in the planned project procurement and delivery method. The following summarizes the strategy, status of the BOP work, and recommendations for improvements, many of which are currently being pursued by the DR Team.

1. Current Contracting Strategy

As memorialized in DR Team's Contracting Strategy for Balance of Plant the BOP Team "determined that the preferred approach for [BOP work] is to collate as much bulk work as possible to best leverage existing Extended Services Master Service Agreements ("ESMSA") and Engineer, Procure, Construct ("EPC") concepts, and to separate out specialized work by exception for alternative sourcing strategies."[61] By implementing this strategy, the DR Team seeks to simplify the BOP procurement approach for an "inherently complex collection of work that doesn't fit well into existing DR projects" and minimize the risk inherent in OPG integrating a large number of separate but inter-related packages of plant system work.[62] The ESMSA contractors are ES Fox and Black & McDonald. These contractors were chosen through an RFP process which allowed OPG to negotiate both the contract terms and the rates in a competitive environment. [redacted]

After reviewing multiple options for executing this strategy, the DR Team decided to bulk BOP work into two major EPC packages made up of multiple DSRs: (1) nuclear side system work ("NSSS") and ii) conventional side system work. Scoping of the work is occurring via development of MDR/MDP packages by Project Engineering and the OSS vendors. The BOP Team's intent is to bid the work between the ESMSA vendors on a "Secondary Compete" basis. The Secondary Compete is intended to identify which of the vendors is most qualified for the work, and the possibility exists for only one vendor to emerge with the

[61] *See* Contracting Strategy for Balance of Plant, NK38-REP-09701-10102 (March 19, 2013) at p. 4.
[62] *Id.*

entire BOP scope. The BOP Team rejected the option of bidding each individual system in smaller packages due to OPEX that such a method could increase field execution rub points and integration issues and put OPG in the position of having greater management and oversight of the work.

The DR Team's evaluation also considered whether to open competition beyond the ESMSA vendors, though the team concluded that the utilizing the existing vendors had a number of advantages: (1) contracts were already in place based on an open, competitive negotiation; (2) the work under the BOP contracts would be similar in type to the work that the ESMSA contracts were intended to control; and (3) an open bid competition would require significantly more scope definition from OPG than time permits.

The DR Team recognized there were certain risks with this contracting strategy, among which are:

- Because of the scope definition timeframes, the BOP work was already behind the other projects. The DR Team's strategy was premised on "bidding the work via ESMSA secondary compete once scope reaches 70% has been developed" rather than waiting for completed scope definition from the OSS vendors.
- The ESMSA's Terms & Conditions ("T's & C's") existing master agreements were fully negotiated, but there was a risk identified that these contracts "may not be sufficient to address the needs and risks for the BOP project scope of work to be done during refurbishment execution outage." The DR Team is planning on approaching the vendors to see if this is the case.
- [redacted]
- [redacted]
- The DR Team appears to understand that there is a risk of owner interference due to "the large volume of plant system work and the continuing development of project scope."

From a purely strategic basis, OPG's concepts for the BOP model fit within that frequently seen in the industry for such work. However, BMcD/Modus has a significant concern that there is an assumption that enough time exists in the schedule for OPG to: (1) wait to bundle the scope into two large packages of work before even starting the procurement process, which will take some 8-12 months based on current progress; (2) engage in a Secondary Compete between two vendors whose pricing is the same and who have areas of specialty which are likely to dictate which vendor will perform a particular scope of work; and, (3) develop detailed engineering and comprehensive work packages with enough definition to develop a Class 2 Estimate in time for the RQE.

2. Scope, Engineering and Schedule Status

Two major factors are complicating the confidence with the BOP work at this time: (1) scope is still a moving target; and (2) an optimistic, very tight plan for scope definition and procurement of BOP work is currently at risk.

a. Current Scope and Possible Reductions

The work that comprises the DR Project's BOP scope is varied and split roughly in half between NSSS and conventional plant work. As of the 2013 Business Plan, this scope consisted of ~200 DSRs that have been estimated to cost approximately [redacted]. It should be noted that the BOP line item for the 2013 Business

Plan reflects a total of only $161M with a reduction from the 2012 Business Plan of $207M[63]. This "reduction" was actually a scope shift to the Turbine Generator Bundle, and the remaining BOP scope was in other categories (SIOs and Contingent scope, among others).

In part because BOP is a basket of disparate scopes, it has been subject to increases since the Project's outset. Based on interviews with the members of the DR Team, the BOP work has expanded to its current state for a number of reasons, including: (1) DSRs were approved for work that should have been considered Life Cycle Management; (2) DSRs were erroneously tagged as Core Scope; and (3) Sustaining Scope definitions were expanded to include items that are outside of the DR Project's commitments.

There is increasing concern that the BOP scope had grown to such an extent that it was threatening the DR Project's viability. The result of the observed scope creep, as expressed in the Darlington Refurbishment Independent Scope Review is, "the volume of scope is contributing to an increasing risk to OPG's ability to successfully refurbish the Darlington units, in terms of cost and schedule. The volume of work will add complexity to the Refurbishment project which may not be necessary, when considering the life-cycle management program at Darlington, i.e. some work may be best performed online or in an outage, managed by the station with utilization of Portfolio funds as required, before or after the refurbishment outage period."[64]

The DR Team's review of BOP scope is ongoing at this time. We discuss this review in more detail in Section III.C.2, above. However, we do note here that the review has already netted tangible results. As an example, the BOP team has recently studied the valve program and identified an 80% reduction in the number of valves the team was anticipating replacing.[65] It is likely that the team will reduce the BOP scope overall, which will serve to enhance the chances of the DR Project's success.

b. Schedule Status

The PIMS Milestone Schedule from January 2012 indicated that detailed design for major components of BOP work would extend well into 2015-6, which is inconsistent with the DR Team's RQE goal. The C&C Schedule's iterations have shown some improvement over those dates; however, in April 2013, the C&C Schedule showed MDR preparation for BOP scopes of work was likely to occur through 2013 and into the 1st Quarter of 2013, and procurement activities into late 2014.

In addition, the BOP's actual progress is running late against this extremely tight plan. BOP has missed three major milestones needed for defining its scope due to process-related issues.[66] Current projections (as of June 30th) in the C&C Schedule show as many as 89 MDR packages are running later than expected, and that 18 of 40 MDPs needed for BOP procurement were completed. The BOP Project Team has recognized that the current progress with MDR/MDP packages is a significant risk "to support EPC contracting timelines for BOP, leading to schedule delays or the need to proceed with RFPs at risk."[67] Moreover, the future scope-defining inspections are looming and could create more scope revisions. To

[63] DNGS Refurbishment Estimate Analysis (April 25, 2013) at p. 4.
[64] Terms of Reference Darlington Refurbishment Independent Scope Review, NK38-REF-09701-10004-R000 (May 23, 2013) at p. 2.
[65] *See* NK38-CORR-09701-0465000 (May 28, 2013).
[66] *See* Program Status Report for period ending June 2013 at p. 61.
[67] *Id.*at p. 62.

date, 166 of 355 planned scope defining work orders are completed.[68] The BOP Project Team identified "The risk is that BOP scope defining inspections are not completed or completed late resulting in the inability to finalize scope and subsequent delays to awarding EPC contracts."[69]

3. Observations and Risks

By its nature, BOP work carries inherent risks which the DR Team attempted to mitigate with its strategic model. However, the BOP schedule has matured and we are concerned that the scoping work is not moving at a pace necessary to carry out the original plan. In particular, BMcD/Modus sees a significant likelihood that the BOP work will not mature to the extent necessary in time for a high quality estimate at RQE. The most problematic areas and consequences are as follows:

- It does not appear that there is enough time to wait for the MDRs to be finished (even at the 70% level) for bundling of the work into two large BOP packages and enter into a planned Secondary Compete process. The schedule is further tightening due to the later completion of the MDR packages, and the procurement process, even if streamlined, adds 3-6 months to an already tight schedule.

- [redacted]

- Because BOP scope is still a moving target, it is entirely likely that even if the scope were "bundled" it would only change again, up or down, and even deductive change orders can be costly and problematic. If bundling the scope is intended to improve the quality of the ESMSA vendors' plans and estimates for performance, scope uncertainty will negate such an advantage; thus, waiting for the scope to be bundled only delays the start of the detailed design of packages that are sitting on the shelf, some of which are there now.

[redacted]

- [redacted]

[68] *Id.*
[69] *Id.*at p. 60.

[redacted]

- The nature of BOP work requires schedule and physical coordination between the BOP and the other EPC contractors. OPG needs to recognize its role in this regard of coordinating this work so that interference is limited.

4. Recommendations—Balance of Plant

The biggest risks to the BOP work right now are scope and schedule. To mitigate the schedule issues, OPG should consider a different contracting approach that would jumpstart the detailed design of the BOP packages; also, consider reducing the scope of those packages to the absolute minimum needed to meet the DR Project's commitments. As part of this strategic refocus, the primary drivers for a revised strategy should be: (1) meeting schedule commitments; (2) reducing potential interference to the RFR contract, and (3) creating flexibility to handle emergent work, schedule perturbations, scope shifting and scope revisions. Without this level of focus on the schedule, it is very likely that the DR Team's commitment to present a high-quality estimate at RQE, at least for the BOP work, will not be met.

As a result, BMcD/Modus recommends that OPG take all reasonable efforts to increase schedule certainty for the BOP work by awarding and assigning smaller packages of the work on a qualifications-based criteria with cost-plus contract terms as soon as reasonable. In this model, the ESMSA could be assigned or awarded projects before the OSS vendor has completed the MDP package for a given modification. This scenario allows for efficiency gains for the ESMSA engineers, who could be involved at an earlier stage of development, which could reduce the re-performance of engineering effort and increase the constructability of the selected modification solution. This structure also allows for easier shifting of packages between the vendors (or other entities) if contractor bandwidth remains a risk. Moreover, if the 2014 Business Plan revised planning assumptions are adopted, the BOP work schedule will have to be the most fluid and allow time for discovery work.

To the extent that there is concern over the cost, OPG could consider using the final as-built price and schedule from Unit 2 to fix or target price more elements of the contract for the later units. By this point, the majority of performance risks will be known and the scope for the remaining units will presumably be substantially identified, allowing for much earlier and more robust planning.

The most pressing problem with the BOP work is the start of detailed engineering necessary for providing management requisite confidence in connection with the RQE. Without changes to the current procurement strategy, this problem will almost certainly manifest itself in a lower quality estimate at RQE than intended. This will cause the DR Team to request greater contingency and have less confidence in the Execution Plan for the work. In our experience, the method of releasing smaller bundles of BOP work is the most prudent and effective means of reducing the risks inherent with BOP work, and in this case, because the ESMSA agreements are in place, would likely be the lowest cost option due to the schedule savings and risk avoidance the DR Project would yield.

C. Campus Plan

BMcD/Modus has reviewed the status of the ongoing work at the DNGS station that is being performed as pre-requisite work for the DR Project. The Campus Plan work includes a wide variety of infrastructure projects OPG intends to aid in the refurbishment of DNGS or improve the reliability of the station from a life cycle management perspective. The most significant current Campus Plan work consists of the following new facilities that are being designed and built by the ESMSA contractors and managed by the Projects & Modifications group:

- D_2O Storage Facility
- Low Pressure Service Water Line Relocation
- Water and Sewer
- Maintenance Facility
- Boiler House
- Refurb Island Annex
- Retube Waste Processing Facility
- Power and Electrical.
- OSB Refurbishment
- SIO – Emergency Power Generator (EPG3)
- SIO – Powerhouse Steam Venting System
- SIO – Containment Filtered Venting System[70]

These various scopes of work vary from commercial buildings to more complex technical undertakings, and include work that OPG has performed before (Dry Storage) to entirely new evolutions. The one critical thing these projects have in common is they all must be completed prior to breaker open on Unit 2. Thus, these projects represent a significant risk to the overall DR Project, due in part to the number of projects, their relative complexity and the amount of work left to be done (from planning to execution).

BMcD/Modus sees the evolution of the Campus Plan (including Facilities & Infrastructure Projects) as highly significant for multiple reasons: (1) many of these projects are essential predecessors to the overall DR Project; (2) these projects provide an early test of the capabilities of and new processes employed by the DR Team; (3) these projects allow for an early assessment of the ESMSA contractors' effectiveness and readiness to perform on the broader DR Project; and (4) these projects will provide valuable OPEX for the future work as some of these Campus Plan projects (D2O Storage Facility in particular) have encountered significant challenges.

1. D20 Storage Facility

The following is a summary of the current status of the D20 Storage Facility, which is the most significant and mature of the Campus Plan projects. There are some of the significant events that have occurred to date and the lessons learned that have already been captured for the team's examination.

a. Background

The D2O Storage Facility will provide storage capacity for water removed from the units during refurbishment. The building consists of multiple tanks for Primary Heat Transport (PHT), Moderator and TRF Feed storage,

[70] Projects and Modifications Division Performance Report, June 2013

and has been sized to accommodate the volume of water from two of the Darlington units. This building has a complex design, is time sensitive, has a significant capital cost ($110 million budget) and employs one of the anticipated key contractors ([redacted]) such that its execution provides a good template for much of the work on the DR Project.

The current schedule identifies the following key milestones:

- Detailed Design Complete by Black & McDonald/RCMT by August 30, 2013. The DR Team currently reports that this date will not be met, and mitigation plans are in place to lessen this impact.
- Low Pressure Service Water Line Relocation, which is needed to clear the building's footprint, is planned to be performed during the D1341 Outage and complete by November 9, 2013
- Start of Tank installation – October 9, 2013
- Substantial Completion – February 15, 2015
- Available for Service – April 15, 2015

The DR Team believes that the baseline schedule had approximately 6 months of float, though some of the current design issues will reduce this float. Nonetheless, there are certain delays that have already been incurred that need to be mitigated to ensure the timely completion of the facility. Challenges to date in the planning and design phase have included:

- MDRs Lacked Scope Definition: The initial MDR for procurement of the EPC contract lacked specificity.[71] As a result, OPG's Engineering reworked the MDR with more specific requirements. This experience with MDR resulted in significant process and quality improvements to the MDR process for procurement of the remaining DR Project modification scope, and was a primary driver in Engineering's budget variance against the 2013 Business Plan.
- Project Schedule: The D20 Storage Facility's schedule included unrealistic durations for detailed design work, the root cause of which was the original bid package lacked meaningful information and definition.[72] As a result, Modification Planning, which was scheduled for a scant 2 months, actually required 6 months, and recovery schedules were also missed along the way.[73]
- Completion of Detailed Design: To overcome the earlier schedule issues, OPG's Engineering Team has dedicated five engineers to provide oversight of the drawing preparation. This bears monitoring, as OPG will not have the resources to provide this level of oversight to the EPC vendors for the other Project Bundles.
- Procurement: Black & McDonald's purchasing of long-lead Class 3 valves on-time is also at risk. This is systemic procurement problem, as these valves are in short supply industry-wide.

[71] *See* D20 Storage and Drum Handling Project: Modification Planning Lessons Learned Report, D-LLD-38000-1001 (March 4, 2013)
[72] *Id.*
[73] *Id.*

- Planning & Assessing: The delays to engineering and procurement are likely to ripple into the completion of detailed planning packages. BMcD/Modus will continue to monitor the package development.

- Construction: [redacted] is the civil subcontractor and has been "daylighting" the excavation for some time in order to expose the buried services in this area of the site. Progress has been slower than planned due to the buried lines being found in different locations than shown on the as-built drawings, a configuration management issue dating back to the original construction of DNGS. Also, direct buried cable is being uncovered where cable trenches are shown on the drawings. These issues should be expected where excavations are undertaken in other areas of the site.

The DR Team appears to have responded to these challenges by increasing the active management of the contractor via daily meetings, additional schedule focus and more aggressive review of the engineering product. OPG has also assisted [redacted] in correcting some of its safety practices on site.

b. Key OPEX/Lessons Learned/Risks

The following are critical OPEX from the D20 Storage Facility that DR Team should take into account for the remaining Campus Plan work and the DR Project in full:

- **Corrective Actions to the MDR Process**: D20 Storage Facility was a leading indicator the DR Team used to revise the MDR development process, which is now significantly more robust as a result.

- **Planning Milestones:** A primary finding in the D20 Storage Lessons Learned report is the work for the project was under inordinate time pressure and the team lacked "managerial courage to recognize when [the] schedule is unrealistic for the required deliverable and to escalate."[74]

- **Management of Contractors**: The mitigation plans in place to recover the D20 Storage Facility have required significant management focus. While these mitigation plans have partially mitigated the impact to the schedule, BMcD/Modus sees a potential concern with the DR Team's bandwidth to deal with larger and more significant issues that are sure to arise on the DGNS Refurbishment Project. [redacted]

- **Impact of Design Delays**: As a result of the delays to detailed design, the D20 Storage Facility has lost float and the window for Planning & Assessing is shrinking. A key lesson learned from PARTS Unit 4 is that Planning & Assessing requires adequate time and focus or the field work will suffer.

- **Management of Engineering Deliverables**: The method being used to track engineering deliverables and the metrics used by Projects & Modifications and OPG Engineering should be examined for its effectiveness and possible export to the larger DGNS Refurbishment Project scopes of work. The OPG review cycles and the metrics capturing these cycles should be reviewed.

- **Configuration Management:** There have been buried services and underground conditions that were not accurately captured in the site plans. While it is virtually routine for site work to be adversely

[74] *Id.*, p. 10

impacted by unforeseen underground conditions on a decades-old utility site, the concern is that some of the configuration management issues materialize in other Campus Plan projects.

- **Procurement of Long Lead Valves**: Based on the D20 Storage Facility and the industry at large, the DR Team should examine how it is both determining and tracking long lead materials, whether or not these materials are being supplied by an EPC vendor. The DR Team needs to have proper tracking of such materials in order to establish reasonable schedule milestones and hold the vendors accountable for their performance.

- [redacted] **Performance**: As noted, the D20 Storage Facility as well as the other predecessor Campus Plan work provides an opportunity to fully examine [redacted], and just as importantly, the management techniques that the DR Team is using. To date, the DR Team has added more staff, in particular engineering, and instituted additional accountability forums (more meetings, etc.) to manage this work. The DR Team is examining what has been effective and whether the assumptions in the current management plans for the broader DR Project need to be adjusted. Considering the additional resources and management focus that have been needed thus far on the D20 Storage Facility, BMcD/Modus would also recommend OPG focus on both the qualifications and right-sizing of the DR Team as part of such reviews.

The D20 Storage Facility is the most notable of the Campus Plan projects because of its size, complexity and history of problems to date. Each of the Campus Plan projects present risks, and mitigating those risks will require significant management focus.

2. Pre-Requisite Work

A leading indicator of site readiness for the refurbishment is the execution of pre-DR Project work orders during the IPG and planned outages approaching the first unit execution. While planned outage execution of pre-refurbishment work orders has been successful, performance of the normal "T-Week" activities are resource constrained by the station. Subsequently the pre-refurbishment work orders are not getting priority for execution by the station Maintenance organization and are requiring the use of no-station personnel for assessing and work order preparation. The addition of the refurbishment work is straining the organization and will require additional resources and continued focus by the station management for refurbishment work orders to get station priority.

This conclusion is supported by Audit OPGN NO-2013-002, Equipment Reliability determined that performance of the Managed System Controls for sustaining ER is not fully effective (Yellow). Finding 1.1 Deficiencies in Preventive Maintenance Implementation 2) Darlington, found that Preventive Maintenance (PM) was deferred for Fuel Handling (FH) equipment due to lack of parts resulting in equipment failures.[75]

These activities and other Campus Plan work will require additional focus.

D. Turbine Generator

1. Scope

The Turbine Generator Project consists of five scopes of work:

[75] Level 2, SCR D-2013-05089 was initiated to document this finding.

- **Steam Turbines and Turbine Auxiliaries**: inspections, repairs, and/or replacements of High Pressure ("HP") and Low Pressure ("LP") turbine components and a number of turbine auxiliaries;
- **Generator and Generator Auxiliaries**: inspections, repairs, and/or replacements of generator components (including generator stator rewind) and a number of generator auxiliaries,
- **Moisture Separator Reheater ("MSR")**: inspection, overhaul, and/or replacements of MSR internals and auxiliaries (e.g. strainers, valves);
- **Turbine Control Upgrade**: replacement of the obsolete analogue Steam Turbine Electronic Control ("STEC") System, includes entire Turbine Supervisory System with modern design (digital system); and
- **Generator Excitation Upgrade**: replacement of the obsolete Generator Excitation system controls with modern design (digital system) and a set of additional Generator Excitation and Protection equipment to resolve obsolescence.[76]

It is our understanding that the DR Team developed the Turbine Generator Project scope of supply based on a review of the station's operating history and OPG's OPEX with the equipment, and results from CCAs. The Project's Scope Review Board gave its approval for these scopes of work and the Turbine Generator Project Team achieved Project Gate 0 on March 5, 2011.

OPG's original cost estimates anticipated that the total estimated value for the Turbine Generator Project would be approximately [redacted] with a base cost of [redacted][77] and [redacted] for contingency. The contingency amount included cost for scope that may ultimately be required depending on the outcome of certain planned inspections. OPG acknowledged that much of the Turbine Generator scope could be performed as a part of its regular inspection and maintenance program, but decided to add it to the DR Project at that time "for efficiency to minimize outage schedule.[78]

2. Contracting Strategy

The original contracting strategy contemplated bundling all of the scopes of work into a single EPC contract. The Original Equipment Manufacturer ("OEM") of the Darlington turbine generator sets, auxiliaries, and controls is Alstom Power ("Alstom").[79] This is highly specialized equipment designed which Alstom designed and supplied as an integrated system for the Darlington Station. Alstom was judged to have the optimal technical knowledge, expertise and full understanding of the complexity of the Turbine Generator Project scope of work. The DR Team identified the following major risks associated with not awarding single source contract to Alstom:

- **Execution Risks. Darlington Turbine Generators are specialized and unique in North America custom designed for Darlington**, and the OEM has provided parts, specialized services and engineering for the last 25 years. Hence, if a non-OEM that does not have knowledge or expertise respecting this highly specialized equipment provides the work in question, it will lead to significant execution risks.

[76] Contracting Strategy for Turbine Generators, N K38-REP-09701-10021 (August 31, 2012) at p. 6.
[77] [redacted]
[78] N K38-REP-09701-10021 at p.8.
[79] The Darlington Turbine Generators were actually originally designed, manufactured and installed by Brown Boveri Canada Inc. ("BBC"). BBC was bought by Asea Brown Boveri ("ABB") and subsequently Alstom Power purchased ABB.

- **Integration Risks**. The interface of the Control systems and Generator Excitation with the Turbine Generator Hydraulics is paramount. Turbine and Excitation Controls replacement involves interface with a large number of field devices, components within the hydraulic system and excitation power system, and the respective auxiliaries. **The risks of the said pieces of equipment not integrating properly with each other are significant if a non-OEM provides the work in question.**

- **Compatibility Risks**. Due to excellent performance of the turbines, OPG is able to take advantage of a cost effective **piecemeal retrofit** rather than a complete steam path retrofit. Reverse engineered components may drive compatibility risks, further costs during commissioning, and lost revenue that could be significantly higher than reverse engineering costs.

- **Operational Risks**. If OPG retains a non-OEM to provide the work in question, the resultant mix of OEM and non-OEM components will lead to increased operational risks of the units post refurbishment. In the worst case, forced loss rate may be impacted.[80]

[redacted]

On March 27, 2013, OPG entered into an Engineering Services and Equipment Supply Agreement with Alstom Power and Transport Canada Inc. The estimated value of the Agreement is approximately $356 M. [redacted]

3. Summary of Observations/Risks

- The Turbine Generator Project includes scope that is commonly performed in the nuclear industry, and while there are always risks from discovery work and examining the condition of critical components, if the Project is properly scoped and procured, it shouldn't become headline news for the DR Project.

- The award to Alstom on the basis of its unique qualifications to refurbish the DNGS turbines was a sound decision and one that mirrors how other utilities make such decisions. The move to separate the construction from the engineering and procurement parts also appears to be sound, given the price OPG received.

- The DR Team is currently reviewing an option to move the performance of the Turbine Generator control work on Unit 2 to a later time. The key driver for this decision would be to simplify the work in

[80] Memorandum Re: Darlington Refurbishment Turbine Generator Project - Single Source Justification Approval Request by Todd Josifovski, Turbine Generator Project Director (March 18, 2013).
[81] N K38-REP-09701-10021 at p. 8.

Unit 2 and focus the team's attention on RFR execution. BMcD/Modus recognizes the logic behind this option and it should be strongly considered, and management needs to robustly document whatever decisions are made.

E. OPG Critical Path Activities

As noted, the DR Team estimates that OPG will control the critical path 25% of the time ([redacted]) of the breaker-to-breaker unit duration[82]. Many of the work items in OPG's critical path scope have been performed before; however, some of the work, like defueling of the Darlington Units, has never been done by OPG, and here, it will have to be performed under enormous schedule pressure.. The DR Team is very aware of these risks and has made adjustments to the plan, most notably with refurbishment of the fueling machines prior to the opening of the Unit 2 breaker. The team is planning to continue to refine its schedule and sequence of events. The following is a summary of some of the DR Team's current efforts to organize and plan the critical path work.

1. Site Integration Planning

The DR Team's success in managing the critical path will depend on developing a cohesive and well-managed team that integrates the Project and Station personnel. BMcD/Modus monitored the integration plans and activities of the site integration team supporting these efforts.

Site Integration Plan meetings are focused at the management level which is appropriate given the time to the execution window. The initial integration plan was functionally based around the organization being reviewed for transition to refurbishment, Chemistry & Environmental, Safety, Design Engineering, Systems Engineering, EP, Licensing, etc. The initial presentations to the site are complete and while providing a broad based format for discussion of general personnel requirements and management structure, but contained few actionable items.

The Site Integration meeting agenda focuses on the near term actions required for the DR Project readiness with organizational transition plans discussed as a subtopic. The first integration topic covered is "Top Five Milestones." These Milestones were chosen by the leadership team and cover the near term actions, owners and due dates to support the milestone completion:

- Scope Frozen at Work Order level
- Improve Fuel Handling Reliability
- VBO Preparations
- Major Site Projects
- Development of Transition Plans

Once all actions are resolved for these priorities, the Site Integration Team will focus on additional strategic considerations and specific support for each of the DR Project Bundles.

2. Defuelling/Fuel Handling/PHTS Bulk Drain

OPG's portion of the Vault Preparation window is currently assessed at [redacted] and consists of the following activities:

[82] DNGS RFR – Execution Phase Estimate Progression, June 21, 2013.

- Breaker Open – 1 Day
- Defuel – 62 Days
- Primary Heat Transport System Bulk Drain – 25 Days
- Airlock Open – 1 Day
- Vault Turn-over – 1 Day
- Moderator Bulk Drain – 25 Days

The DR Team is currently assessing each of these durations. The Fuel Handling systems present unique challenges due to the fact the fueling machines that are needed to support the DR Project are also needed to maintain operations of the operating units. In addition, there is a concern that the station and OPG lack specific operational experience with performing these evolutions under schedule pressure. The team has taken some significant steps since the outset of our engagement to address certain key risks:

- The DR Team's leadership and the CNO recognized the risk of fuel machine reliability and availability could not only impact the project but also the support of the operating units during the project. The FH Team was directed to move forward the work needed to refurbish the fueling machines before the Unit 2 outage.
- Much of the work originally planned for Project will be included in earlier outages or performed on-line.
- Primary responsibility for the defuelling was turned over the Station to manage. There are some risks that have been raised regarding resource availability and support.

B&McD/Modus sees OPG's decision to place the responsibility of the fuel handling system and equipment reliability and for the defuelling of the reactor on Operations as sound and likely to reduce project risk. For the revised plan to work, the Fuelling Machine Operators (FMO's) will need to familiarize themselves with the new Universal Carrier and the different tooling used for defuelling channels with different flow rates. This is a relatively minor addition to the current expertise of the FMO's. BMcD/Modus also sees the benefit of charging the Projects & Modifications and fuel handling maintenance groups with upgrading the fuel handling system and equipment, returning them to the required level of reliability (the as-designed system performance) and for placing the Service Area Rehearsal Facility (SARF) back into service. Consequently, Operations now has the responsibility to turn over a defuelled reactor to the Refurb team.

The planning and organizing of these reliability projects, on top of the routine operations staff work, will need to be addressed from a staffing and funding perspective. Our current observations indicate that the planning for Defuelling tool design is sound, with float included in the schedule for tool design modifications to be made should problems occur during the prototype testing.

Once the breaker is opened, defuelling the reactor core will be the critical path activity. In addition to fuel handling system and equipment reliability there are other key items that should be addressed in order to minimize the time taken to defuel the reactor. B&McD/Modus recommends that the following be considered:

- Staffing for continuous three trolley fuelling/defuelling capability (24 hours/day; 7days/week);
- Fuelling/defuelling across shift changes and breaks.

The remaining Vault Preparation work is being examined for opportunities to improve durations and sequencing.

VI. Summary of Recommendations

In the foregoing, BMcD/Modus has attempted to identify for the DR Team a number of recommendations based on our current assessment of the Project's risks. The most significant of these recommendations are summarized below:

Issue	Risk/Opportunity	Recommendation
Scope	The DR Project's scope exceeds the commitments made to the BOD and Shareholder.	• Continue the process of reducing and optimizing the Project's scope. • Reach a consensus on the scope as expeditiously and reasonably as possible so as to reduce the DR Team's work load and unneeded churn. • Once the scope recommendations are adopted, the team will need to re-review the schedule to ensure the logic network is sound.
Engineering	The schedule and pace of procurement related activities may not support a high-quality estimate at RQE.	• Review strategic considerations for procurement of remaining scope. • Consider early "shoulder to shoulder" work by EPC design partners to expedite the start of detailed engineering and constructability reviews • Review and prepare for likely RFIs from EPC vendors during the Planning and Assessing Phase.
Project Management	The Project oriented focus has created management silos that could make integrated program management difficult, resulting in contractor/owner interferences.	• As the Project matures and contracts with vendors are in place, the DR Team should increase the level of program integration. • Address the fact that the Execution Phase may require individuals with different skills for OPG to effectively manage the contracts. • Clarify reporting lines for matrixed Project Controls Personnel. • Actively seek to assemble the Execution Phase team as soon as possible.
Schedule Development	The DR Team plans to implement a C&C Schedule at Level 2 for management which could create a number of coordination issues during the Execution Phase.	• Continue development of the C&C Schedule through the Definition Phase and migrate to a fully integrated Level 3 schedule for the Execution Phase. • Redirect the Project Controls Team's efforts from the C&C Schedule work to that of monitoring the developing Level 3 schedules from the contractors.

Issue	Risk/Opportunity	Recommendation
	The current schedule development depends on mutual agreement and acceptance of quality standards that owners typically demand, creating the risk that contractors will not comply.	• Clarify and include in commercial contracts OPG's requirements for schedule development by the contractors.
Risk Management	The current methods for scoring risks are inconsistent and the risk register includes "issues" or "concerns" that needlessly dilute management efforts.	• Provide consistent characterization and scoring of risks. • "Concerns" as currently defined should be eliminated from the Risk Management Program. • Ensure that all relevant parties have a seat at the risk table while maintaining a measure of centralized control in the approach to risk identification and tracking. • Consider revising probability scoring to increase granularity and ranking of risks.
	Leadership, training and wide acceptance of the importance of the Risk Management Program is lacking and the Project Controls Risk Group is understaffed.	• Consider bringing in an experienced risk management lead with a demonstrated track record who is singularly focused on the risk function. • Review qualifications within the existing risk team. • Elevate Risk Management to a stand-alone functional group with the same level of prominence as the Schedule team. • Provide training with a focus on the overall importance of the Risk Management Program
	The various databases that the Risk Group is populating suffer from a number of IT issues and lack of focus.	• IT needs to resolve the outstanding issues as quickly as possible. • Training should include instruction for populating databases. • The AIDA database should be examined and updated if it is to be useful for rate proceedings.
Cost Management	The DR Team is inconsistently applying AACE guidelines and other processes and procedures central to the BOD's understanding of the underlying quality of project cost estimates.	• Consistently apply AACE guidelines, and where they are not (as in the RFR project estimates), the DR Team should seek to return to a condition of compliance.
	Revised planning assumptions for	• Document and characterize the

Issue	Risk/Opportunity	Recommendation
	The 2014 Business Plan revised assumptions that are currently being assessed—the business case for these assumptions is centered on the opportunity to reduce risk and increase positive outcome.	information for the BOD and consider meaningful reporting metrics. • Should OPG adopt the revised assumptions, review commercial agreements so as to identify potential issues that could be impacted by the revised plan, as well as other issues within contracts than can be improved based on current OPEX. • Review capture and documentation of Unit 2 OPEX information so maximum benefit is derived from this revised plan.
	The 2015 Business Plan Budget review will likely repeat the process for the 2015 Business Plan in which the budget is refreshed.	• Perform a full project reforecast for the 2015 Business Plan in order to progress the project's cost estimates a far as possible before the date of the RQE. • Such a reforecast will provide management with a detailed blueprint for all of the work needed to satisfy the RQE with information related to the budget that should match the DR Project's growing level of maturity.
	Contingency calculations need closer alignment with the Risk Management Program.	• Actions summarized above • Create a clear and repeatable process for calculating contingency at all levels and for all program participants.
Management Processes	OPG's new processes and procedures are in some cases conflicting and repetitive.	• Look at reducing the number and optimizing the process map.
RFR	SNC/Aecon's Class 4 Estimate (by contractual design) does not monetize contingency nor will it until the date of the 2015 Class 2 Estimate; this fogs the budgeting process and could complicate target price negotiations with SNC/Aecon over risk identification.	• Consider asking SNC/Aecon to monetize risks at a much earlier stage.
	The Class 4 Estimate represents perfect performance; thus, it will form the basis for comparison with actual results.	• The DR Team needs to document and explain the nature of the Class 4 Estimate so that there is no such confusion.
	Project maturation specific to the DR Project was not a factor in SNC/Aecon's estimates to date.	• The Class 3 Estimate preparation should be expedited if possible.

Issue	Risk/Opportunity	Recommendation
		• OPG should seek SNC/Aecon's monetizing of PMT costs.
	[redacted]	• [redacted]
	There are technical improvements that should be reviewed based on OPEX.	• Study opportunities now that the effort is turning to Darlington.
BOP	The time engineering needs to create MDP packages is delaying the procurement of the work and the commencement of detailed engineering.	• Accelerate engineering work as necessary / praticable with the OSS vendors. • Reduce and optimize BOP scope as soon as reasonably possible to decrease wasted effort. • Change procurement method to a packaged approach (see below). • Jumpstart detailed engineering by engaging EPC vendors as early as possible in the design process. • Eliminate unnecessary duplication of effort between OSS vendors and EPC designers. • Review and eliminate OPG delays in approval of design work.
	The procurement process for BOP is designed around packaging two large bundles of BOP work and a Secondary Compete process which adds time to the schedule; the outcome of this "competition" is essentially already known.	• Assign work to ESMSA vendors based on qualifications in smaller bundles. • Use the existing ESMSA agreements and eliminate bidding process.
	[redacted]	• Ensure that appropriate performance metrics are in place and aggressively address specific performance trends and problems as they arise. • Increase flexibility in the assignment of BOP work to give OPG an opportunity to mitigate [redacted]
	There is a risk that scope defining inspections and discovery work during the Execution Phase will add scope not currently	• Optimize the BOP work so that an appropriate schedule window exists for performance of scope adders. • Increase visibility of this potential risk.

Issue	Risk/Opportunity	Recommendation
	anticipated to the BOP work.	
Campus Plan	The D20 Storage Facility work has been delayed [redacted]	• Continue to devote adequate resources to recover the D20 Storage Facility's schedule. • OPEX from this project should be used to guide management of the future Execution Phase work.
	Campus Plan work is multi-faceted and schedule driven; the sheer size and timing of the work adds complexity and risk	• Additional management attention is needed to ensure planning and execution of the work
	The Campus Plan's scope is too large	• Continue to review the Campus Plan Scope and eliminate unnecessary projects.
OPG Critical Path	OPG-directed work is 25% of the Critical Path of the DR Project.	• Ensure that this work is given proper focus and resources.

OPG PROJECT DOCUMENT INDEX

DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Darlington Refurbishment Final Report May 3	Internal Audit	5/12/2013
1 oversight summary	Refurbishment Oversight Report#1	2/22/2013
2 oversight summary	Refurbishment Oversight Report#2	4/2/2013
AssuranceMap_DRP_20130403A_ExecutiveSummary_GeneralApplicability	Part 1 of 2 - General Applicability/Mandate	3/7/2013
Presentation_20130325A_DrpAssuranceMap_Phase-1_Draft_lpapr3	DRP Risk Assurance Map – Phase-1	3/11/2013
Program Assurance Plan - PMP Sheet 11	Program Assurance Plan For Darlington Nuclear Refurbishment	3/1/2013
N-2013-00303 QA Gap analysis	GAP Assessment	2/11/2013
SCR N-2013-00303 from database	Station Condition Record	1/17/2013
SCR N-2013-00303	Common Cause Analysis	1/17/2013
NK38-CORR-09701-0401046 TG Project Contracting Strategy	Refurb Records; add'l correspondence dated 2/29/12 - Sweetnam & Reiner	3/28/2012
NK38-REP-09701-10020 Contracting Strategy - FH & Defueling	Contracting Strategy For Fuel Handling -Defueling	10/2/2012
NK38-REP-09701-10021 Contracting Strategy - TG	Contracting Strategy for TG; email attached	8/31/2012
NK38-REP-09701-10024 Contracting Strategy - Steam Generator	Contracting Strategy for Steam Generator	8/10/2011
NK38-REP-09701-10030 Contracting Strategy Summary - TG	for Turbine Generators; memo attached dated 3/28/12	8/24/2011
NK38-REP-09701-10034 Contracting Strategy - RFR	Contracting Strategy for Retube & Feeder Replacement	7/31/2011
NK38-REP-09701-10102 Contracting Strategy - BOP	Balance of Plant; email attached	3/19/2013
NK38-REP-09701-10130-R000 Contracting Strategy - FH Refurb	Fuel Handling - Refurbishment	11/16/2012
EDMS BRD Final R1	(BS&IT) Bus. Svcs. & Info. Tech. / (BRD) Bus. Rqmts. Doc. - Nuclear Projects EDMS - Define bus. & key syst. Requirements of target syst.	
Document Management Strategy Review Whitepaper	NK38-REP-08133-0460629-T20 WorleyParsons - Strategy Review Whitepaper	7/27/2012
WP EDM report	NR DOCUMENT MANAGEMENT / STRATEGY REVIEW WHITEPAPER - Worley Parsons	7/27/2012
Engineering Process Major Work Streams (Swim Lanes)	Project Unit 2 Major Work Streams - Org Chart	
EPC Vendor Interface Requirements Rev 2	13 page PowerPoint	
Gated Process Apr 8	Nuclear Projects Gated Process	4/8/2013
Scoping Overview	Organizational Chart	3/5/2013
1-EPC Vendor Engineering Interface Requirements - Intro	scanned PowerPoint	
2-Scope Strategy and Plan - 12-15-11	Refurbishment Scope Strategy & Plan	12/15/2011
3-Engineering Interface Requirements - 2-28-13	Engineering Interface Requirements	2/28/2013
5-Desktop Guide for the Preparation of a Needs Document - 2013	Desk Top Guide for the Prep. Of Needs Doc.	3/13/2013
6-Guide to the Development of a Conceptual Design Report - 12-18-12	Guide to the Development of a Conceptual Design Rpt.	12/18/2012
7-Preparation of Modification Design Requirements - 2013	Prep. Of Modification Design Requirements	
8-Modification Outline and Design Scoping Checklist	Modification Outline Report	
9-Design Completion Assurance - 10-15-12	Darlington Refurb.: Design Completion Assurance	10/15/2012
10-Non-Intent Design Deviation Notice	Non-Intent Design Deviation Notice	10/15/2012
11-Construction Completion Declaration Process - 12-31-12	Nuclear Refurb. Constr. Compl. Declaration Process	
12-Appendix C - Good Practices for Achieving High Product Quality	Good Practices	
13-Nuclear Projects Gated Process	Org chart	
14-Unit 2 Major Work Streams - pg1	Org chart	
15-Unit 2 Major Work Streams - pg2	schedule	
DR Scope Strategy and Plan NK38-INS-09701-10001	Refurb Program-Scope Control	12/12/2012
N-FORM-10958 Modification Outline Form	Modification Outline form	
N-GUID-00700-10002 Preparation of Needs Document	Desk top guide for the Prep of a needs doc (email attached)	
N-GUID-01920-10000 Engineering Oversight	Guideline For Engineering Oversight	
N-INS-00700-10007 Preparation of MDR	PREPARATION OF MODIFICATION DESIGN REQUIREMENTS	
NK38-GUID-01900-10001 Design Completion Assurance	Design Completion Assurance	
NK38-GUID-01900-10002 Non-Intent Design Deviation Notice	Non-Intent Design Deviation Notice	
NK38-GUID-01900-10003 Engineering Interface Requirements	Engineering Interface Requirements	2/28/2013
NK38-GUID-01900-10004 Development of Conceptual Design	Guide to the Development of a Conceptual Design Report	12/18/2012
N-PROC-MP-0090 Modification Process	MODIFICATION PROCESS	
N-STD-MP-0009 Engineering Interface & Oversight	CONTRACTOR/OWNER ENGINEERING INTERFACE AND OVERSIGHT	
Audit Report NO-2013-005 DRAFT_TW (2)	Modification Design Requirements and Design Quality Oversight	
CCA 21 June	Common Cause Analysis associated with Ref. SCR# N-2013-02294	Jun-13
N-NR SCRs from 2012 March 1st to 203 May 31	System Lay-Up Technical Requirements Documentation Compliance	
SCRs from July 1-2012 to 30- April 2013 keyword Contractor Interface	database; tabs - Key Word Contractor & Contractor Interface	5/28/2013

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
1 - Agenda - Eng. Schedule Review - 24 May 2013	Engineering Schedule and Metrics Review Meeting	5/24/2013
2 - Minutes - Eng. Schedule Review - 17 May 2013	Engineering Schedule and Metrics Review Meeting	5/17/2013
6 - Other engineering 24 May2013	VBO Outage Status, MDR Work Streams, Eng. Studies	5/24/2013
2013 06 20 Weekly Meeting Presentation	Meeting Minutes	6/21/2013
20130522_WP_Quad_Chart	MDR Pre-Requisites and Completion Status Report chart	5/22/2013
20130523_AMEC NSS_Quad_Chart	MDR Pre-Requisites and Completion Status Report chart	5/21/2013
April 5 2013 Engineering Schedule and Metrics Review Meeting	Meeting Minutes	
April 12 2013 Engineering Schedule and Metrics Review Meeting	Meeting Minutes	
Copy of B-O Chart and MR Tracking_Eng Leads-PM Updates as of 50113	MR Tracking & P6 Blackout	
Engineering MDR and Studies Summary slides June 14	VBO Outage Status, MDR Work Curves, Eng. Studies (Hos), etc.	
Outstanding Actions MDR Issues-Actions	9 Outstanding actions	5/24/2013
Outstanding Actions MR Holds	Outstanding Actions	5/24/2013
Outstanding Actions Weekly Meeting	Engineering Schedule and Metrics Review Meeting - 5 outstanding actions	5/24/2013
1-NR Engineering Communication Book - cover	Project Values - 1 page	
2-AIP Scorecard and Focus Areas - 2013	Scanned doc - database	
3-Program Status Report - 12-31-12	Meeting Minutes	1/23/2012
4-Nuclear Safety, Engineering Services, Project Engineering - 2-27-13	Scanned doc - nuclear safety	
5-Weekly Tactical Update - 3-15-13	Engineering Key Milestones	
6-Design Engineering Weekly Report - 3-5-13	Weekly Report	
7-Engineering Organizational Chart - 1-14-13	Org chart - photos included	
8-Nuclear Safety Division Organizational Chart - 1-14-13	Org chart - photos included	
9-Engineering WBS - 2-1-13	Org chart	
10-Engineering Cost Breakdown Structure - 2-1-13	Org chart	
12-DSRs for Engineering Studies Work Down Curve - 3-11-13	Chart	
13-Engineering Hours Budget - 2-21-13	scanned doc - database	
14-Darlington Integrated Master Schedule March 18 2013	schedule	2/6/2012
15-Engineering Schedule and Metrics Review Meeting - 3-8-13	Meeting Minutes	3/8/2013
16-MDR Prerequisite Blackout Chart - 3-11-13	database	
17-MDR Workdown Curve, MDR Starts, Acceptance Process - 3-11-13	chart	3/11/2013
18-DSRs for Modifications Blackout Chart - 2-21-13	database/chart	2/21/2013
19-MDR Process - 2-28-13	org chart	2/28/2013
21-EV Engineering Breakdown for MODs	org chart	
22-Earned Value Process for MDRs - Example - 3-1-13	org chart	
23-Project Planning, Engineering Staffing - 1-1-13	database	Jan-13
24-Project Numbers - 7-27-12	org chart	7/27/2012
25-Funding Analysis - 3-7-13	scanned doc - database	3/7/2013
26-EC Modification Tracking Report - 3-19-13	EC Black out chart	3/19/2013
27-Management Plan - 1-30-13	DNGS Refurbishment Mgmt. Plan - Refurb. Eng.	1/30/2013
2013-04-26-WorleyParsons_MDR_Integrated_Schedule_DRAFT_L1	MDRs Integrated Schedule - Level 1	4/25/2013
2013-04-26-WorleyParsons_MDR_Integrated_Schedule_DRAFT_L2	MDRs Integrated Schedule - Level 2	4/25/2013
2013-04-26-WorleyParsons_MDR_Integrated_Schedule_DRAFT_L3_OPG_O	MDRs Integrated Schedule - Level 2 - OPG Activities ONLY	4/25/2013
AMEC 2013-04-26-MDR Program- Level 1	AMEC NSS MDR Program Integrated Schedule	
AMEC 2013-04-26-MDR Program- Level 2	AMEC NSS MDR Program Integrated Schedule - Level 2	
AMEC 2013-04-26-MDR Program- Level 3-OPG activities	AMEC NSS MDR Program Integrated Schedule - Level 3	
AMEC202013-05-27-Level2	MDR Program Integrated Sched. - Level 2	
B-O Chart and MR Tracking_Eng Leads-PM Updates	MR Tracking & P6 Blackout	
D1321 scope for refurb	DSR tracking	
DSR Database	DSR database	
DVBO scope for refurb	DSR for vacuum bldg.	
P6 Blackout Chart	charts included; add'l tabs	
WC Scope Review 13-05-02	DSR Based Estimate - Based on Estimate Details as of August 30, 2012	8/30/2012

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Scope Review Process	NK38-REF-09701-10004-R000 [TBC] Independent Scope Review	5/23/2013
Master_Outage Prep Meeting_Jul_11	Action Log; DSR HOS, etc.	
Memo 20130618160713465 Planning Assumptions	memo; changes in refurb planning assumptions	6/6/2013
NK38-CORR-09701-046500 Non-Core Scope Valve Cost Benefit Analysis	Non-Core Scope Valve Cost Benefit Analysis memo	5/28/2013
Scope Presentation	Darlington Refurbishment Scope	2/1/2013
Scope Review as of 062013	Scope type data (CS02, CS03, etc.)	6/20/2013
Scope_Status_Meeting_June6_2013	Review readiness for refurbish preparation work	6/6/2013
ScopeStatusPackageMay9_2013	Outage Preparation Review Meeting	5/9/2013
Table 1. Non-Core Scope DSR's	database	6/6/2013
Appendix 1 Repair vs. Replace Cost Analysis	DSR Repair vs. Replace	
NK38-CORR-09701-046500 Non-Core Scope Valve Cost Benefit Analysis	Non-core Scope Valve cost benefit analysis	5/28/2013
Table 1. Non-Core Scope DSR's	database	6/6/2013
DR_Engineering WeeklyTactical_Update003 April 19, 2013	Weekly Report	4/19/2013
DR_Engineering WeeklyTactical_Update003	Weekly Report	4/19/2013
Engineering Weekly Tactical Update March 15, 2013	Weekly Report	3/15/2013
D1231 Outage Report	D1231 Planned Outage	5/18/2012
NK38-PLAN-31160-10003_R000(22Jan2013) Detailed Design & Qualification for RFR	Scope of Work - Fuel Channel Zr-Nb-Cu Annulus Spacer - Detailed Design & Qual. For Darlington Retube & Feeder Replmt.	1/22/2013
Bulk MDR Contracting Strategy	Engineering Projects Department to execute Bulk MDR as follows in document	6/27/2013
Contracting Strategy D20 Storage	Memo; Proj. 16-31555 D_2O Storage Facility Contracting Strategy; Contracts Rev. Table	3/18/2011
DNGD D20 Storage- Gate 3 Project Execution Plan Form	Heavy Water Storage & Drum Handling Facility; NK38-PEP-38000-0434605	7/10/2012
G1 - 13 - TS Preliminary Contracting Strategy (3) NCD Comments -scf edit oct	CONTRACTING STRATEGY FOR BALANCE OF PLANT – CONVENTIONAL SYSTEMS; **no NK38 #, no date**	
G1 Preliminary Contracting Strategy	COMMERCIAL STRATEGY; **no NK38#**	3/15/2011
G1-14 - PR Contracting Strategy	CONTRACTING STRATEGY FOR BALANCE OF PLANT – Pre-Refurbishment Sub-Bundle	1/30/2013
NK38-CORR-09701-0401046 Contracting Strategy Summary TG	Refurb Records; add'l correspondence dated 2/29/12 - Sweetnam & Reiner	3/28/2012
NK38-CORR-38000-0374630 Contracting Strategy D20 Storage	Project D_2O Storage Facility; contracts review table attached	3/18/2011
NK38-REF-00150-0379237 2009 Presentation Program Contracting Strategy	Email - fr/ Laura Oakes to Refurb Doc Mgmt.; ppt attached - 'Prelim Procurement & Contracting Strategy'	3/16/2011
NK38-REP-00150-10001 Rev001 Program Commercial Strategy	Commercial Strategy report	10/1/2012
NK38-REP-09701-10020 Contracting Strategy FH Defueling	Contracting Strategy For Fuel Handling -Defueling	10/2/2012
NK38-REP-09701-10021 Contracting Strategy TG	Contracting Strategy for TG; email attached	8/31/2012
NK38-REP-09701-10024 Contracting Strategy SG	Contracting Strategy for Steam Generator	8/10/2011
NK38-REP-09701-10030 Contracting Strategy Summary TG	for Turbine Generators; memo attached dated 3/28/12	8/24/2011
NK38-REP-09701-10034 RFR Contracting Strategy-signed R000	Contracting Strategy for Retube & Feeder Replacement	7/31/2011
NK38-REP-09701-10102 Contracting Strategy BOP	Balance of Plant; email attached	3/19/2013
NK38-REP-09701-10130-R000 Contracting Strategy for FH Refurb	Fuel Handling - Refurbishment	11/16/2012
NK38-REP-09701-0442800 BOP Pre Refurb Contracting Strategy	Pre-Refurbishment Sub-Bundle	1/30/2013
N-MAN-00120-10001-RDM R000 Nuclear Projects Records and Document Management	Nuclear Projects Records And Document Management	3/14/2013
N-MAN-00120-10001-RDM Project Records & Doc Mgmt.	Records And Document Management	3/14/2013
N-MAN-00120-10001-RDM-01-R001 Sharepoint 2007	Nuclear Projects Sharepoint 2007	2/19/2013
N-MAN-00120-10001-RDM-02-R001 Supplier Document Hub	Supplier Document Hub	4/17/2013
N-MAN-00120-10001-RDM-09 Release of OPG Docs to Ext Oversight	Release Of OPG Documents To External Oversight Organizations	4/17/2013
Nuclear Projects Records and Document Management	Nuclear Projects Records And Document Management	3/14/2013
DR Scope Strategy and Plan NK38-INS-09701-10001	Program-Scope Control	12/12/2012
NK38-GUID-01900-10001-R001 Design Completion Assurance	Design Completion Assurance	10/15/2012
NK38-GUID-01900-10002-R001 Non-Intent Design Deviation Notice	Non-Intent Design Deviation Notice	10/15/2012
NK38-GUID-01900-10003-R001 Engineering Interface Requirements	Engineering Interface Requirements	2/28/2013
NK38-GUID-01900-10004 Development of Conceptual Design	Guide to the Development of a Conceptual Design Report	12/18/2012
NK38-GUID-09701-10020 Gen Process for Conceptual Studies	Generic Process for Execution of Darlington Refurbishment Services Conceptual Studies	2/15/2013
NK38-INS-01900-10001-R001 Preparing & Issuing Eng. Directives	Management Expectations On Preparing And Issuing Engineering Directives	8/24/2012
Nk38-INS-01920-10002 Quality Engineering Plan	Quality Engineering Plan	10/18/2012
NK38-INS-09701-10001-R004 Program Scope Control	Program-Scope Control	12/12/2012

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
NK38-INS-09701-10008 Tracking Compliance with Environmental Commitments	Tracking Compliance With Environmental Commitments	11/1/2012
NK38-PLAN-1060-10003 Reference Plan Scope Definition	REFERENCE PLAN - SCOPE DEFINITION	6/25/2008
NK-38-PLAN-09701-10003 Terms of Reference	Scope Review Board – Terms of Reference	2/1/2011
NK38-PLAN-09701-10067 Scope Mgmt. Plan	Program Scope Management Plan	1/31/2013
N-MAN-00120-10001-Scope	Nuclear Projects Scoping Process	12/11/2012
N-MAN-00120-10001-Scope-06 Transfer of Work Process	Transfer Of Work Process	7/26/2012
N-MAN-00120-10001-Scoping Process	Nuclear Projects Scoping Process	12/11/2012
Project Planning, Engineering Staffing - 1-1-13	Release 4: Project 73019, 73020, 73094, 73021 & 73022 Detailed Planning	2/1/2013
GOVERNANCE FRAMEWORK	Index	
Governance Chart	Chart	
N-CHAR-AS-0002 Nuclear Management Systems	NUCLEAR MANAGEMENT SYSTEM	
N-PROG-AS-0001 Managed Systems	MANAGED SYSTEMS	
N-PROC-MP-0090 Mod Process	MODIFICATION PROCESS	
N-PROC-AS-0001 Mgmt. of Administrative Governance	PROGRAM MANAGEMENT OF ADMINISTRATIVE GOVERNANCE	
N-STD-AS-0001 Requirements for Admin Governance Docs	REQUIREMENTS FOR ADMINISTRATIVE GOVERNANCE DOCUMENTS	
E-Manual Template	N-STD-AS-0028 – Project Management Standard	7/17/2013
N-PROG-AS-0007 Project Management	PROJECT MANAGEMENT	
NK38-PLAN-09701-10067-0017-R000 Contract Mgmt. Plan	identifies how the major contracts will be defined, managed and controlled throughout program	1/31/2013
N-PROC-AS-0081 Technical Contractor Management Process	TECHNICAL CONTRACTOR MANAGEMENT PROCESS	
N-STD-AS-0028 Project Management Standard	PROJECT MANAGEMENT STANDARD	
N-STD-AS-0029 Contract Management Standard	CONTRACT MANAGEMENT STANDARD	
N-STD-AS-0030 Project Oversight Standard	PROJECT OVERSIGHT STANDARD	
N-STD-AS-0031 Field Engineering Standard	FIELD ENGINEERING STANDARD	
1 Refurbishment Program Structure And Summary Management Plan	Refurbishment Program Structure And Summary Management Plan	1/31/2013
2 Refurbishment Program Scope Management Plan	Refurbishment Program Scope Management Plan	1/31/2013
3 Program Cost Management Plan	Program Cost Management Plan	1/31/2013
4 Program Schedule Management Plan	Program Schedule Management Plan	1/31/2013
5 Refurbishment Program Reporting Management Plan	Refurbishment Program Reporting Management Plan	1/31/2013
6 Darlington Refurbishment Risk Management Plan	Darlington Refurbishment Risk Management Plan	1/31/2013
8 Refurbishment Program Staffing Management Plan	Refurbishment Program Staffing Management Plan	1/31/2013
9 Program Documentation Management Plan	Program Documentation & Project Closure Management Plan	1/31/2013
12 Program Environmental Management Plan	Program Environmental Management Plan	1/31/2013
13 Program Management System Oversight Management Plan	Program Management System Oversight Management Plan	1/31/2013
16 Nuclear Refurbishment Program Health and Safety Management Plan	Nuclear Refurbishment Program Health & Safety Management Plan	1/31/2013
17 Program Contract Management Plan	Program Contract Management Plan	1/31/2013
18 Program Return to Service Management Plan	Program Return to Services Management Plan	1/31/2013
Project Charter D-PCH-09701-10000-R001	Darlington Refurbishment	6/15/2009
0 Project Charter D-PCH-09701-10000-R001	Darlington Refurbishment	6/15/2009
2 Refurbishment Program Scope Management Plan	Refurbishment Program Scope Management Plan	1/31/2013
3 Program Cost Management Plan	Program Cost Management Plan	1/31/2013
4 Program Schedule Management Plan	Program Schedule Management Plan	1/31/2013
5 Refurbishment Program Reporting Management Plan	Refurbishment Program Reporting Management Plan	1/31/2013
6 Darlington Refurbishment Risk Management Plan	Darlington Refurbishment Risk Management Plan	1/31/2013
8 Refurbishment Program Staffing Management Plan	Refurbishment Program Staffing Management Plan	1/31/2013
9 Program Documentation Management Plan	Program Documentation & Project Closure Management Plan	1/31/2013
12 Program Environmental Management Plan	Program Environmental Management Plan	1/31/2013
13 Program Management System Oversight Management Plan	Program Management System Oversight Management Plan	1/31/2013
16 Nuclear Refurbishment Program Health and Safety Management Plan	Nuclear Refurbishment Program Health & Safety Management Plan	1/31/2013
17 Program Contract Management Plan	Program Contract Management Plan	1/31/2013
18 Program Return to Service Management Plan	Program Return to Services Management Plan	1/31/2013
NK38-PLAN-09701-10067-0001-R002 Refurbishment Program Structure And Summary Management Plan	Prog. Structure & Mgmt. Plan	1/31/2013
Earned Value Guide	N-MAN-00120-10001-SCH-07-R000 - EV Mgmt.	3/15/2013
NK38-PLAN-09701-10067-0004 Sh 0004	Program Schedule Management Plan	3/27/2013
NK38-PLAN-09701-10072 Critical path	Nr Conceptual Level 1 Logic (Pims-C)	9/7/2012

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
N-MAN-00120-10001-COM	Project Communications	1/1/2013
N-MAN-00120-10001-CST	Cost Management And Project Reporting	7/19/2012
N-MAN-00120-10001-Est-01	NUCLEAR REFURBISHMENT COST ESTIMATE	7/25/2012
N-MAN-00120-10001-Est-R001	Nuclear Projects Cost Estimating	11/30/2012
N-MAN-00120-10001-GRB	Nuclear Projects Gated Process	11/28/2012
N-MAN-00120-10001-PC	Project Controls	1/1/2013
N-MAN-00120-10001-PC-02-R001	Cost And Schedule Change Control Instruction	4/25/2013
N-MAN-00120-10001-Sch	Schedule Management	7/19/2012
N-MAN-00120-10001-Sch-01	Work Breakdown Structure Direction	
N-MAN-00120-10001-Sch-02-R001	Program/Project WBS Manual	4/5/2013
N-MAN-00120-10001-Sch-02-R003	DNG Refurb -Standard Projects Milestone List	
N-MAN-00120-10001-Sch-03-R001	Program & Project missed milestones recovery process	
N-MAN-00120-10001-Sch-05-R001	Program/Project WBS Manual	4/5/2013
N-MAN-00120-10001-Sch-06	Milestone Definition Framework	8/2/2012
N-MAN-00120-10001-Sch-07	Earned Value Management	3/15/2013
Nuclear Contract Management Manual	guidance for the implementation of the five stages in the contracting process	11/28/2012
Program Schedule Mgmt. Plan Rev 1	Program Schedule Management Plan	3/27/2013
Contingency Instructions	bullet points	
Contingency Presentation for RPET (Jan-30-2013)	proposed strategic direction of contingency development and management	1/30/2013
Contingency Worksheets	database template	
N-MAN-00120-10001 Risk	Task Instruction – Closing Risks	
N-MAN-00120-10001 Risk-R001	Nuclear Projects Risk Management Process	11/22/2012
N-MAN-00120-10001-Risk-03	Nuclear Projects Risk Management Process	11/22/2012
N-MAN-00120-10001-Risk-04	Nuclear Refurbishment Risk Management	7/25/2012
N-MAN-00120-10001-RISK-05-R001 Contingency (1)	Contingency Development And Management Guide	6/26/2013
Do not use--Use R001N-MAN-00120-10001-Risk-05 Contingency Development & Mgmt.	Contingency Development And Management	7/19/2012
N-MAN-00120-10001-Risk-06	Darlington Refurbishment Lessons Learned And OPEX Management	7/19/2012
N-MAN-00120-10001-Risk-07	Nuclear Refurbishment Earned Value Management	3/15/2013
Nuclear Projects Risk Management Manual (1)	Risk Management	7/25/2012
Nuclear Projects Risk Management Process	Risk Management Process	11/22/2012
Nuclear Projects Planning & Control Earned Value Management April 2013	Planning & Controls	Apr-13
R3 May 1 Oversight Workshop	for Senior Management	
GRB Schedule 2013	Nuclear Refurbishment Gate Review Board, 2013 Schedule	3/18/2013
Nuclear Projects Gated Process	Nuclear Projects Gated Process	11/28/2012
OPG Proposal Org and Labor Resource revA	Organization & Labour Resource Strategy	5/11/2010
R3 May 1 Workshop on Oversight	Oversight workshop for senior mgmt.	May-13
PR_G1_Presentation	Gate 1 Pre-Refurbishment Sub-Bundle	4/15/2013
Dispositioning Comments scf	Tabs: Comments, Contingency Table	
G1-0 Gate Progression Form	1.0 GATE SUMMARY, 2.0 GATE PROGRESSION STRATEGY, etc.	4/15/2014
G1-0 Gate Progression Form (pdf)	Balance of Plant: Pre-Refurbishment	4/15/2014
G1R BoP S and C GPF	Balance of Plant Safety and Controls	
G1-2 Cost Estimate	DSR Line Estimate _ Scope List - as of Mar 8, 2013 (In $K)	
G1-3 PR Funding Request Form	Funding Request Form	4/15/2013
BoP_PR_DRAS_Combined	DRAS - Decision Record & Analysis Sum. Form	
G1-4 - PR Decision Records and Analysis Summary	Balance of Plant Pre-Refurbishment Sub-Bundle	4/15/2013
BoP_PR_L1_G1_Waterfall_20130328	Initial Gate Submission - BoP View	2/28/2013
BoP_PR_L1_G1_WBS_20130328	Gate Review Level 1	2/28/2013
BoP_PR_Milestones_20130328	All Pre-Refurbishment Key Milestones	2/28/2013
BoP_PR_WBS_20130328	Primavera org chart	3/28/2013
BoP_PR_L3_G1_Waterfall_20130328	Initial Gate Submission - BoP View	2/28/2013
BoP_PR_L3_G1_WBS_20130328	Gate Review Level 3	2/28/2013
G1-7 - PR Pre-Req. Inspections	Gate 1 Submission Document	4/15/2013

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G1-9_RiskAssessment	Project Risk Assessment	4/15/2013
G1-10 - PR Alternative Option Decision Making Strategy	Alternative Option Decision Making Strategy	4/15/2013
G1-11 2013-2025 Cash Flows	Sheet 2 -Nuclear Refurbishment Program Staffing ($) and Contract Cost	
G1-11 2013-2025 Resource Plan	Sheet 1 -Nuclear Refurbishment Program Staffing (FTE) and Contract Cost	
G1-11 Annual Cash Flows	2013 to 20XX CASH FLOWS	
G1-12 Key Assumptions	Key Assumptions & Constraints; Balance of Plant, Pre-Refurbishment	4/15/2013
G1-13 - PR Gate Progression Strategy	Gate Progression Strategy Plan	4/15/2013
G1-14 - PR Contracting Strategy	CONTRACTING STRATEGY FOR BALANCE OF PLANT – Pre-Refurbishment Sub-Bundle	1/30/2013
ESMSA Overview	Extended Svcs. & Master Svc Agreement	2/23/2012
Extended Services MSA - Main	MASTER SERVICES AGREEMENT; redacted version	2/15/2012
Extended Services MSA Appendix 1 - EPC (Owner, Constructor)	Terms & Conditions for Eng., Procurement & Constr.	2/15/2012
Extended Services MSA Appendix 2 - EPC (Owner Only)	Terms & Conditions for Eng., Procurement & Constr.	2/15/2012
Extended Services MSA Appendix 3 - Engineering	Terms & Conditions for Engineering	2/15/2012
Extended Services MSA Appendix 4 - Procurement	Terms & Conditions for Procurement	2/15/2012
Extended Services MSA Appendix 5 - Construction	Terms & Conditions for Construction	2/15/2012
Extended Services MSA Appendix 6 - Engineering and Procurement	Terms & Conditions for Engineering & Procurement	2/15/2012
Extended Services MSA Appendix 8 - Procurement and Construction	Terms & Conditions for Procurement & Construction	2/15/2012
Extended Services MSA Appendix 9 - Augmented Staff	Terms & Conditions for Augmented Staff	2/15/2012
Labour Requirements Acknowledgement	executing acknowledgement of labour requirements	12/6/2010
Labour Requirements Clause - Form 1	Form 1	11/28/2011
Schedule 5 - Cost Allocation Table	table	
Schedule 6 - COIR	Contractor/Owner Eng. Interface Requirements for Nuclear	6/29/2011
Schedule 8 - Business Expense Schedule	STANDARD FORM	7/27/2010
Schedule 10 to Extended Services MSA	table	
Schedule 11 - Definition of First Aid	informative document	
Schedule 11 - List of Items for Human Performance PI	table	
Schedule 11- Annual Performance Indicators and Scoring	table	
Schedule 13 - Free Issue Materials	informative document	
Appendix 1 Repair vs. Replace Cost Analysis	DSR Repair vs. Replace	
NK38-CORR-09701-046500	Non-core Scope Valve cost benefit analysis	5/28/2013
Table 1. Non-Core Scope DSR's	database	6/6/2013
Gate 3 Presentation 73821	Gate 3 GRB Meeting	6/11/2013
Campus Plan	arial view of campus	
13MAY2013 - DNGS WHITEBOARD	CAMPUS PLAN WHITEBOARD	5/13/2013
16-31555 Full Execution Release April 19 GRB Distribution	Type 3 Business Case Summary	
Business Case - DN Refurb - 2011	N-REP-00120.3-10000-R001, Economic Feasibility Assessment	11/15/2011
CSIS (05-Mar-2013)	Campus Plan Integration Plan - Master Plan - Layout B	3/5/2013
Extended Services MSA - Main	MASTER SERVICES AGREEMENT	2/15/2012
NK38-REF-09701-0439454 T10 Integrated Work Flow Analysis	Personnel Flow; R&FR Workers, BoP Workers, etc.	Jun-12
Project Charter D-PCH-09701-10000-R001	Darlington Refurbishment	6/15/2009
Projects and Modifications information	Email - fr/ Dragan Popovic to E. Gould	5/13/2013
Remaining Work Status 19Apr2013.pdf	DNGS-Heavy Water Management Building West Annex	4/19/2013
Risk Register Template C - Gate 3b R1	Instructions & Notes for Risk Register (RR) Template C; add'l tabs	
Site Layout Yearly Option-Model May 7 2013.pdf	Campus Plan Proposed Refurb Gen Arrangement	
Visio-27FEB2013 DNGS OUTAGE CAMPUS PLAN - Lookahead 2013 Level 1.pdf	2013 LEVEL 1 PROJECT REVIEW	2/27/2013
Visio-Copy (1) of 08APRIL2013 - DNGS - 20 Week Project Look Ahead (3).pdf	20 WEEK PROJECT LOOK AHEAD	4/8/2013
Components requiring Unit overlap Memo	Memo to summarize review performed FH refurb	6/17/2013
Darlington Defueling Study	Darlington NGS Defueling Study	4/1/2011
Email response from FH Proj. Mgr. re documents	Email - Doc for External Oversight Team	4/29/2013
FH and Refurbishment Integration Readiness May 8 2013	chart	5/8/2013
NK38-PLAN-35000-10005- Basis of Flow Defueling Critical Path Evaluation Feb 21 2013	Refurbishment Defueling Basis For Critical Path Estimation	2/21/2013
REVISED Terms of Reference	FH Equipment Reliability and Refurbishment Integration Steering Committee	
2013_Defuel Presentation-Gate 2-June 14-final	Project Status	6/14/2013
Defueling Project Management Plan Rev 0	Defueling Project Management Plan	6/5/2013
Gate Progression Form-Gate 2-final	Fuel Handling Defueling	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
NK38-REP-09701-10005 R001 White Paper Islanding Strategy	White Paper - Refurbishment Island Strategy	4/20/2012
BH Gate 2 Scope Summary Statement	Islanding Bulkhead and Containment Isolation Sub bundle	
Dispositioning Comments scf	templates/tables - blank	
Islanding BH G2 GPF	Islanding - Bulkhead	
NK38-PLAN-09701-10159	Islanding Project Management Plan	4/16/2013
Risk Management Plan R00 Signed	NR Islanding Project - Risk Mgmt. Plan	2/19/2013
Gate 2 DRAS Cover Sheet	Islanding – Bulkhead and Containment Isolation	4/30/2013
BH Milestones Gate 2	Bulkhead Milestones	4/4/2013
BHLevel 1 Gate 2	Bulkhead Level 1	4/4/2013
BH G2-7 Analysis of alternative options	Evaluation of preferred alternative; Islanding – Bulkhead and Containment Isolation	4/30/2013
BH G2-8 Review of Engineering Analysis	Review of scope and engineering analysis to determine/anticipate scope additions; Islanding – Bulkhead and Containment Isolation	4/30/2013
AIDA_Islanding	Current Islanding Assumptions; add'l tabs	
Bulkhead Assumptions	Darlington Refurbishment - Planning & Cntls. (3 pgs. of 150)	4/17/2013
Gate 2 Assumptions Cover Sheet	G2-9 Key Project Assumptions & Constraints	4/30/2013
BH G2-10 2 Percent Design Complete	G2-10 ~2% Design Complete	4/30/2013
PDRI-2 Nuclear bulkhead Letter	Nuclear Bulkhead Containment Project, PDRI-2 Results	4/18/2013
PDRI-Nuclear Bulkhead	Nuclear Islanding (Bulkhead & Containment); instructions & database	
BH G2-12 Identification of major long lead items	G2-12 Identification of major long lead items	4/30/2013
Gate 2 Risks Cover Sheet	G2-13 Project Risk Assessment Subject Project Bundle: Islanding	4/30/2013
Gate 2A Risk Contingency	Islanding Bulkhead & Containment Isolations and Project Management Gate 2A Risk Contingency	
Islanding BH and PM Risks	Residual Risk Description	
BH G2-14 PIR Criteria	G2-14 PIR Criteria	4/30/2013
DRAFT Islanding Oversight Plan Rev 00 (2) 8April2013	Island Project Oversight Plan	4/23/2013
BH G2-16 Review of G0 Scope	G2-16 Review of G0 Scope	4/30/2013
BH G2-17 Level 2 and 3 Schedule	G2-17 Level 2 and Level 3 Schedule	4/30/2013
BH OPG Level 2 3 Gate 2	Bulkhead OPG Level 2/3	4/4/2013
BH Vendor Gate 2	RFR Team; DRAFT Containment Isolations Remaining Work Status: 23Apr2013	4/24/2013
BHLevel 2 Gate 2	Bulkhead Level 2	4/4/2013
Volume Reduction Strategy CP0420-1 Combined	scanned doc - RFR Volume Reduction Location	
QA_RFR_Contract_Confidential	Questions & Answers	4/9/2013
RFR Contract Summary of Key Terms	Eng., Procurement, & Constr. Agreement for Refurb Retube & Feeder Replmt. Proj.	3/12/2012
Contract Strategy for RFR NK38-REP-09701-10034	Retube & Feeder Replacement	7/31/2011
NK38-DAI-0901-10008 RFR Contractor Interface Requirements	RFR Contractor/Owner Interface Requirements	8/15/2012
RFR Eval Summary NK38-REP-09701-10084	R&FR RFP Evaluation & Negotiation Process Sum.	6/25/2012
Dispositioning Comments scf RFR -Gate 2 A	P&C Cost Review; add'l tabs included	
Gate 2 A Summary	Mar 2013 - May 2014	
NK38-REP-09701-10034 RFR Contracting Strategy-signed R000	Retube & Feeder Replacement	7/31/2011
Projects - Retube and Feeder Replacement	Current Gate 2A; Fiscal Mo End 03-July-2013	7/3/2013
RFR G2A GPF	Retube and Feeder Replacement Project	
RFR Gate 2A Level I Schedule 28Feb13	Review Level 1	2/28/2013
RFR Gate 2A Progression Signed off	Retube & Feeder Replacement Proj.	
RFR Risks - by RBS - Feb 21 2013	Risks Level 1 and Level 2; RFR - Retube & Feeder Replacement	2/21/2013
Dec 2012 Estimate Report	ESTIMATE, LEVEL 2 SCHEDULE & RISK REPORT	12/21/2012
RFR Resource Plan - Revised March 6 -Gate 2A	March, 6	
RFR Resource Plan 15 Feb 2013-Gate 2A	Feb 15 2013	
RFR Resource Plan 20 Feb 2013-Execution	Feb 20 2013	
34-120019 Annulus spacer Qual-9jan2013	Annulus Spacer Qualification Test for Darlington Retube	
34-120019 Inconel 9jan2013	Inconel Spacer Qualification Test for Darlington Retube	
2013-02-08- R0031- Basic	R0031 : Retube and Feeder Replacement Resources	
2013-02-08- R0031- Cash flows- Basic with actuals-Oct12-May14.pdf	CT-01 Monthly Project Cash Flow -with actuals	2/8/2013
2013-02-08- R0031- Cash flows- detailed by WBS with actuals.pdf	CT-02 Monthly Project Cash Flow by WBS	2/8/2013
2013-02-08- R0031- detailed	R0031 : Retube and Feeder Replacement Resources	2/2/2013
AECL Op 3 Pricing Submission Form Annulus Spacer	Option 3: Combined Inconel X-750 & Zr-Nb-Cu Tight Fitting Spacers	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
AECL Zr - R1	Zr-Nb-Cu Irradiation Program High Level Schedule and Budgetary Estimate	
AMEC NSS OSS Services- Gate 1 and 2A Deliverable List (verified - Updated)	Appendix B: Deliverable Budgetary Cost and Schedule; add'l tabs	
Appendix 01 - 509407-0000-00000-33RA-0035 OSM (Rev PB)	MATERIAL ALLOWANCE CALCULATIONS - BASED ON A SINGLE UNIT ONLY (2013)	4/12/2013
Assistance for RFR - Hours Estimate	Document list, engineering reviewers, hrs, etc	
Contractor Owner Interface Requirements RFR	NK38-PLAN-28200-10006-R000 Engineering Quality Oversight Plan for RFR Islanding Svc Annex	3/15/2013
NK38-PLAN-31160-10002_R000(22Jan2013)	Scope of Work Fuel Channel Modified Inconel X-750 Annulus Spacer	1/22/2013
NK38-PLAN-31160-10003_R000(22Jan2013)	Scope of Work Fuel Channel Zr-Nb-Cu Annulus Spacer	1/22/2013
RFR Cash Flow 2013 -R2 Current	Progress Curves - Calculations	
RPET Presentation Gate 2A Meeting 1	Execution Phase Estimate	1/23/2013
RPET Presentation Gate 2A Meeting 2	Gate 2a Project Plans	2/6/2013
RPET Presentation Gate 2A Meeting 3	Gate 2a Look Ahead	2/13/2013
Contractor Owner Interface Requirements RFR	NK38-PLAN-28200-10006-R000 Engineering Quality Oversight Plan for RFR Islanding Svc Annex	3/15/2013
NK38-DP-09701-10001 RFR Design Plan Rev. 000	Retube & Feeder Replacement Design Plan	
NK38-DP-09701-10001 RFR Design Plan	RFR Design Plan (Proj. #73100)	3/11/2013
NK38-PLAN-0970-10126 Retube and Feeder Replacement Oversight Plan Rev 01 (3)	Retube And Feeder Replacement (RFR) Project Oversight Plan	2/1/2013
NK38-PLAN-09701-10074 R002 RFR Project Mgmt. Plan	RFR Project Mgmt. Plan	2/4/2013
NK38-PLAN-09701-10126 Oversight Plan Rev 000	RFR Project Oversight Plan	2/27/2013
NK38-PLAN-09701-10148-RFR Project Controls Plan	RFR Project Controls Plan	3/1/2018
NK38-PLAN-09701-10148-RFR Project Controls Plan-3	RETUBE & FEEDER REPLACEMENT (RFR) Project Controls Plan	1/18/2013
NK38-PLAN-09701-10150-RFR Contract Management Plan	(RFR) Contract Management Plan	2/28/2013
NK38-PLAN-09701-10152 RFR Engineering Plan Rev. 000	RFR Engineering Plan	2/4/2013
NK38-PLAN-09701-10152 RFR Engineering Plan	RFR Engineering Plan	2/4/2013
PMP Rev 2	(RFR) Project Management Plan	2/4/2013
509407-0000-00000-30RM-0006 R00 Monthly Progress Report September 2012	Retube & Feeder Replmt. Proj.	Sep-12
509407-0000-00000-30RM-0008_R00 Monthly Progress Report October 2012	Retube & Feeder Replmt. Proj.	Oct-12
509407-0000-00000-30RM-0011_R01 Monthly Report January 2013 Complete	Retube & Feeder Replmt. Proj.	Jan-13
509407-0000-00000-30RM-0012_R00 Monthly Report February 2013 Complete	Retube & Feeder Replmt. Proj.	Feb-13
509407-0000-00000-30RM-0013_R00 Monthly Report March 2013	Retube & Feeder Replmt. Proj.	Mar-13
509407-0000-00000-30RM-0014_R00_Monthly Report April 2013	Retube & Feeder Replmt. Proj.	Apr-13
509407-0000-00000-30IM-0001_RPB_Project_Controls_Plan	identifies the required Project Controls systems, processes and procedures	6/15/2012
509407-0000-00000-30IM-0002 RPA - Resources Management Plan 20120515	identifies the required resource management processes utilized for the purposes of this DNGS RFR Project	5/10/2012
509407-0000-00000-30IM-0003 RPA - Scope Management 20120515	includes a change control process so it has been abbreviated as SCP – a short form for Scope and Change control Plan	5/15/2012
509407-0000-00000-30IM-0003_R02 Scope and Change Management Plan	to ensure there is a controlled work process that will document, track and manage all project changes	5/6/2013
509407-0000-00000-30IM-0005 - R00 JV Risk Management Plan	to describe risk management processes that will be implemented; shall describe the application of SLN-Aecon's corporate risk management program	8/28/2012
509407-0000-00000-30IM-0005_RPB_Risk_Management_Plan	shall describe the application of SLN-Aecon's corporate risk mgmt. program as well as OPG's risk management program(s).	6/13/2012
509407-0000-00000-30IM-0008 Proj Admin Plan RPB - 20120601	to describe SLN-Aecon's project admin practices and policies to provide systematic and practical approach for the project admin function	6/4/2012
509407-0000-00000-30IM-0012_R00 Interface Coordination Plan	will focus solely on the technical interfaces of the Project where differing scopes interface with each other during the Definition Phase	4/10/2013
509407-0000-00000-30IM-0013_R00 JV Human Performance Program	shall aim to recognize and address error-likely situations and potential challenges in task performance by establishing, promoting and reinforcing positive behaviours throughout project	3/1/2013
509407-0000-00000-32IM-0001 Schedule Management Plan -	identifies the required management systems, processes and procedures to be utilized by	4/13/2012

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Apr 13 2012	the DNGS RFR Team	
509407-0000-00000-32IM-0001_R02 Schedule Management Plan	describes the requirements and work processes to be used as they relate to the various schedules	5/6/2013
509407-0000-00000-33IM-0001 RFR - Estimate Plan - Apr 13 2012	to prescribe the processes and the basis of Estimate and requirements for production of the Execution Phase Estimate	4/13/2012
509407-0000-00000-33RA-0035 Apr-23-13_Rev PB JV RFR CL 4 Cost Estimate OSM	TMOD material, supports, hardware, feeder vision system, and miscellaneous items.	5/15/2013
509407-0000-00000-33RA-0035 Apr-23-13_Rev PB	CL-4 Cost Estimate - Owner Specified Materials (OSM)	5/15/2013
509407-0000-00000-34IM-0001_R00_JV Cst_Mgmt_Pln	This Cost Management Plan (CMP) is a component of the Project Controls Plan (PCP). It identifies the required management systems, processes and procedures to be utilized	6/12/2012
509407-0000-00000-40EP-0001 R00 - Engineering Plan	Provide a description of eng. work; how work will be organized; applicable procedures & processes to be used	8/23/2012
509407-0004-00000-60IM-0001_R00 - D1341 Walkdown Plan - 08FEB13 – MASTER	RFR team will perform a series of walkdowns to perform inspections, take measurements and photos to support plant modifications engineering and tooling design	2/7/2013
509407-30CC-I-0224-Letter-Submission of Schedule Management Plan R02	correspondence referring to SMP, Retube & Feeder Replacement	5/27/2013
Appendix 02 - 509407-30CC-I-0109-Intermediate Level Waste Assessment	revised estimate: intermediate level waste components and key assumptions	10/12/2012
JV Project Controls Plan	509407-0000-00000-30IM-0001; Rev 01	5/6/2013
JV Project Management Plan	509407-0000-00000-30IM-0006; Rev 01	8/10/2012
OPG Org Strategy Study Plan _Rev 2a	Faithful & Gould report	Sep-10
Transmittal Milestone and Submittal Schedule 10Agu2012	Milestone schedules/database attached	8/10/2012
OverallRemainingWork2013-05-30 Part1	RFR Team - Retube & Feeder Replacement	5/30/2013
OverallRemainingWork2013-05-30Part2	RFR Team - Retube & Feeder Replacement	5/30/2013
OverallRemainingWork2013-05-30Part3	RFR Team - Retube & Feeder Replacement	5/30/2013
ALSTOM AGREEMENT	ENGINEERING SERVICES AND EQUIPMENT SUPPLY AGREEMENT	3/27/2013
RFR Agreement		3/2012
TG Project - Integration Update - July 4, 2013 v1	TG Project Update (pdf of ppt)	7/4/2013
Turbine Risk Register	Scanned doc - Nuclear Refurb - Turbine Generator	4/3/2013
1 -Table of Contents		3/19/2013
2-Title Page		3/19/2013
3 -Memo - Darlington Refurbishment Turbine Generator Project - Single Source Justification Approval Request	Memo	3/19/2013
4 -Darlington Generator Equipment Single Source Justification	Report, March 18, 2013	3/19/2013
Exhibit 1	Description of Item and/or Service: Darlington Refurbishment Turbine Generator Project Engineering Services and Equipment Supply	3/19/2013
Exhibit 2	Major Contract Memorandum	3/19/2013
Exhibit 3	Contracting Strategy Summary For Turbine Generators (8/24/11)	3/19/2013
Exhibit 4	Turbine Generator Refurbishment Project Alternate Contracting Plan (11/9/12)	3/19/2013
Exhibit 5 - Worley Parsons Burns and Rowe Technical Evaluation Report	Turbine Generator ("TG") Project Independent 3rd Party Technical Scope Evaluation and Validation	3/19/2013
Exhibit 6 - Design Basis Documentation Gap Analysis	Design Basis Documentation Gap Analysis	3/19/2013
Exhibit 7 - Design Basis Documentation Estimate	Design Basis Documentation Estimate	3/19/2013
Exhibit 8 - D.C. Cook OPEX	D.C. Cook OPEX	3/19/2013
Exhibit 9 - Faithful and Gould Class 5 Estimate	Independent Estimate for Fixed Priced Contract	3/19/2013
Exhibit 10 - Pricing Team Evaluation	Pricing Team Evaluation	3/19/2013
Exhibit 11 - Alstom Benchmarking Presentation		3/19/2013
Exhibit 12 - OPG Benchmarking		3/19/2013
Exhibit 13 - Technical Team Evaluation		3/19/2013
Faithful and Gould Proponent Information Form revB	PROPONENT INFORMATION FORM REQUEST FOR PROPOSALS	7/21/2010
Faithful and Gould Risk Program Gap Analysis	Risk Mgmt. Best Practice	Jul-11
Memo to CPO March 2013 rev 3	Single Source Justification approval request (3/10/13)	3/19/2013
NGD Refurbishment Contracting Report_Final	Plant Life Extension Project (PLEP) - Phase II & III Contracting Strategy Analysis	10/6/2006
Summary Memo rev 2	Single Source Justification Summary (3/10/13)	3/19/2013
Gate 2a Presentation to GRB April 2013 [19-Apr-13 revision]	Presenter: Todd Josifovski	Apr-13
TG G2 GPF 19-Apr-13	Turbine Generators	
Gate 2a Presentation to GRB April 2013	Presenter: Todd Josifovski	Apr-13

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
TG G2 GPF	Turbine Generators	
TG Project Staffing Plan Rev 6	TURBINE GENERATORS FUNDING; 2013-2025 Resource Plan, etc.	3/11/2013
TG Project Staffing Plan Rev 6b	TURBINE GENERATORS FUNDING; 2013-2025 Resource Plan, etc.	3/11/2013
TG Project Staffing Plan Rev 2	TURBINE GENERATORS FUNDING; 2013-2025 Resource Plan, etc.	3/11/2013
TG Project Staffing Plan Rev 3 (with Gate Plan and Interest)	TURBINE GENERATORS FUNDING; 2013-2025 Resource Plan, etc.	3/11/2013
TG Project Staffing Plan Rev 4	TURBINE GENERATORS FUNDING; 2013-2025 Resource Plan	3/11/2013
TG Project Staffing Plan Rev 5 Elisabeth's Version r	TURBINE GENERATORS FUNDING; 2013-2025 Resource Plan	3/11/2013
TG Project Staffing Plan Rev 5	TURBINE GENERATORS FUNDING; 2013-2025 Resource Plan	3/11/2013
NK38-PLAN-41000-10001-R000	Turbine Generator (T-G) Project Management Plan	3/12/2013
Attachment to TG11	Technical Evaluation Report	9/21/2012
Condenser Reconfiguration AIDA109 or TG07	Decision Record & Analysis Sum. Form; Condenser Tube Reconfiguration for MW Output Increase	
DRAS TG09 TS0760-43 Remove from scope	Turbine Generator Project - Steam Turbines and Turbine Auxiliaries: Gas Cooling DSR to be removed from scope	
DRAS TG10 SI0300-16 19 remove from scope	Turbine Generator Project Strategic Outage Improvements DSRs to be removed from scope	
DRAS TG11 Final	Turbine Generator Sustaining DSRs	
Generator Aux Improvement AIDA216 or TG04	Turbine Gen. Proj. #73255	
Generator Core Replacement and Rewind AIDA218 or TG06	Gen. Core Replacement & Rewind	
Moisture Separator Reheater Improvement AIDA214 or TG02	DSR TS0680-13; Moisture Separator Rehealer Improvement Initiative	
Stator Cooling Water Skid Replacement AIDA217 or TG05	Stator Cooling Water skid Replacement DSR #TS0760-25	
Stop Valve Seating AIDA213	Stop Valve Revised Seating Angle	
TCV, PRV FRF DRAS AIDA215 TG03	DSR Ts0750-28, SI10270-1, TS0750-34; elimination of the lube Oil TCV, etc	
TG List of DRASs		
2012 01 04 TG Estimate (1.01) 300113	Turbine Generator Independent Estimate	1/30/2013
BOEfxed	TG Independent Estimate for Fixed Cost Contract	1/30/2013
Estimate for Fxed	Confirmation of Faithful-Gould completed estimate	1/30/2013
NOC Data 8th Draft	DSR Database; includes Alstom data	
NOC Data TJ IW March 6th 2013	TG Scope elements	
20130402_TG_Level0 and Level1	Refurbishment Program Coordination & Control Schedule Gate Review Level 1	2/28/2013
Contractors proposed schedule	Classic schedule layout	1/29/2013
P6 milestones	Turbine Generator Gate 2A milestones	2/28/2013
TGContractScheduleandDefinitions_Feb 20 2013	TG Equipment Supplier Vendor (ESV) Contract Milestones & Definitions	
Level 3 april22013	Gate Review Level 3	2/28/2013
TG_Level 1_OPG	Gate Review Level 1	2/28/2013
TG_Level 3_OPG	Gate Review Level 3	2/28/2013
G2-1 Gate 2A Option Decision Making Strategy	Alternative Option Decision Making Strategy DNGS Turbine Generator Refurbishment	3/10/2013
Assumption gaps	Turbine Generator #73255 Key Assumptions Identification Form	2/27/2013
Assumption layup	Turbine Generator #73255 Key Assumptions Identification Form	
Assumption prereqs	Turbine Generator #73255 Key Assumptions Identification Form	
Assumption RFP	Turbine Generator #73255 Key Assumptions Identification Form	
Key Assumption 229	Turbine Generator #73255 Key Assumptions Identification Form	2/27/2013
Output 5 - 2 percent design completion	Initiation Phase Output #5: ~2% of Design Complete	
PDRI-2 TG Letter	Turbine-Generator Project, PDRI-2 Results	3/19/2013
PDRI-2 TG Mar-14-2013 R1	Turbine Generator Project	3/14/2013
Long lead items	Turbine Generator Gate 2A (one page)	
73802 Water and Sewer FULL BCS 3Apr2013	Executive Summary & Recommendations Darlington Water & Sewer Project	
Execution Full Release GRB Presentation 73802 Water and Sewer[1]	Gate 3 Presentation	4/8/2013
W and S G3 GPF[1]	Darlington Water and Sewer	
Processes and Procedures re Cost and Schedule	Project Controls	5/9/2013
RFR Project Controls Requirements	Exhibit 2.9(j) - Project Controls	
AACE Rec Prac 37R-06 Schedule Levels of Detail	applied to eng., procurement & constr.	3/20/2010

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
AACE Rec Prac 38R-06 Documenting the Schedule Basis	7.2 Sched Planning & Development	6/18/2009
AACE Rec Prac 40R-08 Contingency Estimating -- General Principles	7.6 Risk Mgmt.	6/25/2008
AACE Rec Prac 41R-08 Risk Analysis and Contingency Determination	7.6 Risk Mgmt.	10/27/2008
5 DN Refurb_Release 4b Cost Summary	Program & Annual Cash Flow Sum. > Proj. Bundles/Work Pkgs.	
Appendix 1 Repair vs. Replace Cost Analysis	DSR Repair vs. Replace	
Determining P50 Contingency for a Target Price Contract	a proposal of the methodology to determine a 50% confidence level contingency for a Target Price Contract	11/30/2012
Engineering Cost Breakdown Structure - 2-1-13	Scanned Organizational chart	
Engineering WBS - 2-1-13	Scanned Organizational chart > Nuclear Refurb. Eng. WBS	
Funding Analysis - 3-7-13	Eng. Proj. Director - RC 1066, 2077, 2073	3/7/2013
NK38-CORR-09701-046500 Non-Core Scope Valve Cost Benefit Analysis	Non-core Scope Valve cost benefit analysis	3/28/2013
N-MAN-00120-10001 Cost and Schedule Change Control Instruction		7/31/2012
N-MAN-00120-10001 Nuclear Projects Cost Estimating		11/30/2012
N-MAN-00120-10001 Nuclear Refurbishment Cost Estimate		7/25/2012
N-MAN-00120-10001 Risk-05 Contingency Development and Management Guide	hand written notes on doc	6/30/2013
NR Program Cost and Cashflow 2011 E2 R13 (GHR) Sep 28 2011	R&FR Data Summary	9/28/2011
NR Program Cost and Cashflow Estimate File for 4b	2013-2015 Business Plan Listing - Project Life Cycle Costs (K$)	9/14/2012
Proposal for Determining P50 Contingency for Target Cost Contract	proposal of the methodology to determine a 50% confidence level contingency for a Target Price Contract at Nuclear Refurbishment	11/30/2012
RFR Roadmap	Cost Variance Roadmap; RFR used as an example	6/27/2013
Strategic Direction for Nuclear Refurbishment Contingency Development and Management	Basis of Strategy, Classification, Accountability, Development & Monitoring	12/5/2012
Summary of Cost Estimate - Feasibility Asmt - Board Nov 2009_R03	Initiatives, Cost Estimate and Cash Flow	
Summary of Cost Estimate - Feasibility Asmt - Board Nov 2009_R04	DN Refurbishement Feasibility Cost Assessment	Nov-09
Target Cost Contracts Presentation 31 Mar 11	PDF ppt - Target Cost Contracts presentation	3/31/2011
4b Estimate p2	Tabs = Rev. Status, ISR Analysis, Syst. Layup, EPW & Passport Issues	7/22/2013
4b Estimate P3	**NOTE:** Password Protected; Tabs = ISR, 4b, Campus Plan, ISR Mods, ISR Programmatic & ISR TRF	7/22/2013
Estimate Analysis 4b vs. 3 April 2013	DNGS Refurbishment Estimate Analysis	4/25/2013
NR Program Cost and Cashflow 2011 E2 R13 (GHR) Sep 28 2011	R&FR Data Summary	9/28/2011
NR Program Cost and Cashflow Estimate File for 4b	Program and Annual Cash Flow Summary - Release 4b	10/9/2012
Summary of Cost Estimate - Feasibility Asmt - Board Nov 2009_R03	Cost Estimate High Level Summary, Rev 1.1.03 Cost Estimate High Level Summary, Rev 10 (Including Contingency)	
Summary of Cost Estimate - Feasibility Asmt - Board Nov 2009_R04	DN Refurbishement Feasibility Cost Assessment - Board - November 2009 (Rev 1.1.04)	11/1/2009
4b Dataset	Revised DSR Based Estimate > multiple entries for DSR TS0010-4	
DSR Estimates by BoE	Tabs: Passport Issues, Summary, RFR G1, FHG1, ETC. (Jacob Mills)	3/26/2013
Estimating Baseline Schedule 2013		Jan-13
Status Report	Tabs: Status, DSR Database 03282013, Passport Issues, BoE DSRs, ETC. (Jacob Mills)	3/28/2013
Example BoE	example only	
Example Estimate	example only	
Example Factored Rate + Indirect Costs	example only	
Campus Plan Status Report	Tabs: Status, DSR Summary, 4b Data, ETC.	4/2/2013
Campus Plan Estimate validation Report (1)	Parking Constr. Estimate Validation	3/1/2011
Campus Plan Estimate	Tabs: DSR Summary, 4b Data, 2013BP Life Cycle Costs, DSR Database	
N-REP-00120-0373568	Memo fr/ Gary Rose (Campus Plan Est. Validation Rpt. attached)	3/3/2011
RFR BoE	Execution Conceptual Independent Class 5 Summary Basis of Estimate	1/27/2012
RFR DSR Cost Estimate	R&FR Bundle	
4B Data Summary	Tabs: Summary, 4b Data Summary, ETC.	3/7/2013
LISS Nozzle replacement assessment R-01	Retube & Feeder Replacement Study	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
RE DEC CCO Matrix Listing costing and overview drawing		
NK38 SOW 31100 10016 RFR SOW	Retube & Feeder Replacement Scope of Work	1/4/2012
TS0010-3	Est. Sum: LISS Nozzle Replacement Unit 1, 2, 3 & 4	7/8/2011
TS0010-5	Est. Sum: Contingency: Headers Replacement for Unit 1, 2, 3 & 4	7/7/2011
TS0100-6	Est. Sum: Extend Inspection of Pressurizers	8/21/2011
TS0100-7	Est. Sum: Clean Sludge Deposits from Pressurizer	8/21/2011
TS0100-8	Est. Sum: Repair/replace bleed cooler	8/21/2011
TS0100-9	Est. Sum: Replacement of Pipe Sections for 33310-L62, L37 and 33320	8/21/2011
TS0220-4	Est. Sum: Review the Phase 1 Outputs of COG Project on Calandria Vessels	8/5/2011
TS0240-1	Est. Sum: Replace all sections of the high instruments lines	8/8/2011
TS0260-2	Est. Sum: Replace SDS2 Orifice Flow Element	8/9/2011
TS0260-5	Est. Sum: Recommended Actions of SDS2 Instrument tubing	8/10/2011
TS0770-1	Est. Sum: ECI Pressure Breakdown Flow Elements	8/12/2011
TS1310-1	Est. Sum: Investigate the Benefit and Risks of Chromium Plating	8/21/2011
TS1310-2	Est. Sum: Modification of Plate end fittings	8/21/2011
TS1310-5	Est. Sum: Modification of Garter Springs	8/21/2011
RFR Tooling BOE FPage	Tooling Project Chosen Lead Proponent Tooling Fixed Price Cost	1/19/2012
RFR Mock-up BOE FPage	Darlington Energy Complex Chosen Lead Proponent Mock-up Fixed Price Cost	1/24/2012
RFR OSM BOE Fpage	OSM Conceptual Cost Summary	1/24/2012
RFR Independent Class 5 Estimate BOE Fpage	Execution Conceptual Independent Class 5 Estimate w/ Lead Proponent Fee	1/25/2012
RFR Class 5 Summary BOE Fpage	Execution Conceptual Independent Class 5 Summary Basis of Estimate	1/27/2012
Visio-RFR_March20 WBS	WBS Rev 0 - Organizational Chart	3/21/2013
RFR Class4 Estimating Kick-off	Email - From: James Laudanski; material for Kick-off mtg.	1/22/2013
OPG RFR 7March2013-Est	Mtg. Minutes: RFR CL-4 Estimate Meeting #2	3/19/2013
OPG RFR 14March2013-Est	Mtg. Minutes: RFR CL-4 Estimate Meeting #3	3/14/2013
OPG RFR 28March2013-Est	Mtg. Minutes: RFR CL-4 Estimate Meeting #4	3/28/2013
Send RFR DSR with comments Dec. 19, 2011 cost Rev. 1		12/19/2011
UI Prereq Mods BOE Review	Email w/ NR Islanding Project Basis of Est. Prerequisite Modifications doc. attached	2/14/2012
Plot Plan Unit 2 Elev. 100	Dwg: RB, RAB, Turbine AB Turbine Hall	
NK38-SOW-09701-10005 R000 FINAL	Outage Unit Containment Isolations	10/18/2011
Seal Plate	Reactor Bldg. Structure; Calandria Seal; Installation Details; Misc. Steel	
TS0810 1 Install remove Shielding for the Bulkhead	Est. Sum: Install & Remove Shielding for the Bulkhead	2/6/2012
TS0810 1 Install Remove Temp Hor. Bulkheads	Est. Sum: Install & Remove Horizontal bulkheads	2/3/2012
TS0810 1 Install Remove Temp Supports for Hor. Bulkheads	Est. Sum: Install & Remove temporary Supports for hor. Bulkheads	2/2/2012
TS0810 1 Install Seal Plate	Est. Sum: Install Seal Plates	2/3/2012
TS0810 1 Remove install Catenary Deflector	Est. Sum: Remove & install Catenary Deflector	2/2/2012
TS0810 1 Remove Reinstall Plugs for the Bulkhead drain holes	Est. Sum: Install & Remove Plugs for the Bulkhead drain holes	2/6/2012
TS0810 1 Repair Vertical Bulkheads	Est. Sum: Repair Vertical Bulkheads	2/2/2012
TS0810 1 Turnover Closeout	Est. Sum: Turnover/Closeout	2/15/2012
Lessons Learned from D2O Storage 2-13	MODIFICATION PLANNING LESSONS LEARNED REPORT	2/27/2013
NK38-REF-03810-0405549 Need Stmt.-Heavy Water Mgmt.	Need Stmt.: Heavy Water Mgmt.	10/3/2011
NK38-REF-34200-0405550 Need Stmt-Neg Pressure Containmt	Need Stmt.: Neg. Pressure Containment	10/3/2011
NPC Cost Estimating Approximations_R01.docx	Email - NPC Cost Estimating Approximations -attachment	2/13/2012
UI D2O NPC cost estimating approximations	Email - 2 attachments: D_2O Cost Estimating Approximations; NPC Cost Estimating Approx.	1/30/2012
Air Lock Seal Drawings	Drawings	
Airlock Seals CATID Price	Screen prints of Master Materials Catalog	
NK38-REF-34200-0405550 Need Stmt-Neg Pressure Containmt	Need Stmt.: Neg. Pressure Containment	10/3/2011
Signed BOE for Barriers FPage	NR Islanding Proj - Basis of Est. Barriers	2/29/2012
Pre-req. DSR Estimates	Est. Sum: U2-Containment Safety Monitoring - Common Containment Pressure	1/27/2012
Signed BOE for Bulkheads FPage	NR Islanding Proj - Basis of Est. Containment Bulkhead	3/8/2012
Signed UI BOE - Summary Front Page	NR Islanding Proj - Gate 1 Summary Basis of Est	4/3/2012
SHD 4b Comparison	Tabs: DSR Database, 4b Data Sum, Shutdown Est, ETC.	3/7/2013
Moderator-PHT BOE	NR RFR – Moderator Auxiliary, PHT & Auxiliary Layup Project - Gate 2 Basis of Estimate	3/1/2013
Moderator-PHT Estimate	Tabs: Ts0890-2; Ts0890-1; Summary	
RE Planning Basis	Email - Fr: Audrey Razo; To: Nicole Zhang	2/22/2013
Re Request for Your Feedback - Roles and Responsibilities	Email - Fr: Lonnie Schofield; To: Ron Chatterton	3/21/2013
PM Signed SG Estimate Summary	SG Bundle - DSR Line Estimate_Scope List as of 8/31/11	9/1/2011
SG BOE-signed with type of doc. changed	Steam Generator Basis of Estimate	11/11/2011

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Signed SG BOE	Steam Generator Basis of Estimate	11/11/2011
FH-Defueling BOE	Darlington – Fuel Handling Refurbishment – Defueling Basis Of Estimate	1/17/2013
FH-Defueling Estimate	FH-DEFUELING DSR COST	
Final Draft Defueling SOW Oct232012	Scope Of Work: Reactor Defueling	10/23/2012
Signed BOE for FH - Defueling FPage	Darlington-Fuel Handling-Refurb-Defueling Basis of Estimate	1/17/2013
FH Refurbishment BOE	Fuel Handling (FH) Basis Of Estimate	12/28/2012
FH Refurbishment Estimate	FH-REFURBISHMENT BUNDLE	
FH Refurbishment Factors Rates and Costs	Hourly Rate Calculation: 10 Hrs / Shift, 2 Shifts (Appendix B, 7 day Coverage); add'l tabs	
Updated DSR fr Sunil May 24, 2012	TSO Approved Scope	
Cable Estimates	Email - attachment, Trolley Cable estimate Rev 00; Fr: Raihan Khondker/ To: Juan Natividad	6/28/2012
Fuel Handling Mtce Jan 292007	Chart	1/29/2007
List of all cables in the trolley	Email - attachments, List of all Trolley Cables & Trolley Cable estimate Rev 00; Fr: R.Khondker/ To: J.Natividad	6/26/2012
Trolley Cable Estimate	Email - attachments, Trolley Cable Qty estimate & Trolley Cable Manhours Est; Fr: R.Khondker/ To: J.Natividad	6/27/2012
DRAS Comparison	Fuel Handling; add'l tabs	
Work Breakdown Structure	breakdown	
Signed BOE FH-Refurbishment FPage	Basis of Estimate	12/28/2012
FH Defueling Work Packages WBS Layout		
FH - Defueling WBS and Work Package Details	Email - attachment, FH Defueling Work Packages; Fr: Sunil Ingle/ To: J.Natividad	4/3/2013
BoE BOP Common	"Common " Sub Project Basis Of Estimate	11/28/2012
BOP Common Estimate	Tabs: DSR Sum., Overall Sum., ETC.	
01-NK38-FEX-20100-2501-01	Reactor Bldg.	
02-NK38-FEX-20100-2502-04	T.H.R.A.B. & Turbine	
03-NK38-FEX-20100-2502-04	T.H.R.A.B. & Turbine	
04-NK38-FEX-20100-2503-06	R.B., R.A.B., Turbine	
05-NK38-FEX-20100-2503-06	R.B., R.A.B., Turbine	
06-NK38-FEX-20100-2504-01	Reactor Bldg	
07-NK38-FEX-20100-2505-02	R.B., R.A.B., Turbine	
08-NK38-FEX-20100-2505-02	R.B., R.A.B., Turbine	
09-NK38-FEX-20100-2506-02	Reactor Bldg & R.A.B.	
10-NK38-FEX-20100-2507-04	R.B., R.A.B., Turbine	
11-NK38-FEX-20100-2507-04	R.B., R.A.B., Turbine	
12-NK38-FEX-20100-2508-00	R.B., R.A.B., Turbine Aux. Bay	
13-NK38-FEX-20100-2509-00	R.B., R.A.B., Turbine Aux. Bay	
14-NK38-FEX-20100-2510-02	Reactor Bldg & R.A.B.	
16-NK38-FEX-20102-0503-00	Equipment Layout	
18-NK38-FEX-20102-0505-00	Equipment Layout	
19-NK38-FEX-20102-0506-00	Equipment Layout	
20-NK38-FEX-20102-0507-00	Equipment Layout	
22-NK38-FEX-20102-0509-00	Equipment Layout	
23-NK38-FEX-20102-0510-00	Equipment Layout	
24-NK38-FEX-20102-0501-02	Site Building Layout	
25-NK38-FEX-20102-0501-02	Site Building Layout	
27-NK38-FEX-20102-2507-01	Equipment Layout	
28-NK38-FEX-20102-2513-00	Equipment Layout Unit Pumphouse	
29-NK38-FEX-20102-0512-00	Equipment Layout Standby Generator	
30-NK38-FEX-20102-0513-00	Equipment Layout Standby Generator	
CBA_ASW Pressure Regulating Valve	DSR Number SI0270-3, ASW Pressure Regulating Valve	9/13/2012
DSR_SI0270-3	Gate Review Form	5/5/2011
Email Recom_11.01.2012	Email - OPG Acceptance of Balance of Plant Scope Feasibility Studies Report; Fr: G.Mills/ To: L.Crisologo	11/1/2012
NK38-F0H-72500-0002_FLOWD_DWG	Ctrl. Svc. Area Aux. Svc. Water Syst. Flow Diagram	
Pipe Price_passport	Screen prints of Master Materials Catalog	
DSR_TS0150-2	Inspect civil structure of Emergency Coolant Injection Storage Tank	1/26/2011
DSR_TS0150-8	CCA 001441 Contingency - ECI Water Storage Tank	1/26/2011
IWST Construction 1	photograph	
IWST Construction 2	photograph	
IWST Construction 3	photograph	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
IWST Construction 4	photograph	
TS0150-2	ECI Water Storage Tank	
CCA001600	Aging Management Program Component Condition Assessment (CCA) Equipment Room Sump(SUO-RIS)	
NK38-REP-0368-10078	Ageing And Actual Condition Of Systems, Structures And Components Safety Factor Report	10/14/2011
CCA000366	Aging Management Program Component Condition Assessment (CCA) MVC Recirculation pump	
DSR_TS0210-15	Negative Pressure Containment: Rebuild or Replace All 3 Pumps (Contingency)	3/2/2011
NK38-D2H-34222-9026_Vacuum Pumps GA Drwg	vacuum pumps	
NK38-DM-34220	Service Manual - Main Vacuum Pumps	
NK38-DM-34220_Vac System Manual	Vacuum Syst. Manual	
NK38-RH-34222_Main Vac Pumps Manual	Vacuum Syst. Manual	
34220 - P 1-3 vacuum pmp	photograph	
DSR_TS0210-17	Negative Pressure Containment: Replace NPC Vacuum System TK 1-4 (Contingency)	3/2/2011
NK38-D2H-34222-9024_TK4 Drwg	Vertical Tank	
NK38-D2H-34222-9025_TK1-3 Drwg	Horizontal Separator Tanks	
NK38-D2H-34222-9026_Vacuum Pumps GA Drwg		
NK38-F5H-34220-0001_Vacuum Flow Diag		
NK38-FXX-34220-0501_NPC Vacuum Sys		
NK38-WAH-34222-9041_NPC Drwg		
CCA000076	Aging Management Program Component Condition Assessment (CCA) Reactor Building Structure	
NK38-PIP-21100-10001	Reactor Building Non-Containment Components Periodic Inspection Program	4/16/2012
NK38-SR-03500-10001	Darlington Safety Report, Part 1 & 2	12/19/2010
CCA000077	Reactor Building Internal Structure	
NK38-PIP-21200-10001	Reactor Building Internal Structure Periodic Inspection Program	3/29/2012
CCA000083	Central Service Area - Nuclear	
NK38-PIP-22600-10001	Central Control Area Periodic Inspection Program	4/29/2012
NK38-PIP-24100-10001	Turbine Support Structure Periodic Inspection Program	6/8/2012
NK38-FEX-27103-1501-00	C.W. & S.W. Pumphouse 1	
NK38-PIP-27110-10001	Circulating Water Pump House Periodic Inspection Program	5/7/2012
Book3	2009 conversion USD - CAD; Equip. - Carried to Summary	
2004 Underwater Inspection Report	Final Report - Underwater Inspection of Circulating Water Intake Tunnel, Intake Structure & Intake shaft	
DSR_TS0510-7_CCA000092	Component Condition Assessment - Pipes, Ducts & Encasements	
DSR_TS0510-17	DNGS Structures: Perform Inspections on Pipes, Ducts Encasements Structures	4/13/2011
NK38-FEX-20102-0516-00	Equipment Layout - EPS Electr. Bldg.	
NK38-FEX-20102-0517-00	Equipment Layout - EPS Electr. Bldg.	
NK38-FEX-20102-0518-00	ESW Pumphouse	
NK38-FEX-20102-0519-01	ESW Pumphouse	
NK38-FEX-78400-0502-03	EPS Fuel Mgmt. Bldg.	
NK38-PIP-28300-10001	Emergency Power Supply And Emergency Service Water Complex Periodic Inspection Program	
NK38-PIP-22200-10001	Turbine Hall and Turbine Auxiliary Bay Periodic Inspection Program	3/29/2012
CCA000085	Component Condition Assessment (CCA) Central Service Area - Conventional Part	
NK38-PIP-22400-10001	Central Service Area –Conventional Periodic Inspection Program	4/17/2012
CCA000085	Aging Management Program Component Condition Assessment (CCA) Central Service Area - Conventional Part	
NK38-PIP-22400-10001	Central Service Area –Conventional Periodic Inspection Program	4/17/2012
CCA000078	Component Condition Assessment (CCA) Reactor Auxiliary Bay including structural and architectural elements	
NK38-PIP-21300-10001	Reactor Auxiliary Bay Periodic Inspection Program	3/20/2012
CCA000079	Component Condition Assessment (CCA) FFAA - West & East	
NK38-FEX-21400-0501-02	Fueling Facilities Aux. Area West	
NK38-FEX-21400-0502-01	Fueling Facilities Aux. Area West	
NK38-FEX-21400-0503-02	Fueling Facilities Aux. Area West	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
NK38-FEX-21400-0504-05	Fueling Facilities Aux. Area West	
NK38-FEX-21400-0505-02	Fueling Facilities Aux. Area West	
NK38-FEX-21400-0506-01	Fueling Facilities Aux. Area	
NK38-FEX-21400-0507-01	Fueling Facilities Aux. Area West	
NK38-PIP-21400-10001	Fuelling Facilities Auxiliary Area Periodic Inspection Program	
NK38-PIP-21500-10001	Irradiated Fuel Area (West and East) Periodic Inspection Program	
CCA000081	Component Condition Assessment (CCA) Fuel Handling & Service Area	
NK38-PIP-21600-10001	Fuel Handling and Service Area (West and East)Reception Bay Periodic Inspection Program	
CCA000077	Component Condition Assessment (CCA) Reactor Building Internal Structure	
CCA000083	Component Condition Assessment (CCA) Central Service Area - Nuclear	
NK38-PIP-24100-10001	Turbine Support Structure Periodic Inspection Program	
CCA000090	Component Condition Assessment (CCA) Pumphouse	
DSR_TS0510-23	DNGS Structures: Repair/Replacement of Pipes, Ducts, and Encasements (Contingency)	4/13/2011
nk38_bom_27117	Removal of Submerged Injection Piping in Ul Pumphouse	
nk38_d5h_27121_1001_intake tunnel	CW Syst. Structures Intake Tunnel	
nk38_d5h_27141_2003_intake pipe	Pumphouse to Powerhouse Intake Pipes	
nk38_d5h_27141_5001-u2_intake pipe misc	Pumphouse to Powerhouse Intake Pipes & Manifold	
nk38_d5h_27141_pipe earth excav	Pumphouse to Powerhouse Concrete Press Pipe	
nk38_draw_27113_pipe sleeve	CW Pumphouse No. 2 Pipe Sleeve	
nk38_draw_27117_10001_injection piping	CW Syst. Structures, CW Pumphouse, Chlorine Injection Piping Support	
nk38_draw_27117_injection piping	CW Syst. Structures, CW Pumphouse, Chlorine Injection Piping Support	
nk38-rep-27124-10001_Underwater_inspection	Final Report - Underwater Inspection of Circulating Water Intake Tunnel, Intake Structure & Intake shaft	
CCA000084	Component Condition Assessment (CCA) Turbine Hall & Turbine Auxiliary Bay civil/ structural elements	
CCA000469	Component Condition Assessment (CCA) Fire Protection Panel (Conventional)	
CP—35	Siemens CP-35 System 3™ Control Panel	
NK38-FEX-67861-0501-04	Inactive Chem. Waste Transfer Facility Fire Panel	
NK38-FEX-67870-0501-11	Fire & Smoke Detection Syst. Panels	
NK38-FEX-67870-0505-05	Domestic Waste Water Pumphouse	
NK38-FEX-67870-0507-02	Fire & Smoke Detection Syst. Panels	
NK38-FEX-78400-0501-01	CO2 Fire Protection	
NK38-FEX--78400-0502-03	CO2 Fire Protection	
NK38-FEX-78400-0503-02	CO2 Fire Protection	
NK38-FEX-78400-0504-02	CO2 Fire Protection	
NK38-FEX-78610-0501-02	Inactive Chem. Waste Transfer Facility Fixed	
Ansul_Bladder Tank Sight Gauge	Bladder Tank Sight Gauge; Hydraulic Concentrate Control Valve	
Ansul_Bladder_Specs	Vertical & Horizontal Bladder Tanks	
Ansul_Drawings_Specs	Typical Bladder Tank Syst. Piping Requirements	
ANSUL_Email_Prices	Email - OPG CID 187668; Fr: Robert Whiting/ To: Liza Crisologo	11/19/2012
Bladder tank drawing	Drawing	
CCA 000707	Component Condition Assessment (CCA) Foam Concentrate Tank	
DSR_TS0660-2	Fire Protection System: Replace Diaphragm of the Foam Concentrate Tanks	4/13/2011
Email_Ansul Quote	Email - OPG CID 187668; Fr: Yatin Nayak/ To: G. Mills	10/3/2012
Existing Diaphragm drawing	drawing	
Flow Diagram	Standby Generators, Oil Tanks Foam Fire Protection System	
Flowsheet	Air Form Fire Protection	
Foam Fire Protection Piping	Standby Generator Fuel Mgmt. Bldgs. #1 & #2	
FW bladder tanks	Email - attachments, Vertical Bladder Tank, Bladder Replacement vertical, picture	
FW OPG CID 187668	Email - attachments, Vertical & Horizontal Bladder Tanks svc. Manual/specs & drawing	
RE BOP-CS DSR TS0660-2 - Replace Diaphragm of the Foam Concentrate Tanks	Email - attachment, CHUBB Fire Security Installation, Operation & Maint. Manual	
NK38-D1H-24900-9021	Ground Floor Plans	
Appendix C_Productivity Factors (1)	Tabs: Rubber Day/Night 10, Zone 1/2	
Appendix D_Height factor	Appendix D: Height Factors	
Appendix E_Crew Rates_Factors	Tabs: shifts for Pipefitters, Boilers, and Electr.	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Appendix F_Indirect cost	Tabs: Auditing, Site ofc., Summary, BOE	
Appendix A_CS Summary	CS System DSR Line Estimate _ Scope List - as of Nov 6, 2012 (In $K) / Provided from database; several tabs included	
Appendix A_Estimate Summary_11 28 2012	CS System DSR Line Estimate _ Scope List - as of Nov 6, 2012 (In $K) / Provided from database	
Appendix A_System_Summary	Tabs: FIRE PROTECTION-SUMMARY, NPC REPAIRS-SUMMARY, MCR HVAC UPGRADES - SUMMARY, STRUCTURES -SUMMARY	
Appendix B_Project Breakdown of DSR	The 38 Darlington Scope Review (DSRs) items approved by the SRB (and pending approval as noted) for the CS Systems Sub-Bundle	
Appendix C_Productivity Factors	Appendix- C: Productivity Factors	
Appendix D_Height factor	Appendix D: Height Factors	
Appendix E_Crew Rates_Factors	Appendix-E: Crew Rates	
Appendix F_Eng Assessment and Mods	APPENDIX F- Assessment Engineering and Modification Works; add'l tabs	
Appendix F_Indirect cost	Appendix -F: Indirect Cost; add'l tabs	
Appendix G_RFI -List-Common Systems.docx	Appendix G: RFIs, Emails & references; emails, status reports, etc. included in file	
Appendix H_Detailed Estimates	CS System DSR Line Estimate _ Scope List - as of Nov 6, 2012 (In $K) / Provided from database; add'l tabs	
BOP CS BOE R000_11 28 2012	Darlington Refurbishment Balance of Plant (BOP) “Common ” Sub Project Basis Of Estimate	
BOP_CS_Index	BOP Common Systems Sub-bundle	
BOP Conventional BoE	Darlington Refurbishment Balance of Plant (BOP) “Conventional ” Sub Project Basis Of Estimate	
BOP Conventional Estimate	Tabs: DSRs List, BOP_TS (Summary), individual DSR tabs	
Answer for RFI 019	Request for Info: BOP - Conventional Sub-Bundle	9/11/2012
Conventional system_RFI 009_08 29 2012	Clarify the cost arrangement	8/29/2012
Conventional system_RFI 010_08 29 2012_	Clarify the scope, DSR - TS 0530 -1, DSR - TS 0530-3 (CCA-000144 related to the DSR)	8/29/2012
Conventional system_RFI 011_08 30 2012	Clarify the scope, DSR - TS 0840 -3 (CCA- related to the DSR ; Not applicable).	8/30/2012
Conventional system_RFI 013_09 04 2012	Clarify the scope, TS-0560-9, related with CCA 001732	9/4/2012
Conventional system_RFI 014_09 04 2012	Clarify the scope, TS-0170-1, related with CCA 000337	9/4/2012
Conventional system_RFI 016_09 06 2012	TS-0570-21, related with CCA 001296	9/6/2012
Conventional system_RFI 018_09 010 2012	TS-0570-25, related with CCA 001313	9/10/2012
Conventional_RFI012_30.08.2012	TS0630-7/TS0630-11	8/30/2012
Conventional_RFI015_05.09.2012	SI0280-2, SI0280-3, SI0390-1, TS0590-22	9/5/2012
Conventional_RFI017_07.09.2012	TS0590-22, TS0590-18, TS0610-17	9/7/2012
Conventional_RFI019_11.09.2012	TS0610-17, TS0610-3, TS0610-18, TS0610-22, TS0610-3/18/22	9/11/2012
F+G RFIs_client answer	RFI Master List; add'l tabs per RFI included	
RFI -List-Conventional	Appendix G : RFI/Reference- List	
Design Basis	documents sourced from OPG systems in support of information provided from the DSR database	
CCA 000337	Component Condition Assessment (CCA) MCCs, contactor, motor starter	
NK38-F3S-53397-0018	600V Distr., EPS Reactor Aux Bay, EPS MCC 821	
NK38-FXX-53390-1501-04	Unit, 600V EPS Distr. Syst.	
NK38-F0S-55490-0002	129V CC Distr. Syst.	
NK38-F0S-55590-0002	4 BV DC Distr. Syst.	
NK38-F0S-55590-0003	4 BV DC Distr. Syst.	
NK38-FEX-55410-0501	Common 125V DC Class 1 Pwr. Supplies	
NK38-FEX-55410-1501	Unit 1 125V DC Class 1 Pwr. Supplies	
NK38-FEX-55510-0501	Common 48V Class 1 Pwr. Supplies	
NK38-FEX-55510-0502	Common 48V Class 1 Pwr. Supplies	
NK38-FEX-55510-1501	Common 48V Class 1 Pwr. Supplies	
NK38-FEX-55510-1502	Common 48V Class 1 Pwr. Supplies	
NK38-F0S-55490-0002	128V DC Distr. Syst.	
NK38-F0S-55590-0002	48V DC Distr. Syst.; EPS Powerhouse	
NK38-F0S-55590-0003	48V DC Distr. Syst.; EPS Powerhouse	
NK38-FEX-55410-0501	Common 125V DC Class 1 Pwr. Supplies	
NK38-FEX-55410-1501	Unit 1 125V DC Class 1 Pwr. Supplies	
NK38-FEX-55510-0501	Common 48V DC Class 1 Pwr. Supplies	
NK38-FEX-55510-0502	Common 48V DC Class 1 Pwr. Supplies	
NK38-FEX-55510-1501	Common 48V Class 1 Pwr. Supplies	
NK38-FEX-55510-1502	Common 48V DC Class 1 Pwr. Supplies	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
CCA 000049	Component Condition Assessment (CCA) Distribution Bus	
NK38-CMP-53307-03-R012	KLOCKNER MOELLER SERIES 200 MOTOR CONTROL CENTRE INSPECTION AND MAINTENANCE	
NK38-D1S-53320-9012	Automatic Transfer Switch	
NK38-D1S-53320-9014	Ctrl. Panel Parallel Syst.	
NK38-D1S-53320-9016	Channels A&B 347/600V Class II	
NK38-E3S-53320-9018-SHT0004	D2O/TRF Bldg.	
WMS-Equipments list	List	8/31/2012
ABB product list	list	
CCA 000048	Component Condition Assessment (CCA) Transformers	
NK38-D1S-53320-9016	Channels A&B 347/600V Class II	
NK38-D1S-53320-9017	Channels A&B 347/600V Class II	
NK38-F0S-53520-0001-U2	120V/208V AC Class II Distr. Syst.	
NK38-F0S-53520-0002-R011	120V/208V AC Class II Distr. Syst.	
NK38-F1S-53520-0005-R007	Unit 1 Ctrl. Computer	
ABB-TX price list	Transformers	
CCA 000048	Component Condition Assessment (CCA) Transformers	
NK38-F1S-53520-0005-U2-R007	Unit 1 Ctrl. Computer	
CCA 001732	Component Condition Assessment (CCA) Transformers, 4 kV (10MVA) (oil)	
NK38-D1S-53202-9001	drawing	
NK38-D2S-53202-9005-U2	wiring diagram distr. Syst. Transformer	
NK38-FEX-53240-1501-01	Electr. Pwr. Distr. Unit 4	
CCA 001292 (1)	Component Condition Assessment (CCA) Isolated Phase Bus	
NK38-D0S-51100-0001-U2	Generator Voltage Output Syst.	
NK38-D3S-51100-0002-U2	Generator Voltage Output Syst. Isolated Phase Bus Electr. Arrng. - Isometric	
NK38-D4S-51100-9031-U2	Deionizing Grid Syst.	
NK38-F1S-51100-9012-REV 007	Isolated Phase Bus Cooling Syst. Flow Diagram	
NK38-M4S-51100-9017-SHT002	Isolated Phase Bus	5/26/1986
CCA 001301	Component Condition Assessment (CCA) Main Switch	
NK38-D1S-52120-9008-REV9	Unit Service Transformer	
NK38-D1S-52520-9014-REV13	Syst. Svc. Transformer	
NK38-D3S-51521-9006-U2	Main Output Transformer	
NK38-D3S-51521-9007-REV005	Main Output Transformer	
NK38-D5S-51521-9008-B	Main Output Transformer	
NK38-D5S-51521-9009-A	Main Output Transformer	
Passport finding- equipment location	Screen Prints of TIMD030-Equipment/Component Header	
CCA 001323	Component Condition Assessment (CCA) Switchyard Voltage Transformer	
NK38-DM-51500-R001	500 KV OUTPUT SYSTEM Design Manual	
NK38-DXS-15400-0031-R1	Proposal, Land Use & Planting Programme	
NK38-OM-51000-R055	MAIN POWER OUTPUT	11/14/2011
CCA 001292	Component Condition Assessment (CCA) Isolated Phase Bus	
NK38-CMP-51150-01-REV011	Ctrl. Maint. Procedure, Isolated Phase Bus Link Removal, Install. & Meggering, IPB Inspection & Cubicle Checks	
CCA 001296	Component Condition Assessment (CCA) Main Output Transformer	
NK38-CMP-51520-01-REV 001	Ctrl. Maint. Procedure, MAIN OUTPUT TRANSFORMER ROUTINE MAINTENANCE	
NK38-FEX-51520-2501-01	Main Output Transformer, One Phase	
CCA 001296 (1)	Component Condition Assessment (CCA) Main Output Transformer	
NK38-CMP-51520-01-REV 001	Control Maintenance Procedure MAIN OUTPUT TRANSFORMER ROUTINE MAINTENANCE	
NK38-FEX-51520-2501-01	Main Output Transformer, One Phase	
CCA 001305	Component Condition Assessment (CCA) Unit Service Transformer	
NK38-D0S-52120-0002-U2	Gen. Voltage Sta. Serv. Sup. Sys. Unit Serv. Transformer T2	
NK38-D1S-52120-9003-U2	Unit Service Transformer	
NK38-WAS-52120-9021-REV05	Westinghouse Instruction Book No. CT-289, Four 80 MVA Type OFAF Three-Phase	
CCA 001296	Component Condition Assessment (CCA) Main Output Transformer	
NK38-CMP-51520-01-REV 001	Control Maintenance Procedure MAIN OUTPUT TRANSFORMER ROUTINE	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
	MAINTENANCE	
NK38-FEX-51520-2501-01	Main Output Transformer One Phase	
CCA 001305	Component Condition Assessment (CCA) Unit Service Transformer	
NK38-D0S-52120-0002-U2	Gen. Voltage Sta. Serv. Sup. Sys. Unit Serv. Transformer T2	
NK38-D1S-52120-9003-U2	Unit Service Transformer	
NK38-WAS-52120-9021-REV05	Westinghouse Instruction Book No. CT-289, Four 80 MVA Type OFAF Three-Phase	
NK38-D0S-52520-0002-U2	500KV Station Serv. Supply Sys. Transformer T3	
NK38-D0S-52520-0002-U2	500KV Station Serv. Supply Sys. Transformer T3	
NK38-CMP-53130-01	Control Maintenance Procedure STANDBY GENERATOR BUS MAINTENANCE	
NK38-CMP-65300-28	Control Maintenance Procedure CALIBRATION GUIDE FOR PROTECTIVE RELAYING ASSOCIATED WITH 13.8 KV SWITCHGEAR ASSEMBLIES	
NK38-D1S-53103-9020	13.8 KV Distribution System	
NK38-F0S-53130-0001	13.8 KV Distribution System	
NK38-FXX-53130-0501	Electr. Pwr. Distr. 13.8 KV Class III/IV	
Conventional system_RFI 009_08 29 2012	BoP -Conventional Sys Sub-Bundle	
Conventional system_RFI 010_08 29 2012_	DSR - TS 0530 -1, DSR - TS 0530-3 (CCA-000144 related to the DSR);	
Conventional system_RFI 011_08 30 2012	DSR - TS 0840 -3 (CCA- related to the DSR ; Not applicable)	
Conventional system_RFI 013_09 04 2012	TS-0560-9, related with CCA 001732	
Conventional system_RFI 016_09 06 2012	TS-0570-21, related with CCA 001296	
Conventional system_RFI 018_09 010 2012	TS-0570-25, related with CCA 001313	
Conventional_RFI012_30.08.2012	TS0630-7/TS0630-11	
Conventional_RFI015_05.09.2012	SI0280-2, SI0280-3, SI0390-1, TS0590-22	
Conventional_RFI017_07.09.2012	TS0590-22, TS0590-18, TS0610-17	
Conventional_RFI019_11.09.2012	TS0610-17, TS0610-3, TS0610-18, TS0610-22, TS0610-3/18/22	
F+G RFIs_client answer	RFI Master List; add'l tabs per RFI included	
RFI -List-Conventional	Appendix G : RFI/Reference- List	
NK38-CMP-53140-01-REV007	Control Maintenance Procedure 13.8KV BUS INSPECTION AND MAINTENANCE	
NK38-CMP-53200-01-REV003	Control Maintenance Procedure 4.16 KV BUS INSPECTION AND MAINTENANCE	
NK38-F0S-53230-0001-U2	4.16KV Distr. Syst. Class III (Unit)	
RFI -List-Conventional	Appendix G : RFI/Reference- List	
BOP Pre-Refurb Estimate	PRE-REFURBISHMENT- DSR Line Estimate _ Scope List - as of Mar 8, 2013 (In $K) / Provided BY PM; add'l tabs included	
BOE BOP Pre-Refurb	Darlington Refurbishment Balance of Plant (BOP) "Pre-Refurbishment " Sub Project Basis Of Estimate	
Appendix A_ PR System_Summary	Tabs: ESW, ALW, VALVES, CONTROLLERS	
Appendix B_Project Breakdown of DSR	The 8 Darlington Scope Review (DSRs) items included in the BOP Pre-refurbishment Sub-Bundle.	
Appendix C_Productivity Factors	Appendix- C: Productivity Factors	
Appendix D_Height factor	Appendix D: Height Factors	
Appendix E_Crew Rates_Factors	ES MSA Hourly Rate Calculation: 10 Hrs / Shift, 2 Shifts (EPSCA : Appendix B, 7 day Coverage); Add'l Tabs included	
Appendix F_Mods 021513	OPG- MODIFICATION PROCESS - COST ESTIMATING	
Appendix G_Correspondence	RFIs, Emails & references	
BOP Reactor Estimate	BOP Reactor Systems - Overall Estimate Summary	
BOP Reactor Factors Rates+Costs	Appendix- C: Productivity Factors; add'l tabs	
BOP Reactor BoE	Darlington Refurbishment Balance of Plant (BOP) "Reactor Systems" Sub Project Basis Of Estimate	8/28/2012
BOP_RS_Appendix G_Emails	Emails	
BOP_RS_Appendix G_RFI List	RFI List	
BOP_RS_Appendix G_RFI006_RFI007	Emails	
1_Supporting Docs_Design Basis	List of reference docs	
SI0300-30	Strategic Outage Improvements: Dedicated Vault Vapour Relocated Flowpaths for Ice Plus	5/5/2011
SI0300-31	Strategic Outage Improvements: Dual Pwr. Supple for Vault Vapour Recovery Purge Dryer	5/5/2011
SI0300-36	Strategic Outage Improvements: Provide On-Line De-Tritiation Capability for Heat Transport	5/5/2011
TS0070-1	Inspect End Shield Cooling Expansion Tanks	1/26/2011
TS0070-2	Inspect Piping of End Shield Cooling System	1/26/2011
TS0070-3	Contingency - End Shield Cooling Expansion Tanks	1/26/2011

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
TS0070-4	Contingency - Piping Associated with End Shield Cooling	1/26/2011
TS0080-10	Contingency - Moderator Pumps	1/26/2011
TS0090-1	Overhaul & Inspect the Two Main HT Pumps w/ Cover Gasket Leaks	1/26/2011
TS0090-3	Inspect One Representative PHT Purification Strainer	1/26/2011
TS0090-4	Inspect Collection Tank, Vent Condenser Tank, & Collection Tank Coolers on U2	1/26/2011
TS0090-7	Replace the Switch Modules & Connecting Cable Associated w/ PHT Trip Press. Switches	1/26/2011
TS0090-12	Contingency - Refurbish All PHT pumps	1/26/2011
TS0090-14	Contingency - Extend Collection Tank Inspection to the Rest of the Units	1/26/2011
TS0100-3	DNGS Primary Heat Transport Pressure & Inventory Ctrl: One-Time Inspection of Piping	3/11/2011
TS0110-1	Video Inspection of Shell Side	1/26/2011
TS0110-4	Inspect Flow Orifices (x28)	1/26/2011
TS0120-2	Darlington Arilocks & Transfer Chambers: Replacement of non EQ Pressure Switches	4/13/2011
TS0200-3	Liquid Zone Ctrl. Syst.: Replace the Recombination Units	3/2/2011
TS0200-5	Liquid Zone Ctrl. Syst.: Replace the Recombination Units (Contingency)	3/2/2011
TS0210-12	Neg. Pressure Containment: Replacement of all Reactivity Mechanism (RMD) Seals	3/2/2011
TS0320-1	Refurbish all PHT Pump Motors	12/6/2010
TS1370-1	Vapour Recovery - Part 3: Replace all the Dryers	5/5/2011
TS1370-2	Vapour Recovery - Part 3: Replace all the Dryers (Contingency)	5/5/2011
TSO110-16	Contingency for HX	1/26/2011
0_BOE Signed	Darlington Refurbishment BOP 'Reactor Systems' Sub Project Basis of Estimate	8/28/2012
1_BOP RS BOE R000_08.28.2012	Darlington Refurbishment Balance of Plant (BOP) “Reactor Systems” Sub Project Basis Of Estimate	8/28/2012
2_Overall Summary signed	Scanned, BOP Reactor Systems - Overall Estimate Summary	
3_Funding Stream Signed	Scanned documents	
5_Appendix A_Overall and Per System Summaries	Scanned docs, BOP Reactor Systems Overall Estimate Summary	
6_Appendix B_WBS from PM	Scanned doc, Applicable DSR	
7_Appendix C_Productivity Factors	Scanned docs	
8_Appendix D_Height Factor	Scanned docs, Appendix D: Height Factors	
9_Appendix E_Crew Rates	Scanned docs, ES MSA Hourly Rate Calculation: 10 Hrs / Shift, 2 Shifts (EPSCA : Appendix B, 7 day Coverage)	
Appendix G	Scanned doc, RFI List	
Appendix G_Emails	Emails	
Appendix G_RFI006_RFI007	Emails	
0_BOE Signed	Darlington Refurbishment BOP 'Reactor Systems' Sub Project Basis of Estimate	8/28/2012
1_BOP RS BOE R000_08.28.2012	Darlington Refurbishment Balance of Plant (BOP) “Reactor Systems” Sub Project Basis Of Estimate	8/28/2012
2_Overall Summary signed	Scanned, BOP Reactor Systems - Overall Estimate Summary	
3_Funding Stream Signed	Scanned documents	
5_Appendix A_Overall and Per System Summaries	Scanned docs, BOP Reactor Systems Overall Estimate Summary	
6_Appendix B_WBS from PM	Scanned doc, Applicable DSR	
7_Appendix C_Productivity Factors	Scanned docs	
8_Appendix D_Height Factor	Scanned docs, Appendix D: Height Factors	
9_Appendix E_Crew Rates	Scanned docs, ES MSA Hourly Rate Calculation: 10 Hrs / Shift, 2 Shifts (EPSCA : Appendix B, 7 day Coverage)	
Appendix G	Scanned doc, RFI List	
Appendix G_Emails	Emails	
Appendix G_RFI006_RFI007	Emails	
BOP DSR	DSR List	
BOP_Gate1_WP1	DSR List	
Accepted BOP Estimating	Outlook Mtg. Response	2/3/2012
Accepted BOP Summary BOE	Outlook Mtg. Response	3/21/2012
Below is the UPDATED DRAFT Timeline based on Garry Rutledge input	BOP SAFETY AND CONTROLS SYSTEM GATE 1 (based on Gary Rutledge input)	
BOE Comments	Email - attachments, BOE_Sbagshaw Comments_2012-03-03 / BOE_Summary_SBagshawComments_2012-03-03	3/3/2012
BOE	Email - Fr: Jennifer Nodwell / To: Ian Wright; request for BOE, Summary Table & Estimate Sheets on gate submission	3/13/2012
BoEs	Email - Fr: Ian Wright / To: Jennifer Nodwell; Ian hasn't recvd. Updated BoEs	3/5/2012

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
BOP - Safety and Control Sub-Bundle	Includes links to Sharepoint	1/10/2012
BOP - SCS Estimates	Email - Fr: Sean Bagshaw / To: Ian Wright	2/10/2012
BOP Fee	Total hrs & rates	
BOP Overview Package	Email - Outlook mtg. request	4/2/2012
BOP Summary Report	Email - Fr: Gary Rutledge / To: Lonnie Schofield; request for Summary Rpt. updated	5/8/2012
BOP_WP1.4_ Prereq Mods BOE R0_ Feb 27	NR Islanding Project – Basis of Estimate – Pre-requisite Modifications	
CANDU Reactivity Devices		1/1/2008
DSR_IP0510-7	ISR Acceptable Deviations - Contingency: Shut Down Systems	4/27/2011
DSR_SI0270-2	SPV - Potential Redesign for Refurbishment: Logic and Control Modules	5/5/2011
DSR_TS0220-1	Darlington Reactor Regulating: Inspection of the Spiroid Gear Set	3/2/2011
DSR_TS0220-2	Darlington Reactor Regulating: Replace Gear Boxes Based on Results of D1111 (Contingency)	3/2/2011
DSR_TS0220-3	Darlington Reactor Regulating: Replace Control Absorber Rods and Adjusters (Contingency)	3/2/2011
DSR_TS0220-5	Darlington Reactor Regulating: Replace All RRS Flux Detectors	3/2/2011
DSR_TS0220-13	Darlington Reactor Regulating: Replace Spiroid Gear Set (Contingency)	3/2/2011
DSR_TS0220-14	Darlington Reactor Regulating: Review the Phase I Outputs of COG Project	3/2/2011
DSR_TS0220-15	Darlington Reactor Regulating: Reactivity Worth Check	3/2/2011
DSR_TS0220-16	Darlington Reactor Regulating: Inspection of Worm Gear Boxes	3/2/2011
DSR_TS0240-10	Shutdown System 1 Process: Replace All 228 Vertical Flux Detectors	3/2/2011
DSR_TS0260-1	Shutdown System 2 Process: Perform Video/Visual Inspection on 1-34710-TK4	3/2/2011
DSR_TS0260-8	Shutdown System 2 Process: Replace all SDS2 In-Core Flux Detectors	3/2/2011
DSR_TS0260-9	Shutdown System 2 Process: Replace 34710-TK4 (Contingency)	3/2/2011
DSR_TS0350-1	Replacement of the SDS1 Trip Computers	12/22/2010
DSR_TS0350-2	Replacement of the SDS1 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-3	Replacement of the SDS1 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-4	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-5	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-10	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-11	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-12	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-13	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-14	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-15	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-16	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-17	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
DSR_TS0350-18	Replacement of the SDS2 Trip Computers (Item #1)	12/22/2010
Darlington SDS Refurb	Darlington SDS Computers Refurbishment Level 1 Logic/Schedule	
BOP Safety and Controls BOER000	Balance of Plant “Safety and Control Systems” Sub Projects (BOP) Basis Of Estimate	1/3/2012
Signed Copy	Darlington Refurbishment BOP "Safety & Control Systems" Sub Project Basis of Estimate	1/3/2012
BOP Safety and Controls Summary BOER000 030412 _2__05 25 2012 _3_	Darlington Refurbishment Balance of Plant (BOP) “Safety and Control Systems” Sub Project For BOP & SIO Summary Basis Of Estimate	5/25/2012
BOP Safety and Controls BOER000	Balance of Plant “Safety and Control Systems” Sub Projects (BOP) Basis Of Estimate	1/3/2012
BOP Safety and Controls Summary BOER000 030412 (2)	Darlington Refurbishment Balance of Plant (BOP) “Safety and Control Systems” Sub Project For BOP & SIO Summary Basis Of Estimate	4/12/2012
BOP Safety and Controls Summary BOER000 030412 (2)_rev105.25.2012	Darlington Refurbishment Balance of Plant (BOP) “Safety and Control Systems” Sub Project For BOP & SIO Summary Basis Of Estimate	4/13/2012
BOP Safety and Controls Summary BOER000 030412 (3)	Darlington Refurbishment Balance of Plant (BOP) “Safety and Control Systems” Sub Project For BOP & SIO Summary Basis Of Estimate	4/18/2012
BOP Safety and Controls Summary BOER000 030412	Balance of Plant “Safety and Control Systems” Sub Projects (BOP) Summary Basis Of Estimate	2/3/2012
BOP Summary Errata	DARLINGTON REFURBISHMENT BALANCE OF PLANT (BOP) “SAFETY AND CONTROL SYSTEMS” SUB PROJECTS SUMMARY BASIS OF ESTIMATE	4/18/2012
BOP S+C BoE	Darlington Refurbishment Balance of Plant (BOP) “Safety and Control Systems” Sub Project For BOP & SIO Summary Basis Of Estimate	5/25/2012
bop summary R001 (2) (Final032712)	Scope List - as of March 09, 2012	3/9/2012
bop summary R001	Scope List - as of Feb. 28, 2012	2/28/2012
BOP	Tabs: DCMS, DSR Calc	

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
bopDSR List (4)	dbo_MASTER_SYS_LINEITEM	
Copy of BOP_GRB_04 03 2012 (8)	DSRs; add'l tabs	
Copy of BOP_GRB_04 03 2012 (8)_REV1_05.23.2012	DSRs; add'l tabs	
Copy of BOP_GRB_04 03 2012 (9)	DSRs; add'l tabs	
BOP S+C Estimate	BOP Summary DSR, PROJECT - SUMMARY ESTIMATE +/- 00%; add'l tabs	2/27/2011
BOP007_TS03500-1-18_Estimate	TS0200-3 - BOP007 - Replacement of SDS2 Trip Computers; add'l tabs	
Estimate SDS Computer Replacement	TS0200-3 - BOP007 - Replacement of SDS2 Trip Computers; add'l tabs	8/23/2011
Estimate SDS Computer Replacement_rev1	TS0200-3 - BOP007 - Replacement of SDS2 Trip Computers; add'l tabs	8/23/2011
BOP S+C 1A BOE	Balance of Plant "Safety and Control Systems" Sub Projects (BOP) Basis Of Estimate	3/13/2013
BOP S+C 1A Estimate	Appendix A_DSR Summary by DSR; add'l tabs	4/29/2012
Preparatory Work	Tabs: Excitation, Turbine Ctls, Pwr. Cables, etc.	
TG BOEN	Turbine Generator (TG) Basis Of Estimate	9/13/2011
TG Signed BOE Sheet	Turbine Generator (TG) Basis Of Estimate	9/13/2011
Approved Scope by Project-2.xlsb	Scope List - as of August 18, 2011 (In $K)	8/18/2011
Approved TG DSR List Page 1	PAGE 1, Scanned Doc: …System DSR Line Estimate_Scope List	8/18/2011
Approved TG DSR List Page 2	PAGE 2, Scanned Doc: …System DSR Line Estimate_Scope List	8/18/2011
Approved TG DSR List Page 3	PAGE 3, Scanned Doc: …System DSR Line Estimate_Scope List	8/18/2011
Scope Summary August 31 2011 (Revised 030911 IMW)	Scope List - as of August 18, 2011 (In $K)	8/18/2011
Canceled Turbine Generator - F G Class 5 Estimate Update and Review	Email: Mtg. Cancellation	8/2/2011
Dale	Digital Plant Control Systems and Plant Simulators	
Bearings 1 (thrust 2)	Organizational Chart	4/1/2010
Bearings 3+4	Organizational Chart	
Bearings 5,6+7	Organizational Chart	
HI POT Testing	D1021 HI POT Testing Org Chart	
HP Turbine Overhaul	D1021 HP Turbine Overhaul, Org Chart	
LP 2 Overhaul	D1021 LP 2 Overhaul (with BCH in Place), Org Chart	
LP1 Overhaul	D1021 LP1 Overhaul Org Chart	
LP2 Cleaning Logic	D1041 LP2 Cleaning Logic Org Chart	
MSR Inspection	D1021 MSR Inspection Org chart	
NR TURBINE GENERATOR WORK ORDER MATRIX	NR TURBINE GENERATOR WORK ORDER MATRIX	
Slip Ring Grind	1021 Slip Ring Grind WO #1762744	
Stage 5 Liner Repair	LP1, LP2 & LP3 Stage 5 Liner Repair	
Standardization of network technologies	Alstom	
Steam turbines	Article	8/1/2007
STOP GOV Valves MV1 MV2 MV3 MV$	D1021 - STOP/GOV Valves MV1, MV2, MV3 & MV4	
The Alstom control system ALSPA Controplant is designed for energy applications	Alstom Control System ALSPA Controplant	
Unit 2 HP Large Scale	Turbine Overhaul	
Unit 2 HP Spindle Removal	Spindle Removal	
Apendiix F PWU 10HR Burdened Pipefitters	Shifts	
Appendix B TG Work Breakdown Structure	WBS Code & Name	
Appendix D Productivity Factors 10 Hr Shift Z2	Basic Shift	
Appendix E Height Factors	Height	
Appendix F -1 Crew Rate 10Hr	2011 Overnight Burdened Rate	
Appendix F CSU+PWU 10Hr Burdened Electrician	10 hr day shift	
Appendix F PWU 10Hr Burdened Boilermakers	10 hr day shift	
Appendix F PWU 10Hr Burdened Machinist	10 hr day shift	
Appendix F PWU 10Hr Burdened Millwright	10 hr day shift	
Appendix F PWU 10Hr Burdened MTE	10 hr day shift	
Appendix G Estimators Assumptions and Instructions	Release 4 AACE 5 Estimating Assumptions/Instructions	
Appendix H Control Systems Draft_ Estimate_TGSI_25.08.11	TG summary DSR Line No. SI0010-1	
Appendix H Excitor Draft_ Estimate_TGSI_25.08.11	TG summary DSR Line No.	
Appendix I Revised Estimate Range 03 September 2011	TG System DSR Line Estimate Scope List	
SI0010-1	TG ELECTRONIC CONTROL SYSTEM	8/29/2011
SI0020-1	OBSOLETE GENERATOR EXITATION SYSTEM	7/21/2011
SI0020-2	INSPECT, TORQUE CHECK AND CLEAN 830 VOLT AC	8/2/2011
SI0020-3	REPAIR 830 VOLT AC BUS SECTIONS	8/2/2011

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
SI0270-1	INSTALLATION OF NEW SPV FOR INCREASED REDUNDANCY	8/2/2011
SI0280-1	FIELD WORK RECONFIGURE CONDENSOR TUBE $	8/2/2011
SI0300-16	INSTALL 15 TONNE CAPACITY CRANE	8/2/2011
SI0300-18	LP CASING DOWELS	8/2/2011
SI0300-19	COMPONENT SWAPPING AND OFFLINE OVERHAUL CREW	8/2/2011
TS0680-1 (1 OF 6)	UNIT 1- 1st Stage GV 1 to 4-41870-MV1, MV-2	7/28/2011
TS0680-1 (2 OF 6)	UNIT 1- 2nd Stage GV 1 to 4-41880-MV1, MV-2 $	8/2/2011
TS0680-1 (3 OF 6)	UNIT 1- Separator GV 1 to 4-48100-MV16, MV17, MV18 & MV19	8/2/2011
TS0680-1 (4 OF 6)	UNIT 1- HP Drain GV 1 to 4-48500-MV30 &MV192	8/2/2011
TS0680-1 (5 OF 6)	UNIT 1 -HP Turbine Extraction GV 1 to 4-48100-MV22 & MV23	8/2/2011
TS0680-1 (6 OF 6)	UNIT 1- HP DRAIN GV 1 to 4-48500- MV36, MV48, MV115, MV121, MV145, MV151, MV1	8/5/2011
TS0680-4 (1 OF 3)	X-48100-NV1/2/3 LP TURBINE 1,2 & 3	8/2/2011
TS0680-4 (2 OF 3)	X-48100-NV10/11/12/13 HEADER 4	8/2/2011
TS0680-4 (3 OF 3)	X-48100-NV14 DEAERATOR	8/2/2011
TS0680-6 (3 OF 6)	UNIT 1 Separator GV 1 to 4-48100-MV16, MV-17, MV18 & MV19	8/4/2011
TS0680-6 (4 OF 6)	UNIT 1 HP Drain GV 1 to 4-48500-MV30 & MV192	8/4/2011
TS0680-10 (1 OF 2)	INCREMENTAL WORK TO MOISTURE PRE-SEPARATOR (MOPS)	8/2/2011
TS0680-11	MSR MOP REPAIR	8/2/2011
TS0680-13 (2 OF 2)	REPLACE HEATING SYSTEM IN THE PIPES TO THE FIRST STAGE BUNDLE	8/2/2011
TS0680-15	RE-TUBE MSR	8/2/2011
TS0680-17	REPLACE CROSSOVER LINES	8/2/2011
TS0680-19	REPLACE MSR INLET LINE	8/3/2011
Crew Rate 10Hr	10 hr day shift	
DR Estimating Assumptions and Instructions		
EPSCA_Elec 2011-2012	Burdened Labour Rate Calculation - Plain Time - Electrical Worker	1/20/2012
Height	OPG Height Factors	
Overhead	Definition Phase - RFR & Assumed TG Estimate	
TGP BoE	Turbine Generator (TG) Independent Estimate Basis Of Estimate For Fixed Cost Contract	
TGP FC Estimate		
Estimate	Tabs: DSR Summary, 4b Data, DSR Database, etc	
FC Signed Estimate	Turbine Generator (TG) Independent Estimate Basis Of Estimate For Fixed Cost Contract	
Independence Confirmation Signed	Turbine Generation	
SGP 4b Comparison	Steam Generator Status 8th March 2013	
SGP 1 Estimate	Current DSR Estimates as of March. of 2013; Tabs - SG, Summary (Rel4), Rel4B (DSR estimate)	
SGP BOE	Steam Generator (SG) Basis Of Estimate	2/3/2011
SGP Factors Rates Costs	Steam Generator Project Crew 12 Hrs Shift Hourly Rate Calculation	
SG DSR list as August, 2011	Screen Print, TS0050-1, etc., approved/not approved	
SG Validate Info	Project: Steam Generator	
PM Signed SG Estimate Summary	Scanned Doc - SG Bundle - DSR Line Estimate_Scope List as of 8/31/11	9/1/2011
SG BOE-signed with type of doc. Changed	Steam Generator (SG) Basis of Estimate	11/11/2011
Signed SG BOE	Steam Generator (SG) Basis of Estimate	11/11/2011
2013-2015%20CEO%20CFO%20BP%20Presentation_Sept%2013%20r1	2013-2015 Bus Plan	9/18/2012
DN 2012-2014 BP Presentation Sept 8 Final	2012-2014 Bus Plan	9/12/2011
2013-2015 CEO CFO BP Presentation_Sept 13 r1	2013-2015 Business Plan	9/18/2012
N-GUID-00400-10000 Nuclear Refurbishment Cost Estimate Review Guide	Nuclear Refurbishment Cost Estimate Review	5/6/2011
ON Outlook Highlights - Draft for Committee Review	Construction Looking Forward - Draft	2/1/2012
Ontario LMI -- Preliminary Trade Rankings (Dec 2011)	GTA: December 2011 Forecast	12/1/2011
Productivity Factors 10 Hr Shift Z2	Rubber Day & Night 10 Zone 2	
Productivity Factors 10 Hr Shift Z3	Rubber Day & Night 10 Zone 3	
Productivity Factors 12 Hr Shift Z2	Rubber Day & Night	
Productivity Factors 12 Hr Shift Z3	Rubber Day & Night	
Productivity Factors	hourly rate	
509407-0000-00000-33RA-0035 Apr-23-13_Rev PB	TMOD material, supports, hardware, feeder vision system, and miscellaneous items.	5/15/2013
Appendix 01 - 509407-0000-00000-33RA-0035 OSM (Rev PB)	Material Allowance Calcs based on Single Unit	4/12/2013
Appendix 02 - 509407-30CC-I-0109-Intermediate Level Waste	revised estimate: intermediate level waste components and key assumptions	10/12/2012

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Assessment		
Dec 2012 Estimate Report	Docs & Correspondence from Aecon Joint Venture - ESTIMATE, LEVEL 2 SCHEDULE & RISK REPORT (373 pgs)	12/21/2012
RFR May_Data	Planned, Actual, Forecasted & Earned budget breakdowns by period. WP breakdown.	11/6/2012
RFR Resource Plan - Revised March 6 -Gate 2A	Retube & Feeder Replacement Project- Cash Flows by Year- Gate 2A (March 2013- May 2014); add'l tabs	
RFR Resource Plan 15 Feb 2013-Gate 2A	Retube & Feeder Replacement Project- Cash Flows by Year- Gate 2A (March 2013- May 2014); add'l tabs	
RFR Resource Plan 20 Feb 2013-Execution	Retube & Feeder Replacement Project - Resource and Contract Cost Estimate Sheet- Gate 2A to Project Completion (2014-2025)	
34-120019 Annulus spacer Qual-9jan2013	Annulus Spacer Qualification Test for Darlington Retube; schedule portion	
34-120019 Inconel 9jan2013	Inconel Spacer Qualification Test for Darlington Retube; schedule portion	
2013-02-08- R0031- Basic	All Active Project - Master Schedule (10 pgs)	
2013-02-08- R0031- Cash flows- Basic with actuals-Oct12-May14.pdf	CT-01 Monthly Project Cash Flow -with actuals	2/8/2013
2013-02-08- R0031- Cash flows- detailed by WBS with actuals.pdf	CT-02 Monthly Project Cash Flow by WBS	2/8/2013
2013-02-08- R0031- detailed	All Active Project - Master Project Schedule; NSS-OPG-001-Ganttchart-with SPI-Final	2/8/2013
AECL Op 3 Pricing Submission Form Annulus Spacer	Pricing Submission Form - Fuel Channel Annulus Spacer Design Concept for Darlington NGS Refurb. Program	
AECL Zr - R1	AECL Zr-Nb-Cu Irradiation Program High Level Schedule and Budgetary Estimate	
AMEC NSS OSS Services- Gate 1 and 2A Deliverable List (verified - Updated)	Appendix B: Deliverable Budgetary Cost and Schedule; add'l tabs - Deliverable List, Summary by Area, PO Named Individuals	
Assistance for RFR - Hours Estimate		
NK38-PLAN-31160-10002_R000(22Jan2013)_RFR-Fuel Channel Modified Inconel X-750	Scope of Work - Fuel Channel Modified Inconel X-750 Annulus Spacer	
NK38-PLAN-31160-10003_R000(22Jan2013)_RFR - Fuel Channel Zr-Nb-Cu Annulus Spacer	Scope of Work - Fuel Channel Zr-Nb-Cu Annulus Spacer	
RFR Cash Flow 2013 -R2 Current	Tabs: Curve Data, Summary 2013-2014, Issued Curves, CPI-SPI Ctgcy Curves, Mock Up Milestones, etc.	
RFR Cashflow 20121116	Mark RL-03 Cost Loading RFR by Groups (Late Dates)	11/16/2012
summary of cost estimate - feasibility asmt - board nov 2009_r04	Darlington Site Master Plan; Cost Estimate and Cash Flow	
DVBO scope for refurb	DSR tracking	
information for Jim... with MDRs	database	
D1321 Level 1 REV H - May 7th draft	D1321 Unit 2 Outage Logic Level 1October	5/8/2013
D1501Level 1 - Rev A April 19, 2013	Vacuum Building Outage ** Rev A ** Level 1 Overview	4/19/2013
Darlington Critical Path Schedule January 31 2013	Critical Paths before Oct 15 2016	1/31/2013
Darlington Integrated Master Schedule March 18 2013	Integrated Master Sched	2/6/2012
Darlington Integrated Master Schedule	Critical Paths before Oct 15 2016	1/31/2013
Darlington Unit 2 Conceptual Level 1	schedule	7/20/2012
Engineering Major Work Streams	schedule (draft)	2/14/2013
June 17 Latest Eng Schedule_ALL	Integrated Master Sched	5/30/2013
Key Milestone Report and Contract Status Nov 2012	Key Milestone & Contractor Status	11/15/2012
Nuclear Projects Planning & Control Earned Value Management April 2013	EV Mgmt.	Apr-13
Program Integration Summary Master Schedule Revision 1 Visio Overview	Org Chart - Revision 1 (Visio Overview)	
Program Master Schedule Dec 19 2012	Critical Paths before Oct 15 2016	12/19/2012
Revised Project Controls Chart 1	Org Chart	5/17/2013
Program Schedule Mgt Plan Rev 1	Program Schedule Management Plan	3/27/2013
RFR Contract Schedule	Exhibit 3.1(c)(A) Definition Phase Target Schedule (scanned doc)	
Appendix A - Health of CandC Score_Card	Health of the C&C Schedule as of April 04 ,2013	4/4/2013
Appendix_07_Fuel Handling Defueling	Program C&C Schedule	4/4/2013
Appendix_08_Turbine Generator Bundle	Turbine Generator Project Bundle	4/4/2013
Appendix_09_Campus Plan Bundle	Campus Plan Project Bundle	4/4/2013
Appendix_C_PMSS_Completed	Program Milestones & Key Dates -- Achieved	4/4/2013
Appendix_D_PMSS_3M_Lookahead	Program Milestones and Key Dates -- 3 Months Look Ahead	4/4/2013
Appendix_E_PMSS_All_Remaining	Program Milestones & Key Dates -- All Remaining	4/4/2013
Appendix_F_PMSS_All_in_2013	Program Milestones and Key Dates -- 2013 Milestones	4/4/2013
Appendix_G_Outage_Prep_Milestones	Program Milestones and Key Dates -- Refurb Outage Prep Milestones	4/4/2013

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APPENDIX_H_Update-Critical_Path-2013-04-04	RFR Bundle Schedules - Critical Activities	4/4/2013
AppendixBCandC-Schedule-Development Plan	C&C Schedule Development Plan	4/7/2013
Copy of Appendix A - Health of CC Score_Card	May 2013 Status	May-13
Planned Outages Inspections - BOP	Major Works for All Planned Outages Prior U2 Breaker Open	Apr-13
Planned Outages Inspections - FH	Fuel Handling and Defueling Bundle - Major Works for All Planned Outages Prior U2	4/4/2013
Planned Outages Inspections - Islanding	Major Works for All Planned Outages Prior U2 Breaker Open	4/4/2013
Planned Outages Inspections - RFR	Major Work for All Planned Outages Prior U2 Breaker Open	4/4/2013
Planned Outages Inspections - SG	Steam Generator Bundle - Major Works for All Planned Outages Prior U2 Breaker Open	4/4/2013
Preamble 032013	Preamble – March 2013 Status Submission – Unit 2	4/7/2013
Scope Development - BOP	Scope Development Schedule	4/4/2013
Scope Development - ISL	ISL Bundle - Scope Development Schedule	4/4/2013
Scope Development - Shutdown and Layup Serv	Shutdown and Layup Services - Scope Development Schedule	4/4/2013
Update-MU-3M-2013-04-04-APPENDIX Q	RFR Bundle - Mock Up Schedule - 3 Months Lookahead	4/4/2013
Update-MU-CM-2013-04-04-APPENDIX O	RFR Bundle - Mock Up Schedule - Completed Activities	4/4/2013
Update-MU-RM-2013-04-04-APPENDIX P	RFR Bundle - Mock Up Schedule - Remaining Activities	4/4/2013
Update-PM-3M-2013-04-04-APPENDIX T	RFR Bundle - PMOD's Schedule - 3 Months Lookahead	4/4/2013
Update-PM-CM-2013-04-04-APPENDIX R	RFR Bundle - PMOD's Schedule - Completed Activities	4/4/2013
Update-PM-RM-2013-04-04-APPENDIX S	RFR Bundle - PMOD's Schedule - Remaining Activities	4/4/2013
Update-TL-3M-2013-04-04-APPENDIX N	RFR Bundle - Tooling Schedule - 3 Months Lookahead	4/4/2013
Update-TL-CM-2013-04-04-APPENDIX L	RFR Bundle - Tooling Schedule - Completed Activities	4/4/2013
Update-TL-RM-2013-04-04-APPENDIX M	RFR Bundle - Tooling Schedule - Remaining Activities	4/4/2013
Update-TM-3M-2013-04-04-APPENDIX W	RFR Bundle - TMOD's Schedule - 3 Months Lookahead	4/4/2013
Update-TM-CM-2013-04-04-APPENDIX U	RFR Bundle - TMOD's Schedule - Completed Activities	4/4/2013
Update-TM-RM-2013-04-04-APPENDIX V	RFR Bundle - TMOD's Schedule - Remaining Activities	4/4/2013
2013-04-26-WorleyParsons_MDR_Integrated_Schedule_DRAFT_L1	MDRs Integrated Schedule - Level 1	4/25/2013
2013-04-26-WorleyParsons_MDR_Integrated_Schedule_DRAFT_L2	MDRs Integrated Schedule - Level 2	4/25/2013
2013-04-26-WorleyParsons_MDR_Integrated_Schedule_DRAFT_L3_OPG_O	MDRs Integrated Schedule - Level 2 - OPG Activities ONLY	4/25/2013
AMEC 2013-04-26-MDR Program- Level 1	AMEC NSS MDR Program Integrated Schedule	
AMEC 2013-04-26-MDR Program- Level 2	AMEC NSS MDR Program Integrated Schedule - Level 2	
AMEC 2013-04-26-MDR Program- Level 3-OPG activities	AMEC NSS MDR Program Integrated Schedule - Level 3	
AMEC202013-05-27-Level2	MDR Program - Integrated Schedule Level 2	
OverallRemainingWork2013-05-30 Part1	RFR TEAM - Part 1	5/30/2013
OverallRemainingWork2013-05-30Part2	RFR TEAM - Part 2	5/30/2013
OverallRemainingWork2013-05-30Part3	RFR TEAM - Part 3	5/30/2013
WorleyParsons_2013-05-27_MDR_Integrated_Schedule_L2	Level II Schedule	5/9/2012
OPG Darlington Schedule Quality	ribbon & phase analysis; details 2007-2025	5/9/2013
NK38-PLAN-09701-10067-0004 Sh 0004	Program Schedule Management Plan	3/27/2013
NK38-PLAN-09701-10072 Critical path (1)	Nr Conceptual Level 1 Logic (Pims-C)	9/7/2012
NK38-PLAN-09701-10072 Critical path	Nr Conceptual Level 1 Logic (Pims-C)	9/7/2012
CC_Apr_ME	schedule	
5_BOP_L2	schedule	
5_FUNCTIONAL_L3 1b	schedule	
5_FUNCTIONAL_L3 b	schedule	
5_FUNCTIONAL_L3	schedule	
6_BOP_L2	schedule	
9_FUNCTIONAL_L3 1b	schedule	
9_FUNCTIONAL_L3 b	schedule	
9_FUNCTIONAL_L3	schedule	
CC_Apr_ME	schedule	
CMP_L2 b	schedule	
CMP_L2	schedule	
D1321 Level 1 REV H - May 7th draft	D1321 Unit 2 Outage Logic Level 1October	5/8/2013
D1501Level 1 - Rev A April 19, 2013	Vacuum Building Outage ** Rev A ** Level 1 Overview	4/19/2013
FH_DF_OPG_Uc_L2	schedule	
FH_DF_OPG_Uc_L3	schedule	
IS_OPG_Uc_L3	schedule	
Program Master Schedule Dec 19 2012	Critical Paths before Oct 15 2016	12/19/2012

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Revised Project Controls Chart 1	Org Chart	5/17/2013
RFR_L2 b	schedule	
RFR_L2	schedule	
SD_OPG_Uc_L3	schedule	
TG_SG_OPG_Uc_L3	schedule	
2010 a year in review_final (3)	PowerPoint - Dietmar Reiner	Jan-11
Program Update - External Advisors - Feb 27 2013	Program Update ppt (145 pgs)	2/27/2013
SC_NCD_Prj_Execution_Workshop _FINAL _March_18_2013	PDF ppt - Excellence in Executing Accountabilities & Interacting in a Mega-Proj. Environment	3/18/2013
NP Information Management SC Mtg.		
Refurb SC 26 April 13	Adobe PowerPoint - Refurb Program Contract Steering Committee	4/26/2013
EAC April 29 013	Adobe PowerPoint - Refurb Executive Advisory Comm.	4/29/2013
May 22 2013 NPMSRB Decisions docx	File: N-REF-09701-0465832	5/22/2013
N-PLAN-09701-10002-DN Refurb Executive Advisory Committee DRAFT	Darlington Refurbishment Executive Advisory Committee Terms Of Reference	2/15/2012
Oversight and Control - EAC	Adobe PowerPoint - Oversight & Ctrl. Function of Major Projects	4/29/2013
May 22 2013 NPMSRB Decisions docx	Decisions and Records of Key Points	5/22/2013
Outstanding Actions for NPMSRB Latest	Outstanding Actions	11/22/2012
April Program Status Report	DN Refurb Program Status Report Meeting	5/22/2013
Darlington Refurbishment Program Update Outline Feb 2013	Program Update outline	2/1/2013
June Program Status Report	Agenda, Mtg. Minutes, Outstanding Actions	7/24/2013
March Program Status Report REV02	Meeting Minutes: Outstanding Actions & Status Rpt.	3/1/2013
May Program Status Report	agenda, Mtg. Minutes, Outstanding Actions (5)	6/19/2013
Program Status Meeting June 12(2)	Agenda; Attached docs: Listing of Outstanding Actions, Program Status May ppt, Functional Update	6/12/2013
Program Status Report Mtg for Period Ending December 2012	Outstanding Actions & Sect. 5.0, B - Project Quad Charts included	1/23/2012
Program Status Report Mtg for Period Ending February 2013	Outstanding Actions & Darlington Refurb Overview	3/20/2013
Darlington Refurbishment D2O Board Memo - May 2013	Heavy Water Storage and Drum Handling Facility - submitted to BOD	5/16/2013
Darlington Refurbishment Economic Update - NOC May 2013	Darlington Refurbishment Program Economic Update - submitted to NOC	5/14/2013
Darlington Refurbishment Refurb Project Office Memo - May 2013	Refurbishment Project Office - submitted to BOD	5/16/2013
Darlington Refurbishment Water and Sewer May 2013 (2)	Darlington Water and Sewer Project - submitted to BOD	5/16/2013
NOC Q1 2013	Darlington Refurbishment Program Status Report - submitted to NOC	May-13
Outstanding Actions for NPMSRB Latest	NPMSRB - Outstanding actions, total of 2	11/22/2012
13-04-17 20U2 20Readiness	Scope Status Meeting (revised format – 3/fiscal month)	
April 17-13 Integrated Proj. Functional Coordination Mtg	INTEGRATED PROJECT/FUNCTIONAL COMMUNICATION MEETING; attachments included	4/17/2013
Functional Update March	Update	Mar-13
Functions - Quad Charts March 2013	Management System Oversight	4/3/2013
Projects - Quad Charts March 2013	Fuel Handling Refurbishment	3-Apr
Outstanding Actions	scanned doc - NR Execution RPET/Proj. Mgr.	4/16/2013
Program Status March	PowerPoint	Mar-13
Action Items 051513 Project Meeting	NR Execution RPET/Project Mgr. - Outstanding Actions	5/14/2013
Functional Update April 2013	April 2013 Month End	Apr-13
Functions - April 2013	Management System Oversight	5/1/2013
Pre reqs	Unit Ready for Refurb	
Program Status April 2013	April 2013 Month End	Apr-13
Projects - April 2013	Fuel Handling Refurbishment	5/1/2013
Functional Update May 2013	Update (ppt)	May-13
Functions - 05 13	Management System Oversight	5/29/2013
Program Status May 2013	Report card, cost perf., program milestones	May-13
Projects - 05 13	Fuel Handling Refurbishment	5/29/2013
Projects - Retube and Feeder Replacement	Current Gate 2A; Fiscal Mo End 03-July-2013	7/3/2013
Arnone Email unlapping of units 070713	Email, Attachments: Impact of Changing Units, Considerations, copy of Outage Duration Impact & Components documents	7/4/2013
Components requiring Unit overlap Memo	Attachment to Arnone Email; review conducted on the FH refurbishment and defueling approved scope	6/17/2013
Considerations for Refurbishment Outage Logistics Ver2_U2Finish_toStartU1	Attachment to Arnone Email; U2 Finish to Start U1	6/26/2013
Copy of Outage Duration Impact	Impact of Planned Darlington Refurbishment Unit Outage Overlap Dates	6/28/2013

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Impact of Changing Units 2 and 1 from Parallel to Series	Re: Contracts, 4C, Staffing, Procurement, Changed/New Risks, Help Required, & Actions	7/4/2013
Monthly Integrated Projects and Funtional Comm Meeting (July 17)	Agenda, Action Items, Qtly rpt. info, Program Status	7/17/2013
TG Turbine and Excitation Controls removal from Unit 2 Refurb scope - draft June 28, 2013	TG Turbine and Excitation Controls removal from Unit 2 Refurbishment scope with installation during 1st planned outage after Unit 2 Refurbishment	6/27/2013
Refurb Work Program ActionDecision Log	Action, Decision, Completed Actions	7/22/2013
Refurb Work Program Integration Meeting COMBINED Agenda - June 3 2013	Meeting Agenda	6/3/2013
Project Quality Assurance Plan (CD-0022) 509407-0000-00000-38QP-0001 R0 1	Assurance report	5/31/2012
12-H13.1-Written submission from OPG on EA for Darlington Nuclear Generating Station	Proposed Environmental Assessment Screening Report	9/13/2012
12-H13.80A-Presentation from CNWC	Environmental Assessment of OPG's proposed Refurbishment and Continued Operation of the DNGS	11/26/2012
12-H13.80-CNWC and DDLC	Environmental Assessment; renew Waste Mgmt. Facility license; renew Nuclear Pwr. Reactor Operating license	10/15/2012
12-H13.A Supplementary Submission from CNSC Staff on the Proposed EA Screening for DNGS	Proposed Environmental Assessment Screening Report	11/15/2012
12-H15.1-Written submission from OPG on Licence Renewal for Darlington Nuclear Generating Station	Renewal of the licence for the Darlington Nuclear Generating Station	9/14/2012
12-H13.1A-Presentation from OPG	Environmental Assessment; renew Waste Mgmt. Facility license; renew Nuclear Pwr. Reactor Operating license	11/23/2012
12-H13.1-Written submission from OPG on EA for Darlington Nuclear Generating Station	Proposed Environmental Assessment Screening Report	Nov-12
12-H13.2-Sierra Club Canada	HOW NOT TO EXTEND THE LIFE OF AGING REACTORS IN ONTARIO	7/18/2012
12-H13.59-Bruce Power	Bruce Pwr. - in support of license renewal for Darlington Waste Mgmt. Facility	10/15/2012
12-H13.79A-Presentation from Power Workers Union	presentation	11/26/2012
12-H13.79-Power Workers Union	REQUEST TO INTERVENE and WRITTEN SUBMISSIONS	10/15/2012
12-H13.83A- Presentation from the Organization of CANDU Industries	supplementary info & presentation	11/26/2012
12-H13.83-Organization of CANDU Industries	Request to Intervene at CNSC Public Hearing on November 13 and 14, 2012	10/15/2012
12-H13.86-Candu Energy Inc	Environmental Assessment of OPG's proposed Refurbishment	10/15/2012
12-H13.A Supplementary Submission from CNSC Staff on the Proposed EA Screening for DNGS	Proposed Environmental Assessment Screening Report	11/15/2012
12-H13-Written submission from CNSC Staff on EA Screening-DarlingtonNGS	Proposed Environmental Assessment Screening Report	9/12/2012
12-H15.1-Written submission from OPG on Licence Renewal for Darlington Nuclear Generating Station	Licence Renewal for Darlington Nuclear Generation Station	9/14/2012
12-H15-Written submission from CNSC Staff on Darlington Nuclear Generating Station Licence	Request for License Renewal	9/14/2012
April Meeting Schedule	Agenda	Apr-13
OPG_IRM_Report_of_the_Board_20130328	Incentive Rate-making for Ontario Power Generation's Prescribed Generation Assets	3/28/2013
Power_Advisory Presentation OEB 82812 Incentive Regulation Options	Incentive Regulation Options for Ontario Power Generation's Prescribed Generation Assets	8/28/2012
Power_advisory_report_OPG_20120511	Incentive Regulation Options for Ontario Power Generation's Prescribed Generation Assets	4/20/2012
5142_First_Amendment_BPRIA_20070829	First Amending Agreement to the Bruce Pwr. Refurb. Implementation Agreement	8/28/2007
Assumptions - Detailed Report	Planning and Controls - Key Assumptions	5/9/2013
Assumptions - Summary Report	Planning & Ctrls - Assumptions Summary	5/9/2013
Decisions - Detailed Report	Planning & Ctrls - Decisions Identification	5/9/2013
Decisions - Summary Report	Planning & Ctrls - Decisions Summary	5/9/2013
AECON Lessons Learned	Nuclear Restart Early Lessons Learned	7/27/2007
Bruce Lessons Learned	Self-Assessment D11-000190	6/2/2011
Lesson Learned Bruce Self Assessment	Nuclear Refurb Islanding	5/18/2011
Lessons-Learned_Wolsong	List; Fuel Channel Installation NIR	
NK38-REP-09701-10164R00 Lessons Learned Report	Quarterly Lessons Learned Rpt. - Q3 2012	4/29/2013
OPEX Process Chart	org chart	
Report from OPEX	Lessons Learned database	
Tooling OPEX Database 03 18 2013	database - Type, Evidencing, etc.	5/2/2013
Wolsong OPEX list	OPEX-1 thru OPEX-VI	
Concerns	RFR Construction Management	12/20/2012

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
PLN OPEX - Constable	database	12/20/2012
Copy of Outage Duration Impact	Impact of Planned Darlington Refurbishment Unit Outage Overlap Dates	6/28/2013
Contingency Presentation for RPET (Jan-30-2013)	proposed strategic direction of contingency development and management	1/30/2013
ROC-June 2013	Risk Oversight Committee	6/5/2013
Components requiring Unit overlap Memo	Attachment to Arnone Email; review conducted on the FH refurbishment and defueling approved scope	6/17/2013
Considerations for Refurbishment Outage Logistics Ver2_U2Finish_toStartU1	Attachment to Arnone Email; U2 Finish to Start U1	6/26/2013
F&G RISK MANAGEMENT REVIEW	Faithful+Gould Assessment	3/4/2012
Impact of Changing Units 2 and 1 from Parallel to Series	Re: Contracts, 4C, Staffing, Procurement, Changed/New Risks, Help Required, & Actions	7/4/2013
N-FORM-11306	Program Risk Identification Form	
N-FORM-11390	Decision Record & analysis Sum.	
N-FORM-11394	Key Assumption Identification Form	
OPG Risk Management Review - rev 1	Assessment of Program & Project Risk Management	3/4/2012
RISK MANAGEMENT SUMMARY TABLE	Risk Self-Assessment Summary Table	
ROC June Meeting Agenda	Agenda	6/5/2013
TG Turbine and Excitation Controls removal from Unit 2 Refurb scope - draft June 28, 2013	TG Turbine and Excitation Controls removal from Unit 2 Refurbishment scope with installation during 1st planned outage after Unit 2 Refurbishment	6/27/2013
1 oversight summary	Oversight Report#1	2/22/2013
2 oversight summary	Oversight Report#2	4/2/2013
3 oversight summary	Oversight Report#3	5/7/2013
Darlington Refurbishment Risk Management Plan	Risk Mgmt.	1/31/2013
DARLINGTON REFURBISHMENT RISK REPORT	Risk Reporting for the Darlington Refurb Progress	4/5/2013
ENTERPRISE RISK MANAGEMENT PROCESS AUDIT	Internal Audit report	Feb-13
Enterprise Risk Org Chart	Org chart	
Meeting Minutes March 2013 Risk Oversight Committee	Meeting minutes	3/12/2013
N-MAN-00120-10001 Sh RISK-03	Task Instruction – Closing Risks	
N-MAN-00120-10001 Sh RISK-05	Contingency Development And Management	7/19/2012
N-MAN-00120-10001 Sh RISK-06	Lessons Learned And OPEX Management	7/19/2012
N-MAN-00120-10001 Sh RISK-07	Assumptions And Decisions Management	7/19/2012
Nuclear Projects Risk Management Manual	Nuclear Refurbishment Risk Management	7/25/2012
Nuclear Projects Risk Management Process (1)	Nuclear Projects Risk Management Process	11/22/2012
OPG-MAN-08708-0001 Guide to Proj Risk Mgmt	Guide To The Project Risk Management Standard	12/23/2011
OPG-STD-0062 Proj Risk Mgmt Standard	PROJECT RISK MANAGEMENT STANDARD; correspondence attached to file	2/27/2012
Program Risk Register RADAR	Risks Mitigation - Summary (114 pgs)	4/4/2013
Program-RiskList	Risks Mitigation - Summary (118 pgs)	3/11/2013
RFR Overall risk list	Risk Mitigation summary by Category	4/4/2013
RFR-Level 1 and Level 2 Risks	Risks Level 1 and Level 2	4/4/2013
Risk Management Self Assessment	Self-Assessment rpt. details	4/14/2013
Risk Work Flow Diagrams	org chart/diagram	
ROC June 2013 Minutes	Meeting minutes	6/5/2013
ROC-June 2013	PPT presentation	6/5/2013
SNC Lavalin 2225_Corporate_Project_Risk_Mgt_Procedure	Risk Mgmt Procedure 2225	Sep-10
Visio-Sharepoint DB Relationship Map	Organizational Chart	3/11/2013
Wolsong OPEX re Estimating RFR	Feeder program breakdown	
Campus Plan Risks	Campus Plan Program	6/18/2013
Contract Management Risks May	Refurbishment Contract Management	6/18/2013
EA Risks May	Licensing & Environment	6/18/2013
ENG NS Risks May	Refurbishment Nuclear Safety	6/18/2013
ENG Proj Risks May	Refurbishment Engineering Projects	6/18/2013
ENG Risks May	Refurbishment Engineering	6/18/2013
Ops_Mtc Risks May	Operations and Maintenance	6/18/2013
Oversight Risks May	Management System Oversight	6/18/2013
PA Risks May	Public Affairs	6/18/2013
P-C Risks May	Planning and Controls	6/18/2013
Program Risk Register - Review of Risk Descriptions	Review of the Darlington Refurbishment Program Risk Register	Apr-13
RFR Contract Language - Target Cost and Risk	Definitions	7/3/2013
RFR Exhibit 3.5 Target Cost and Schedule	Exhibit 3.5- Development of the Execution Phase Target Schedule, Execution Phase Target Cost and Execution Phase Fixed Fee	
Risk List Program	Risks Mitigation - Summary	7/2/2013

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DOCUMENT NAME	DOCUMENT DESCRIPTION	DOC. DATE
Risk List Projects run July 3	Risk Mitigation summary by Category	7/3/2013
Sample Program Risk Register Format	Risks Mitigation - Summary	4/4/2013
Section 3.5 RFR Contract-Risk Register	Section 3.5 for Definition Phase Work	
Supply Chain Risks	Supply Chain	6/18/2013
2011-CNSC-NPP-Safety-Report-INFO-0823_e	CNSC Staff Integrated Safety Assessment	Sep-12
03-21-13 -Chem and Environ	Transfer Ownership Plan – NR, Chemistry and Environment	3/21/2013
03-21-13 -ERT and SATM	Transfer Ownership Plan - Fire and Emergency Response	2/22/2013
04-11-13 Conv Safety	Department Transfer Ownership Plan – Conventional Safety	4/11/2013
02-04-13- Design Eng	Design Engineering	4/4/2013
02-04-13-WMa Transition plan	Transfer Plans Update	2/4/2013
02-22-13 Systems Transition Plan	Perf/Syst. Engineering	2/22/2013
02-25-13 Presentation Frank	Site Transition Oversight Committee	2/22/2013
03-07-13 - EP Presentation	Transfer Ownership Plan: NK38-PLAN-09701-10113 EP-01 R000	3/7/2013
03-07-13 -Licensing Presentation	Department Ownership Transfer Plan – LICENSING	3/7/2013
03-07-13 Operations	Transfer Ownership Plan: NK38-PLAN-09701-10113 OPS-01 R000	3/7/2013
03-21-13 Radiation Protection	Department Transfer Ownership Plan – Radiation Protection	3/21/2013
04-11-2013 CAP STOC pres	Corrective Action Control Group/MSO	4/11/2013
2013-04-25 - Nuclear Safety	Department Transfer Ownership Plan – Nuclear Safety Analysis	4/25/2013
FH Dept Transfer Plan	Department Integration/Transition Ownership Plan – Fuel Handling	
Training Transition STOC Apr 11_13	PROJECT TRAINING WORK PLAN	4/11/2013
Chemistry and Environment - Ownership Transfer Plan D2	Chemistry & Environment - Ownership Transfer Plan	11/26/2012
EP Ownership Transition Plan	Refurbishment Emergency Preparedness Ownership Transfer Plan	2/28/2013
FH Tansition Plan_LN (3)	FUEL HANDLING - INTEGRATION / TRANSITION PLAN	4/19/2013
Fire Protection - Ownership Transfer Plan	Fire Protection - Ownership Transfer Plan	11/15/2012
Licensing Ownership Transfer Plan	Licensing - Ownership Transfer Plan	11/23/2012
Maintenance Ownership Transfer Plan	Maintenance Ownership Transfer Plan	10/15/2012
MSO Department Ownership Transfer Plan	Corrective Action Control Group/Oversight - Ownership Transfer Plan	11/21/2012
Nuclear Safety Analysis Ownership Transfer Plan	Nuclear Safety Analysis - Ownership Transfer Plan	4/23/2013
OPS - Ownership TP	Operations - Ownership Transfer Plan	2/27/2013
Radiation Protection - Ownership Transfer Plan	Radiation Protection - Ownership Transfer Plan	11/1/2012
Work Managment Ownership Transfer Plan	Work Management Ownership Transfer Plan	11/23/2012
02-22-13- Mtce Presentation	Maintenance	2/22/2013
2012- Prj Execution Update_ Oct 19 2012 Final	TG, SG, RFR Constr. Update information	10/19/2012
COMBINED Agenda - July 19 2013	Refurbishment Work Program Integration Meeting	7/19/2013
COMBINED Agenda - June 13 2013	Refurb Work Prog. Integration Mtg agenda; top 5 milestones	6/13/2013
Conventional Safety - Ownership Transfer Plan	Conventional Safety - Ownership Transfer Plan	10/22/2012
Design Engineering - Ownership Transfer Plan	REFURB DESIGN ENGINEERING OWNERSHIP TRANSFER PLAN	8/19/2011
Licensing Ownership Transfer Plan (pdf)	Licensing - Ownership Transfer Plan	11/23/2012
Project Training Work Plan	scanned doc - Training Work Plan	6/10/2011
Refurb Work Program Integration Meeting COMBINED Agenda - June 3 2013	Refurb Work Prog. Integration Mtg agenda; top 5 milestones (docs attached to agenda)	6/3/2013
Systems-Components Eng. Ownership Transfer Plan	SYSTEMS/COMPONENTS ENGINEERING OWNERSHIP TRANSFER PLAN	11/15/2011

Exhibit 2

4Q 2013 Report

Supplemental Report to
Nuclear Oversight Committee

2nd Quarter 2014

Darlington Nuclear Refurbishment Project

Report to Nuclear Oversight Committee

4th Quarter 2013

Darlington Nuclear Refurbishment Project

Burns & McDonnell
Modus Strategic Solutions

November 12, 2013

I. Executive Summary

Burns & McDonnell Canada Ltd. and Modus Strategic Solutions Canada Company ("BMcD/Modus") provide the following Quarterly Report to the Nuclear Oversight Committee of the OPG Board of Directors ("NOC") regarding the status of the Darlington Nuclear Generating Station's Refurbishment Project ("Project" or "DR Project") as of October 31, 2013. The DR Project continues to advance toward its major goal of producing a Release Quality Estimate ("RQE") for final Board of Directors and Shareholder approval by October 15, 2015.

The following is a brief summary of the Project's most significant developments over the last quarter:

- **Retube & Feeder Replacement Project Risk**: The RFR project remains the DR Project's most notable risk, [redacted]

- **4c Cost Estimate Release**: The DR Team completed the Project's request for release of funding as part of the 2014 Business Plan ("4c Cost Estimate"). The DR Team used the 4c Cost Estimate to evaluate the status of the Project and all of its component parts, and address potential risks to the Project's success. In this Report, we provide our comments regarding the 4c Cost Estimate effort and recommendations for the development of the 4d Cost Estimate and related contingency model, which will be an important predecessor to the Release Quality Estimate ("RQE") in 2015.

- **DR Project Scope and Schedule Review**: Project scope and schedule assumptions were vetted and management issued its recommendations for reducing the DR Project's scope and "unlapping" the performance of Unit 2. The 4c Cost Estimate reflects these changes. BMcD/Modus found the process the DR Team used for revising its plan to be robust and in keeping with the Project's core mission and processes. The results achieved – reducing the Project's scope and focusing on a single unit refurbishment – are reasonably calculated to mitigate the Project's overall performance risks.

- **Balance of Plant ("BOP") Contracting Model Change**: BOP planning and related Engineering product are advancing well. Management has moved forward with suggested modifications to the BOP contracting model that should streamline the work and reduce performance risks, as well as advance the work to the detailed engineering phase that underpins a robust and reliable RQE. Engineering has geared up to support the BOP work and has met interim milestones. In addition, the scope reduction should positively impact both BOP and Engineering.

- **Campus Plan Project Risk**: The Campus Plan also remains a significant risk. The work on the D20 Storage Facility excavation has been impacted by unforeseen conditions and ongoing engineering challenges and is projecting to complete four weeks late. Management is taking appropriate action to bring needed focus to this work and the remainder of the Campus Plan scope.

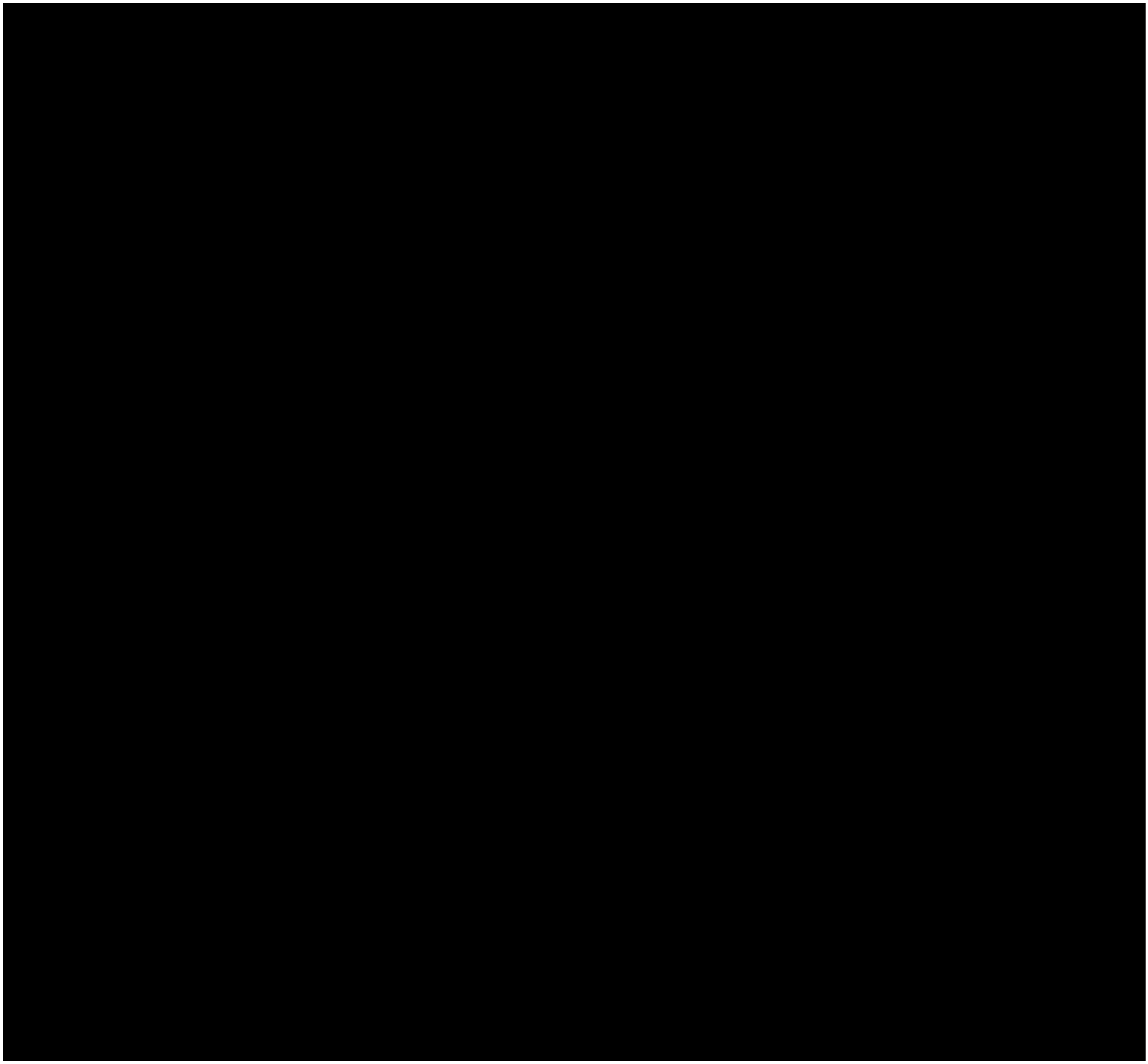
Overall, the DR Team's senior leadership has positively responded to the recommendations in our Initial Project Assessment that we presented to the NOC last quarter as well as ongoing challenges. Attachment A to this Report summarizes the Project's current risks and generally tracks the Team's progress in implementing improvements to the Project's plan.

BMcD/Modus has worked with Internal Audit to identify areas within the Project's Assurance Plan that BMcD/Modus is covering in our Independent Oversight role. It is important to note that BMcD/Modus is not performing audits and that this assurance coverage will be performed under our existing reporting and lines of authority. As such, it should provide the DR Team some relief from "audit fatigue." We will continue to work at the NOC's direction in support of OPG's Assurance Plan.

II. Major Projects – Summary of Key Risks

A. Retube & Feeder Replacement

1. Work Status – Tooling, Definition and Mock-up



[redacted]

BMcD/Modus draws the following conclusions from the review of project data:

- Management's recent actions with SNC/Aecon [redacted]. This is a very positive step, as OPG's senior project leadership recognizes the importance of working with the contractors to overcome challenges. It was also timely, in that catching these trends now at this early stage allows for course corrections at an opportune time before the teams become entrenched. We will now measure SNC/Aecon's performance [redacted].
- The current SNC/Aecon situation shows the importance of tracking contractors based on earning rules that have interim steps based on tracking ongoing physical progress and key commodities. Placing too much importance only on deliverables and completion milestones will result in tremendous peaks and valleys, making forecasting and accurate progress reporting very problematic. BMcD/Modus recommends earning rules to be structured based on a combination of physical progress and milestones, utilizing earned work hours and commodities bought/installed as the basis for earned value.
- The DR Project's reports should have more emphasis on period-over-period performance so that negative trends are more easily discernible from the project's data. The monthly Project Status and Program reports show monthly variances but the metrics focus on cumulative results which can easily mask the velocity of performance changes. Correcting these trends requires their visibility.
- OPG should not hesitate to request the contractors to provide the information it needs to properly manage the work. As an example, OPG will be hampered in gauging [redacted] if it does not receive actual work hours and costs for every activity, regardless of whether the work is part of a fixed-price component. [redacted]
- [redacted]

BMcD/Modus is closely monitoring this situation, and has been invited to attend progress meetings with SNC/Aecon's management.

2. SNC/Aecon Class 3 Estimate Plan

SNC/Aecon is required under the contract to submit its next phase of estimate on May 15, 2014. This estimate has been termed a "Class 3 Estimate" though, as with the earlier SNC/Aecon Class 5/4 estimates, the AACE-based definition for this estimate is imperfect at best. While this Class 3 Estimate will turn the focus from OPEX gathered at other stations to DNGS, it will still not account for risks, nor will it strictly adhere to other AACE requirements. The DR Team recognizes the need to monetize risks in concert with the Class 3 Estimate and will seek visibility to these risk items. The SNC/Aecon and OPG Teams are meeting weekly to reach an agreeable Class 3 Estimate Plan which should put the concerns over the basis of the estimate to rest.

SNC/Aecon's team announced at the October 28, 2013 project meeting that the Class 3 Estimate development has no float through May 15, 2014. [redacted] SNC/Aecon believes that there is an anomaly or error in this report, though the amount of work apparent to date on the Class 3 Estimate suggests [redacted] This also bears close monitoring over the next quarter.

B. Scope Rationalization Process / Unlapping of Unit 2

In 2Q 2013, the DR Team's Senior VPs initiated a process to review, scrutinize, and rationalize the DR Project's scope. This process was performed by a "Tripartite Review Team" drawn from the Project Team, the station and a team of independent reviewers including VPs external to the DR Project who have knowledge of the plant. The Tripartite Review Team evaluated the DR Project's scope with a view of the Project's objectives as well as requirements/commitments that have been made to the CNSC. The Tripartite Review Team's results were aggregated and presented to the DR Project and DNGS station representatives for future review and disposition by the Project Scope Review Board ("PSRB").

In all, the Tripartite Review Team reviewed 579 DSRs with an estimated value of [redacted] and determined that 210 DSRs with an estimated value of $212M should be removed from the DR Project's scope. In addition, 22 DSRs totaling $125M are slated for further review and potential future action. The chart below summarizes the results of the Tripartite Review Team's evaluation:

Tripartite Review Team Recommendations

Funding Stream	Total DSR Database	Confirmed To Perform in Refurb.	Not Reviewed[1]	Further Review Needed/Potential Further Reduction	Recommended to Cancel
Nuclear Refurbishment	[redacted]		$32 M	$125 M	$202 M
Other			$0	-	$10 M
Total			**$32 M**	**$125 M**	**$212 M**

BMcD/Modus has followed this process from its conception and found it to be robust. In fact, the DR Team should review OPEX from this process to improve the gate process. We have the following observations:

[1] These DSRs were not considered by the Tripartite Review Team and thus remain the DR Project's scope.

- The Tripartite Review Team's findings indicate that significant scope reductions can be achieved in order to reduce risk in certain aspects of the DR Project. In addition, the process has reduced the Project's budget, though not necessarily as much as was initially anticipated.
- The process also challenged the value and overall scope of items that remain in the DR Project, and provided additional guidance for contingent scope items and future potential reductions.

BMcD/Modus has reviewed the documentation and related analyses supporting the scope recommendations and decisions made by Tripartite Review Team and found them to be acceptable and generally complete. There will be considerably more documentation needed for PSRB presentation and disposition, though the preparation of this documentation should not be a cause of delay for the PSRB to render its decisions.

Simultaneous to the Scope Rationalization, the DR Team was instructed by Management to change the planning assumptions for the Project's refurbishment schedule, resulting in the unlapping of Unit 2 from Unit 1. As noted in our Initial Project Assessment, BMcD/Modus sees this change as a positive for the Project so long as the there is a strong technical basis for life extension of the remaining units. The revised schedule should substantially reduce the overall risk of the Project and result in valuable lessons learned for the performance of the remaining units.

C. Campus Plan

The Facilities and Infrastructure Projects that are part of the Campus Plan remain a significant risk to the DR Project. The projected 4 week delay to the D20 Storage Facility's excavation and another one month delay to the building's engineering are just the latest in a series of events. In addition, current estimates have put this sub-project's cost at $20M above the $130M budget. While the D20 Storage Facility differs from much of the Campus Plan work in that it is inside the security fence, the risk of this portfolio is its sheer volume and the multitude of tasks that must get done prior to opening breaker on the Unit 2 Outage.

The DR Team's senior leadership is taking action to turn the performance around, including:

- Additional focus on helping the ESMSA vendors' design partners' efforts by co-locating with OPG resources;
- Developing a plan to integrate all of the pre-requisite work into a large project with an integrated schedule so that the ESMSA's can properly plan and resource load the work and OPG can manage the contractors' work load and performance.
- Completion of work allocation to each of the vendors so that the ESMSA can properly plan their work.

The Campus Plan work will require close monitoring over the next several months.

D. Balance of Plant

In the Initial Project Assessment, BMcD/Modus expressed concerns over the plan for the BOP work, which we believed could have impacted the quality of the RQE. Specifically, we believed the BOP plan had unnecessary steps for procurement and assignment of work that would deprive the ESMSA vendors with requisite time to perform the detailed design, which in turn would increase the risk and variability around the BOP work at RQE.

In our last report to the NOC, we noted that the DR Team's Senior Leadership was fully aligned with our observations and was in the process of moving forward with streamlining the BOP work. The DR Team is planning to direct-assign work to the ESMSA contractors on an equitable basis in keeping with the principles in the ESMSA contracting strategy. In parallel, the BOP Team has been preparing plans for this split of work and Engineering is preparing to support the ESMSA in the engineering phase. Now that this work is moving forward and in the right direction, it will be critical for the DR Team to learn from the OPEX from the D20 Storage Facility and work hand-in-hand with the vendors to produce a quality design product. In addition, many of the changes initiated with the Campus Plan should benefit the BOP work, as this work can

be used as a beta test for many of the processes put in place. The DR Team's actions are encouraging and should lead to a better result.

III. Vetting of 4c Cost Estimate

A. Summary of 4c Cost Estimate

As noted, the DR Team finalized its 4c Cost Estimate and 2014 Business Plan input and presented the results to the Board for its approval. The 4c Cost Estimate was not a full reforecast of the DR Project's costs; instead, it was developed to show variances from the predecessor 2013 Business Plan ("4b Cost Estimate") which the Board approved. A summary of the 4c Cost Estimate and the results of the variances from the 4b Cost Estimate are summarized in Attachment B. The DR Project's cost estimate currently stands at $10.8 B including contingency and management reserve.

As the Project progresses toward RQE, the DR Team is working to reduce the Project's cost estimate to $10 B. This goal appears to be reasonable and can be achieved through: (1) continued maturation of the Project's planning; (2) corresponding reductions of both the Project's overall point cost estimate and related contingency, and; (3) locking down or further reducing scope and determining that results from the remaining scope defining inspections are favorable. The DR Team has currently identified approximately $158 M of cost reductions that will be specifically scrutinized over the next year. In addition, there are other opportunities for cost reduction and re-allocation that OPG may consider, in particular, the characterization of Operations & Maintenance ("O&M") support costs, which currently total [redacted]. The DR Team is studying the projected "value add" cost that O&M will be providing directly to the Project. OPG should investigate whether it can characterize the remaining O&M cost as a regulatory asset and not burden the Project with that cost.

In reviewing the 4c Cost Estimate, BMcD/Modus focused more on the processes that the DR Team used in developing this estimate than the actual results. In our Initial Project Assessment, we recommended that OPG consider the 4d Cost Estimate that the DR Team will be presenting for next year's Business Plan a "dry run" for RQE, and that recommendation has been embraced by Senior Management. With that understanding, we have looked at the development of the estimate as a way of testing certain key assumptions that OPG has put forth and we will provide recommendations for improving those processes, as necessary.

BMcD/Modus's vetting exercise has focused on the following with respect to the 4c Cost Estimate:

- Reasonable sampling of the 4c Cost Estimate to validate the underlying basis of the estimate;
- Assessing the efficacy of the processes that the DR Team has put in place for scope control, most notably the Gate Process;
- Review of methods used for contingency and management reserve derivations; and,
- Review of systems that the DR Team is developing to report on cost development.

The results of our review and related recommendations for the next phases of cost estimating are summarized below.

B. Sampling and Validating of 4c Cost Estimate

In our August 12, 2013 report to the NOC, we emphasized the importance of the Project Team properly characterizing the basis of the cost estimates it was putting forward for Board approval. In the case of the 4c Cost Estimate, the DR Team has characterized the estimate as one that generally meets the AACE's definition of a Class 5 or Class 4 estimate. Typical expected accuracy ranges for Class 5 estimates are (-20% to -50%) on the low side, and (+30% to +100%) on the high side, and Class 4 estimates range (-15% to -30%) on the low side, and (+20% to +50%) on the high side.

BMcD/Modus performed some reasonable sampling of the 4c Cost Estimate including:

- Detailed vetting of the current SNC/Aecon cost estimate for the RFR work;
- Review of six DSRs in the BOP scope that total [redacted], or [redacted] of the BOP Basis of Estimate cost;
- Review of one DSR in the Turbine Generator sub-project scope that totals [redacted], or [redacted] of the projected turbine Basis of Estimate costs.

In all, we considered approximately [redacted] of the project bundle costs. In this review, we vetted the nature of the driving aspects of these cost estimates, including: work hour derivations, labor and productivity modification factors, allowances, and the like. Our purpose in doing so was to confirm the basis of the estimates' components and the level of maturity underlying the information. In addition, we reviewed the development of the OPG costs for project management and support, which are essentially drawn from head counts of staff and flowed-out over time. This analysis essentially confirmed that the DR Team has prepared and presented an estimate that generally conforms to the AACE Class 5/4 definitions. This characterization is generally confirmed by the DR Project's current overall status at this time.

As noted in our Initial Project Assessment, the 2015 Business Plan ("4d Cost Estimate") will need to reflect an expected leap in Project maturity that will occur over the next 8 to 10 months; thus, we would expect that the quality of OPG's estimate would parallel that increase. BMcD/Modus has the following additional observations and recommendations for development of the 4d Cost Estimate and 2014 Business Plan:

- With the expected ramp-up of the amount of information needed to support estimates, the DR Team should focus on improving traceability, sourcing, vetting and suitability of database information underlying the estimate as this will be even more essential for vetting the Class 3 Estimates.
- Quality control will be critical as the estimates move from ranges to point numbers. The DR Team may consider migrating to a standard estimating platform such as SNC/Aecon is now utilizing for its Class 3 cost estimate.
- Many of the tools Finance and Project Controls developed for reviewing of the 4c Cost Estimate should find their way into the metrics the DR Team uses in an attempt to increase cost consciousness.
- Vetting of OPG costs was impacted by the timing of the 4c Cost Estimate effort, which began in the middle of the summer months. The next phases of estimating should have a schedule of activities and begin earlier in the year, particularly considering the increased complexity expected for the 4d Cost Estimate.

Attachment C provides more details regarding our review of the 4c Cost Estimate. Our comments and recommendations are geared toward helping OPG to strengthen its review of costs for this next critical phase of estimating.

In summary, BMcD/Modus found that the processes the DR Team used to develop the 4c Cost Estimate were robust and generally conformed to customary practices for an AACE Class 4/5 estimate. The DR Team has also properly characterized the nature of the estimate that it has advanced for approval. The DR Team has also conceptually accepted our recommendations regarding its going-forward activities, though implementation of those recommendations will require focus and attention over the next 10-12 months, as development of the 4d Cost Estimate will be an ongoing effort.

C. Evaluation of Gate Process

The DR Team is utilizing the Gate Process for evaluation of cost, scope and schedule [Nuclear Projects Gated Process, N-MAN-00120-10001-GRB-R001]. Each portion of the work as it matures is subject to a "gate" review in order to obtain full funding for the successive phase of the work. To date, majority of the gate reviews have been for projects in early planning stages, though over the next 12 months, passing through gates will require considerably more rigor. Thus, the Gate Process represents an interim step between the cost forecast efforts to evaluate and vet key elements of the Project's cost and maturity level.

BMcD/Modus has evaluated the Gate Process in concept and in practice, as well as participated in a number of Gate Review Board ("GRB") meetings. We have also sampled multiple "gate packages" that the Project Team has prepared.

The process itself is well-formulated and should serve the intended purpose. However, the DR Team's execution within the process should be addressed. From our sampling of the process, we have found the DR Team is not consistently developing the materials needed for the GRB's evaluation. Some comments and recommendations are as follows:

Observation from Gate Review Process	Recommendations
Quality and consistency of the materials in Gate packages should be addressed. Gate review packages are often hastily assembled by the project teams and provided to the GRB only shortly before the gate review meetings.	➢ Gate package development should follow the existing schedule and key documents should be delivered well in advance of the GRB. ➢ The quality of the gate packages presented to the GRB would be improved by timely delivery of materials prior to pre-vetting sessions within the Project Team.
Within gate packages, there are requirements for explaining variances in cost estimates, there is no formal controlled process for presenting these changes. We have generally found little consistency between the various files kept on the bundles, and in some cases, the estimates used for gate reviews were not preserved.	➢ Improve record keeping and chain of document retention. ➢ Provide a reconciliation of the estimates presented with the gate package to prior estimates (i.e., 4b, 4c) and the basis of estimates so that changes can be traced and sources are identifiable. ➢ Provide an estimate reconciliation within the standard gate package template. ➢ The estimates developed for evaluation at the gates should follow the same general vetting methodology and adhere to the same quality and consistency standards described in **Attachment C**.
Although designed to provide a forum for challenging scope and cost estimates, the gate review process has thus far had mixed results for that purpose.	➢ In addition to Project Controls, the DR Team should consider utilizing a 3rd Party (e.g., Finance and the Controllership) to provide an independent analysis and examination of the sufficiency of the gate packages. The 3rd party can report to the GRB its findings and concerns.

Now that the Project's scope has essentially been determined, the Team's focus should turn to fully supporting the work that will be done in the Gate Process. We have recommended to Management the need to drive down to the lowest levels of the DR Team the importance of schedule and cost consciousness. Senior Leadership has accepted these recommendations and is implementing changes to the process that should address these concerns.

D. Assessment of Contingency and Management Reserve

BMcD/Modus undertook a review of contingency to determine how discrete risk elements are accounted for in the 4c Cost Estimate. Our review found that while risks are being identified and analyzed in a reasonable manner, the value of individual risks are not directly traceable or otherwise transparent all the way through the estimate to the bottom line. Instead, management has made a decision to carry Monte Carlo Output risk amounts at a more global level, namely, at the project bundle level only. As a result, discrete risks and associated amounts are merely subsumed into a single contingency number with no tractability back to the individual risk elements.

BMcD/Modus has the following observations regarding the methods the DR Team is using for establishing and managing contingency and management reserve:

- As noted in our Initial Project Assessment, the DR Team needs wider and increased appreciation of the importance of accurately identifying risks and related parameters. Furthermore, as evidenced by a review of the risk register, more than a few DR Team members do not understand the distinction between management performance issues and true project risks. Senior management needs to continue to focus the DR Team on weeding-out unnecessary risk items that take up management time and attention.
- The risk group needs to be more involved and empowered as part of the initial risk identification efforts. Challenge meetings would help to identify true project risks and proactively eliminate false risks and duplicate inputs.
- OPG's choice to aggregate risk at the bundle level is not without precedent in the industry. However, given this choice, OPG will lose transparency as well as the ability to focus on and manage individual post-Monte Carlo risk amounts, which is particularly important for addressing the Project's most significant risks. Without having a discrete risk basis for formulating contingency, project managers will need to request individual Monte Carlo analyses on selected risk items and expend extra effort to track those risks. In addition, such retrospective calculations will not be consistent with the results of bundled-level analyses.
- The distinction between Management Reserve and Contingency needs further definition as do the rules for allocation of funds.
- Future cost estimates should include a composite roll-up of contingent scope so that the extent of the "unknowns" in the estimate are transparent.

At this time, BMcD/Modus have not undertaken an analysis of the specific amounts of contingency and management reserve being held or the adequacy of this reserve. However, as the estimate progresses toward RQE, the derivation of contingency will become increasingly important. Going forward, BMcD/Modus would expect to see contingency dollars for the Project's most significant known risks developed on a deterministic basis with stochastic modeling limited to chances of occurrence. Future reports will focus on how well contingency and management reserve is defined, calculated, managed, and released to the Project.

IV. Functional Group Update

A. Schedule

In our Initial Project Assessment, BMcD/Modus identified several concerns with the DR Team's plan for the development of the Project's Execution Phase schedule. The DR Team is currently populating the schedule utilizing the Coordination & Control ("C&C") Schedule. We questioned the application and efficacy of this approach, particularly for the Execution Phase. Our chief concern with the C&C Schedule was the point of integration between the contractors and other work groups. Per the Team's original Schedule Management Plan, this integration would occur at Level 2 and not at the detailed Level 3, which we saw as problematic, as the determination of a Project's critical path relies on linkage of detailed activities. We also saw that developing the C&C Schedule was diverting the Team's attention from the integration, assessment and reporting of the Level 3 pieces of the schedule. We articulated additional concerns in our Initial Project Assessment regarding earned value tracking and schedule performance.

Subsequent to our Initial Project Assessment, in further examination of the schedule, we noted some additional issues in the DR Team's plans for integration of the DR Project's Execution Phase—including the fact that the Project Managers' expressed preference to integrate and otherwise use the Level 3 schedule as the tool for day-to-day management during the Execution Phase. Additionally, the DR Team's ability to resource load and manage the work force will be an issue of growing significance, as doing so requires the Level 3 details. Since future contracts (most notably RFR and BOP) are based on target price arrangements, it is essential that the operative schedule is resource loaded; otherwise, the Project Team will lack an essential tool for holding the contractors accountable to their budgets. Thus, the DR Team has now recognized that the best use of the C&C Schedule is for developing the plan during the Definition Phase while the integration of the execution schedule should occur at Level 3.

In consultation with the Project Controls Team, we have made certain recommendations related to the path forward for schedule development, including:

- The Master Schedule the Project Team will use to manage the Execution Phase of the DR Project should be populated with fully integrated Level 3 schedules to form the Project's critical path. This Master Schedule should be the primary tool for determining the status of the Project, and include comprehensive critical path and sub-critical paths, as well as full resource loading. The Level 3 activities will be coded to roll-up to Level 2, thus eliminating duplicative effort.
- OPG will continue utilizing the C&C Schedule but not for its originally intended purpose. The DR Team will consider the C&C Schedule as the "Plan for the Plan" that it will use to detail and track the Project Team's efforts to populate the Level 3 schedule. Currently, there are only a small number of executed contracts so fully integrating at Level 3 is not currently possible. As the maturity of the schedule increases, the DR Team can explore further integration at the detailed Level 3. The C&C Schedule will be updated through RQE on a monthly basis, though operative Level 3 execution work, such as the RFR Mockup, Campus Plan and Fuel Handling, will be updated at Level 3 as necessary. This will provide an opportunity for the DR Team to test the schedule well in advance of breaker-open on Unit 2.
- For areas of work for which there is currently no submitted schedule by a contractor, OPG should develop placeholders to the extent necessary. Such placeholder schedules should include enough detail that nature of the work, key milestones and integration points with other work groups are apparent.
- Commercial contracts should reflect specific schedule requirements that govern such things as resource loading, activity durations, float patterns and banning schedule devices that keep a schedule from calculating. To the extent that certain contracts have already been negotiated, OPG should, if necessary, incorporate its expectations for obtaining earned value, including contractor's budgets and actual work hours per schedule activity, as well as schedule development into existing contracts.
- Project Controls will need management support to hold the work groups accountable for developing and utilizing the Master Schedule, including developing forums for discussion of the Execution Phase Master Schedule status and preparation.

To the extent OPG agrees with these recommendations, the Program Schedule Management Plan and related processes will require revision to explain these changes. OPG will also need to address and simplify the WBS coding structure as necessary.

B. Engineering

Engineering continues to make progress in performing the MDR/MDP work that is needed for completing the procurement and scoping of the Project. Engineering reported in October that it had met an interim goal of completing 75 MDRs two months earlier than the milestone date. Engineering's focus on MDP's has resulted in a number of improvements since the start of our engagement:

- Closer working relationships between OPG and the two OSS vendors, AMEC and WorleyParsons;
- Improved quality of the MDP packages;
- Risks are being more closely evaluated, which ultimately will require less contingency in estimates for work;
- Efficiencies have been gained from collocating staff and the 'leaning-out' of the administrative process.

Whereas there is room for further gains in each of these areas, maintaining the current pace of MDP package development will satisfy the schedule needs of the DR Program. There are still 51 remaining MDRs, of which 20 are currently in process. All of these MDRs will need to be completed by April 1, 2014, which means that Engineering will have to continue its focus on producing MDRs/MDPs.

The next challenge for Engineering will be to morph into an organization that can manage the next phases of work, and here remains some concern. Engineering will have multiple roles, from design authority to reviewer of the various EPC contractors' work-product to developing the restart plan for the units. This will require a significant planning effort. However, because the effort needed to produce MDPs has sapped Engineering to such an extent, the knowledge and experience of DR team members is not currently being applied to a forward-look at this next phase of work.

BMcD/Modus has advised the Engineering team to embrace active management of the engineering effort and look for solutions to help the EPC vendors navigate the detailed design phase. We have advised the team to examine certain of the principles in the Construction Industry Institute's (CII) Front End Planning for Revamp and Renovation Projects.

The Engineering Team has completed its review of the phases of engineering and has prepared a new tool for tracking progress and claiming earned value. This work should also help with the Engineering team's attempts to further plan and execute the work.

C. Risk

In our Initial Project Assessment, BMcD/Modus provided our views regarding certain deficiencies in the DR Project's risk program. Since that time, and in concert with the 4c Cost Estimate effort, the DR Team has made an effort to vet the risk database and increase the quality of its content. There has also been an increased effort to adequately train the DR Team on proper Risk Management techniques. This work is ongoing and will require greater focus as the DR Team begins the full reforecast of costs in the next business plan cycle. BMcD/Modus will provide a more detailed status of these efforts in our next report to the NOC.

D. Project Team Development

In the Initial Project Assessment, we stressed the need for the DR Team to recognize the role OPG plays in managing the work, begin to break down the Project-based silos and begin developing the Construction team upon whom the day-to-day management of this Project will reside. Since our last Report, we have seen some steps in this regard, and the Project's Senior Leadership is moving in the right direction. Many of the changes the DR Team is initiating with its scheduling methodology will foster greater focus and a more cohesive view of the Project's development and execution. The DR Team's integration will be of significant focus through RQE and into breaker-open of Unit 2.

Attachment A

4Q Risk Perspective

Report to Nuclear Oversight Committee

4th Quarter 2013

Darlington Nuclear Refurbishment Project

Attachment A – 4Q 2013 Risk Perspective

Area	Observations	Low / Medium / High	Current Status / Mitigation
RFR	**SNC/Aecon Performance**: Largest Program risk due to overall risk to the DR Project and OPEX		[redacted] ▸ Project Team has ordered recovery plan by May 15, 2014
	Class 3 Estimate: Progression to RQE requires SNC/Aecon's Class 3 Estimate to be thoroughly vetted		▸ Class 3 Estimate preparation is [redacted] ▸ Completing estimate to OPG standards by May 15, 2014 will be challenging ▸ OPG team actively engaged in vetting plan and estimate
	Schedule Development: Level 3 schedule based on payment milestones; task durations and float unrealistic		▸ Project Team has taken action and required SNC/Aecon to provided resources loading and measure progress via target schedule ▸ Implementing the recovery plan and schedule changes will take transparency and focus
BOP	**Contracting Strategy**: Alterations needed to advance work to detailed design as quickly as possible		▸ Final approvals for contracting strategy have been obtained ▸ Project Team is already working to move work forward ▸ Needs final sign-off from all stakeholders ▸ More focus by management on engineering and scope coordination
	[redacted]		▸ Allocation of work from revised contracting strategy will emphasize each contractor's strengths [redacted]
Scope	**Review Period**: Urgency mounting for scope review; planning/prep underway for work that may be eliminated; concerns regarding scope		▸ Tri-partite review followed a deliberative process and netted positive results ▸ Scope removed from DR Project will be engineered and planned ▸ Needs final close-out
Campus Plan	**Project Status**: D20 Storage Facility work is behind schedule and causing critical path to the TRF		▸ Lessons learned are being collected and disseminated ▸ Management is taking appropriate action to schedule and plan work ▸ Vendor performance/unforeseen issues remain risks
	Engineering and Planning: D20 provides key lessons learned for remaining Campus Plan and BOP		▸ Engineering is co-locating with ESMSA vendors ▸ Clarification of RFPs and process ongoing ▸ Modifications to planning and scheduling underway
Schedule	**Unlapping and Reduction of Risk**: Performance of Unit 2 as a stand-alone will reduce risk		▸ Risk avoidance and decision-making prudence have been further quantified ▸ Impact on Project plan is being considered ▸ Commercial planning and strategy is being developed awaiting BOD
	Continued Schedule Development: Schedule approach was unproven; integration at appropriate level at risk		▸ Project Team has generally accepted BMcD/Modus's recommendations ▸ Revised schedule should reflect organizational change to flatten "silos" and manage as a single project

Attachment B

Variance Report 4b v. 4c Cost Estimates

Report to Nuclear Oversight Committee

4th Quarter 2013

Darlington Nuclear Refurbishment Project

Date: Oct 2, 2013

Refurbishment Estimate - Variance -Release 4c - Release 4b

		Categories	Description of Work	[redacted]	Comments
Overnight Costs	DPP EPC	Retube & Feeder Replacement	Contract Award, tooling and Mock up		
		Fuel Handling	PM, Engineering and some Materials		
		Defueling	PM, Engineering and some Materials		
		Specialized Projects	SDS/ Vault Cooler		
		Steam Generators	PM & Engineering only		
		Turbine Generators	PM, Engineering and some Materials		
		Balance of Plant	Pre requisite, PM, SIO and Eng'rg Projects		
		Islanding	Engineering and ordering of Materials		
		System Shutdown	Engineering and ordering of Materials		
		Infrastructure Projects - Refurbishment In-Station	Facilities inside protected area required to support Refurbishment		
		Infrastructure Projects - Holt Rd	Holt Road improvements		
		Total DPP EPC			
		Operations/Maintenance Support	All costs (less Trainees)		
		Waste Management			
		New Fuel			
		Facilities & Infrastructure Projects (CR Projects)			
	OPG Oversight and Support - DPP	Execution	Proj O/S, Proj Mgrs, Unit Exec., Matrix stf		
			Security		
			Facilty Maintenance		
		Engineering	Design, Projects, and VP		
		Ops/Mtce Trainees	Operations Trainees		
		Proj Planning & Cntls			
		Supply Chain & CS	(include Matrix)		
		Quality Management			
		Program Support	Includes HR, Finance, Public Affairs, External Oversight. Admins		
			Liability Insurance		
			Facility Costs		
			Licensing (Reg Office and CNSC Fees)		
		Preliminary Planning (excluding F&IP)	Release #3		
		Nuclear Safety	Excludes ISR		
		Total DPP Oversight & Support			
	Reserve	Contingency	Includes F&IP		
		Management Reserve			
	$ of Year	Interest			
		Escalation	Mgmt Reserve not escalated		
		Subtotal Request to BoD (NR Program)			
Incl. CS Projects	F&IP CS Prj.	F&IP CS Projects	Overnight Costs		
			Contingency		
			Interest		
			Escalation		
		Grand Total (including CS Projects)			
FAC		OM&A			
		Capital (Including Interest)			
		(Excludes Provision)			
Prvsn.		Retube Waste Containers	Provision		
		Grand Total (including Provision & CS Projects)			

Attachment C

Detailed Observations from 4c Cost Estimate Review

Report to Nuclear Oversight Committee

4th Quarter 2013

Darlington Nuclear Refurbishment Project

Attachment C

DETAILED OBSERVATIONS FROM 4C COST ESTIMATE REVIEW

Overview

As summarized in our 4Q 2013 Report to the Nuclear Oversight Committee, BMcD/Modus's review of OPG's 4c Cost Estimate consisted of testing and sampling of approximately [redacted] of the DR Project's costs to determine whether the DR Team followed accepted standards in developing and characterizing the estimate for Management and Board of Directors review and approval. The portions of the 4c Cost Estimate we reviewed were:

- Detailed vetting of the current SNC/Aecon cost estimate for the RFR work;
- Review of six DSRs in the BOP scope that total [redacted], or [redacted] of the BOP Basis of Estimate cost;
- Review of one DSR in the Turbine Generator sub-project scope that total [redacted] or [redacted] of the projected turbine Basis of Estimate costs.

This document describes the process utilized for our review and the detailed recommendations we have provided to the DR Team for future estimate preparation.

Process for Review

A. Estimating Process for Project Bundles:

1. The estimates for Release 4c were based on a "refresh" of the Basis of Estimates (BoE) prepared for Release 4b.

2. The BoE's were adjusted to reflect changes resulting from increased definition of the scope of work (SOW), updated vendor quotes, relevant approved Darlington Refurbishment Decision Record and Analysis Summary Forms (DRAS), approved Change Control Forms (CCF's) and the costs impacts resulting from the scope rationalization effort.

3. The BoE's are prepared as independent assessments of costs to meet AACE Class 5/4 classification for use by the Project Team as they advance through the Gating process. Estimators have met with Project Team members and challenged them to refine the DSR scope in an attempt to achieve a Class 5/4 estimate classification.

4. BoE's were prepared according to the following governance documents:
    a. N-PROC-LE-0011 R000: Nuclear Refurbishment Cost Estimating Procedures.
    b. N-INS-00400-1001 R000: Nuclear Refurbishment Cost Estimating Instruction
    c. N-PROC-LE-0017: Darlington Refurbishment Discovery, Contingency and Management Reserve Procedure.
    d. AACE Recommended Practice No. 17R-97.

5. Typical expected accuracy ranges for Class 5 estimates are (-20% to -50%) on the low side, and (+30% to +100%) on the high side. For Class 4 estimates (-15% to -30%) on the low side, and (+20% to +50%) on the high side.

6. Estimates are prepared on excel based spreadsheet templates which are slightly modified as necessary to accommodate the SOW involved for each DSR line item.

7. The primary driver of hard costs is direct "norm" labor hours which are sourced from an F+G library of data bases and OPG Model Work Orders held in Passport. When in-house data was not available, third party sources were used as appropriate; such as international standards, OPCA (Oil and Petroleum Contractors Association), DACE (Dutch Association of Cost Engineering) and RS Means.

8. When the SOW was similar to historical norms, labor hours were sourced directly (un-factored) from data bases. However, when SOW's differed from historical norms, labor hours were "normalized" (i.e. adjusted) by applied factors (% or formula) in the cell of the respective line item.

9. Once labor hours are established they are further adjusted by productivity and height factors and multiplied by the hourly rate to arrive at labor costs.

    a. Productivity factors (PF) are unique to OPG and have been complied over the past 3 years while estimating projects. The PF's are generated by analyzing a basic 10 hours shift and breaking out the amount of downtime or non-productive time to determine the actual productive time. For BOP, [redacted].

    b. Height factors are unique to OPG and used to account how ascending/descending from scaffolding effects labor hours. Generally, the height of work is broken down to (4) parameters; greater than 30ft, between 21-30ft, between 11-20ft and less than 10ft.

10. Once labor hours and costs are established, "estimating metrics" in the form of % of costs or $/hr are applied, again as factors within a given range, to determine the respective cost elements for Project Management, Engineering, Indirect Costs, Construction Plant, Scaffolding, Training, Commissioning, Small Tools and Profit.

11. The estimating metric factors are a range of values expressed as $ per labor hour ($/hr) or percentage (%) of labor costs. The factors were developed based F+G and OPG historical information.

12. Based on the complexity of the SOW, the estimator selects the value of estimating metric (subject to approval of the Lead Estimator) and applies it to each line item of the DSR.

13. All DSR line items have been assessed without any allowance for rework.

a. All assumptions detailed in the BoE for labor hours and costs are based on one (1) unit. Experience factors for lessons learned resulting from repeat work advancing from the first unit to the last unit are applied on the first unit; 1st Unit – 1.00; 2nd Unit – 0.975; 3rd Unit – 0.970; 4th Unit – 0.965

B. Testing/Sampling – Project Bundles

1. Sampled cost elements (Labor, Material, Construction Plant, Small Tools, Scaffolding, etc.) from six (6) DSR line items totaling [redacted] or [redacted] of total Balance of Plant bundle. For the Turbine Generator Basis of Estimate, one (1) DSR was sampled totaling [redacted] or [redacted] of the TG bundle.

2. Since labor hours are the primary cost driver, the estimating team walked through the labor hour entries. Generally, when the scope of work was similar and lined-up with scopes in the estimating data bases, the labor hour entries were hard keyed with no adjustments. However, in circumstances when scope differed from estimating data bases, a factor (judgment call) was applied to the historical norm labor hours to best approximate the given scope.

3. In regard to applying estimating metrics to the labor hours and labor costs, the Team explained that the selection process of the applied factor was based primarily on the complexity of the DSR line item.

4. Several material costs were also tested. Costs were primarily sourced from Work Orders in Passport and adjusted for inflation. Other material costs were validated by vendor quotes.

5. Profit ([redacted]) is applied only to Material Cost and also included in the labor rates per OPG MSA Contracts.

Recommendations for Future Estimating

The 4d Cost Estimate will need to reflect an expected leap in Project maturity that will occur over the next 8 to 10 months; thus, we would expect that the quality of OPG's estimate would parallel that increase in maturity. BMcD/Modus provided high-level observations and recommendations for development of the 4d Cost Estimate/2014 Business Plan in the 4Q Report that are based on the following detailed observations.

Observation from 4c Cost Estimate	Recommendations
The primary driver of hard costs in the 4c Cost Estimate is direct "norm" labor hours which are sourced from an F+G library of data bases and	• With the expected ramp-up of the amount of information needed to support estimates, the DR Team

Attachment C

DETAILED OBSERVATIONS FROM 4C COST ESTIMATE REVIEW

Observation from 4c Cost Estimate	Recommendations
OPG Model Work Orders held in Passport. When in-house data was not available, third party sources were used as appropriate; such as international standards, OPCA (Oil and Petroleum Contractors Association), DACE (Dutch Association of Cost Engineering) and RS Means.	should focus on improving traceability, sourcing and vetting of database information underlying the estimate as this will be even more essential for vetting the Class 3 Estimates.
Platform for Cost Estimate: At the heart of the 4c Cost Estimate, the DR Team has utilized a series of spreadsheet the in the 4c Cost Estimate is direct "norm" labor hours which are sourced from an F+G library of data bases and OPG Model Work Orders held in Passport templates. These spreadsheets utilize a large number of "hard-keyed" entries rather than "lookup" or "reference" functions that refer back to the source data. In addition, many cell formulas are unprotected. This method works but can be inefficient and requires extensive QA/QC as the estimate becomes more detailed.	➢ DR Team may consider migrating to a standard estimating platform such as SNC/Aecon is now utilizing for its Class 3 cost estimate. Such platforms allow for greater consistency among estimators, though there is a learning curve for effective implementation. ➢ If the DR Team does not adopt a standard estimating platform, it should consider utilizing comment boxes and/or text cells to reference the source data or utilize lookup functions to directly refer to input data. ➢ In any event, the team will need to dedicate resources and time for running ongoing QA/QC checks, particularly when including linked spreadsheets and contractor-produced database.
The 4c Cost Estimate relies on a number of estimating factors, some of which are a product of the current level of Project definition (i.e. Class 5/4). Factors have been used to approximate the result that will come with greater Project definition.	➢ Utilizing such factors in estimating is common industry practice. However, OPG should increase the level of documentation regarding the factors that are used so that these are traceable when used. ➢ Going-forward, OPG will need a more organized set of estimate templates for vetting of Class 3 estimates and target price proposals from contractors. Utilizing a standard estimating platform (like Timberline) could provide an acceptable alternative.
Labor estimates used in the 4c Cost Estimate are generally based on productivity and include:	➢ Traceability of the source of such factors is critical. Industry-based studies for developing productivity factors can be

Attachment C

DETAILED OBSERVATIONS FROM 4C COST ESTIMATE REVIEW

Observation from 4c Cost Estimate	Recommendations
• a crew sheet that analyzes process flow and work series and • height of operations These factors are unique to OPG and have been developed over the past three years.	distinguishable, as can a contractor's experience when work is not entirely similar. ➢ Vetting of these factors and record-keeping related to the source will be critical for Class 3 estimate reviews.
OPG Costs: the major drivers the DR Team examined for the 4c Cost Estimate were: • Impact of unlapping of Unit 2 • Scope rationalization and impact on overall size of the Project and associated level of effort. The different work groups were given a blank template for defining their staffing needs; this was later changed to variance reporting against 4b when it was apparent the work groups were exceeding cost boundaries. Costs were eventually brought in line via vetting and challenge meetings with RPET and the efforts of the Finance and Project Controls groups.	➢ Finance and Project Controls developed metrics for showing cost flows and variances over time that were extremely helpful in determining the right-sizing of the team. These (and similar) tools should be incorporated into the metrics the team is reviewing in an attempt to increase cost consciousness. ➢ Vetting of OPG costs was also impacted by the timing of the 4c Cost Estimate effort, which began in the middle of the summer months. The next phases of estimate should have a schedule of activities and begin earlier in the year, particularly considering the increased complexity expected for 4d.

Exhibit 1 to Attachment C – Sampling of 4c Cost Estimate

No.	Bundle/Sub Bundle		DSR Line	Title	AACE Class
1	BOP	Common System	TS0510-11	DNGS Structures: Perform Inspections For Civil Structures in the Reactor Auxiliary Bay (RAB).	5
2	BOP	Common System	TS0510-18	DNGS Structures: Repair / Replacement of Civil Structures Located in the Reactor Auxiliary Bay (RAB).	5
3	BOP	Conventional	SIO390-1	Install Flash Tank and Treatment Skid	5
4	BOP	Pre- Refurbishment	TS0630-6	Service Water System	5
5	BOP	Reactor Systems	TS0320-1	Refurbish all PHT Pump Motors by sending them to a repair shop.	5
6	BOP	Reactor Systems	SIO300-31	Dual power supply for Vault Vapor Recovery Dryer	5
7	BOP	Safety & Control Systems	TS0350-6	Replacement of SDS Computers (DSR's TS0350-1 to TS0350-18) Installation Costs	5
8	Turbine		SI0010-1		4
9	Fuel Handling		TS0410-6	Replace all trolley pumps	5
10	Unit Islanding		TS0810-1	Reactor Building Containment Bulkhead Isolation: Containment Bulkhead Installation	5
11	Steam Generator		TS0050-4	Assess Ports Installation	4
12	Shutdown & System Layup		TS0890-2	Unit Layup Modification for Nuclear Systems: Drying of Main HT Circuit	5
				Total	

[redacted]

Exhibit 3

1Q 2014 Report

Supplemental Report to
Nuclear Oversight Committee

2nd Quarter 2014

Darlington Nuclear Refurbishment Project

Report to Nuclear Oversight Committee

1st Quarter 2014

Darlington Nuclear Refurbishment Project

Burns & McDonnell
Modus Strategic Solutions

March 4, 2014

I. Executive Summary

Burns & McDonnell Canada Ltd. and Modus Strategic Solutions Canada Company ("BMcD/Modus") provide the following Quarterly Report to the Nuclear Oversight Committee of the OPG Board of Directors ("NOC") regarding the status of the Darlington Nuclear Generating Station's Refurbishment Project ("Project" or "DR Project") as of February 21, 2014. The DR Project continues to advance toward its major goal of producing a Release Quality Estimate ("RQE") for final Board of Directors and Shareholder approval by October 15, 2015.

In this report, we provide current updates regarding the DR Project's most significant risks. In addition, we provide a high level assessment of the DR Project's compliance with the principles set forth in the Minister of Energy's December 2013 Long Term Energy Plan ("LTEP"), and identify recommendations for strengthening OPG's planning for completion of the Release Quality Estimate ("RQE"). We would also like to note that pursuant to the Project's Assurance Plan approved by the Audit Committee, BMcD/Modus has prepared independent reports documenting the DR Team's status as well as further recommendations for improvement. This quarter we have issued an Assurance Report based upon our detailed review of the DR Team's Risk Management Program. Next quarter we will issue three other Assurance Reports relating to: 1) DR Project schedule process and development; 2) the 2013-2014 Business Plan as it relates to the latest project estimate (the "4C Estimate") and 3) scope status and process. These full reports will be available for the NOC's review at its convenience. With respect to our ongoing involvement in the Assurance Plan, we will continue to work at the NOC's direction.

The following is a brief summary of the Project's most significant developments over the last quarter:

- [redacted] The DR Team is closely monitoring SNC/Aecon's progress and has recommended SNC/Aecon increase schedule reporting and supplier surveillance.

  [redacted] As we have stated in previous reports, we are concerned that this increases the risk of a "surprise" in the final Class 2 Estimate and could complicate target price negotiations with SNC/Aecon. Furthermore, OPG could use this information to provide a more mature 4d Cost Estimate in the fall of 2014.

- **Commercial Risks:** We have encouraged the DR Team to evaluate its major contracts to ensure that the proper incentives and disincentives are included in light of the LTEP. As an example, the RFR Contract includes certain incentives and disincentives that were focused on improving performance unit-over-unit. However, the LTEP and OPG's decision to "unlap" Unit 2, puts more focus on the success of the first unit. The DR Team should therefore

revisit these contract incentives and disincentives to ensure such success. Future negotiation of the SNC/Aecon target price for the Execution Phase should include re-examination and clarification of certain elements that could not have been contemplated at the time the parties negotiated the Contract. Similarly, the ESMSA contracts should be evaluated in light of current considerations.

- **Campus Plan Performance Project Risk**: Performance of the Campus Plan work remains a significant risk. The D20 Storage Facility foundation work has been impacted by subsurface conditions and ongoing engineering challenges and is now projected to complete in April 2016. Based on the current schedule, there is now a 3-month delay to the critical path, impacting OPG's ability to open the Unit 2 breaker in October 2016. Additional work on other key Campus Plan facilities is tracking behind schedule and/or over budget. In addition to recovering the schedule delays to the D20 Storage Facility, it is critical for the DR Team to increase the predictability of this work and identify any lessons learned that could impact the Balance of Plant ("BOP") work that will be performed by the same contractors under the ESMSA terms and conditions.

  Both Projects & Modifications ("P&M") and the DR Team are increasing their focus on the remainder of the Campus Plan scope. Project controls (schedule and cost) are currently under intense review, as is the process for engineering oversight. BMcD/Modus recommends that as part of its review, the DR Team refresh its understanding of required end dates for these Facility and Infrastructure ("F&I") projects and examine what appears to be poor schedule logic and unrealistic float that could be masking further delays and performance issues. In addition, BMcD/Modus is engaged in a root cause analysis of the systemic budget variances that have become apparent for this work.

- **RQE Preparation**: RQE development remains essentially on schedule, but will be heavily reliant on the quality of the various inputs. It is essential that the DR Team carefully plan and manage the RQE development process. The DR Team has assigned a manager for the planning and development of the multiple pieces that must come together for RQE. The team is developing an RQE planning schedule and further definition for expectations for deliverables. The Blue Ribbon Panel assigned to review the DR Project's scope has completed its work and its final recommendations have resulted in $179 million of work being removed from the DR Project, some of which has been cancelled entirely.

Other ongoing challenges to the DR Project include the continued development of the BOP work, further refinement of the Risk Management Program and completion of pre-requisite F&I and Fuel Handling work. Attachment "A" provides an update regarding the DR Project's risks.

II. Project's Conformance to LTEP

A. LTEP Principles

The LTEP identifies priorities for OPG and Bruce Power to follow in their respective mid-life refurbishments of DNGS Units 1-4 and Bruce Units 2-8. The LTEP supports the refurbishment of DNGS Unit 2, but states that "the province will proceed with caution to ensure both flexibility and ongoing value for Ontario ratepayers," and "(f)inal commitments on subsequent refurbishments will take into account the performance of the initial refurbishments with respect to budget and schedule by establishing appropriate off-ramps." In addition, the LTEP identifies seven priorities for OPG and Bruce Power to follow in their respective refurbishments:

1. Minimize commercial risk on the part of the ratepayers and the government.
2. Mitigate reliability risks by developing contingency plans that include alternative supply options if contract and other objectives are at risk of non-fulfillment.
3. Entrench appropriate and realistic off-ramps and scoping.
4. Require OPG to hold its contractors accountable to the nuclear refurbishment schedule and price.

5. Make site, project management, regulatory requirements, supply considerations, cost and risk containment the primary factors in developing the implementation plan.

6. Take smaller initial steps to ensure there is an opportunity to incorporate lessons learned from refurbishment including collaboration by operators.

7. Hold private sector operator accountable to the nuclear refurbishment schedule and price (*not applicable to OPG*).

In addition, the LTEP states that "(t)he government will encourage the province's two nuclear operators, Bruce Power and OPG, 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." We are aware that OPG's management has engaged in such discussions with Bruce Power but to date no progress has been reported.

B. BMcD/Modus Assessment

The following is our assessment of the extent to which the DR Team is currently in compliance with the LTEP's principles. We have also identified gaps that may currently exist and recommendations for strengthening OPG's compliance with these requirements. In this assessment, we have focused solely on the DR Project's readiness, as BMcD/Modus has not been retained by NOC to assess each of the considerations in the LTEP. In addition, there are LTEP principles that have commonality, which we identify below.

1. Minimizing commercial risks	
Current Initiatives:	The primary commercial risks to the Province from mid-life refurbishments emanate from the potential for unplanned significant cost and schedule overruns. OPG has recognized these risks and others from prior nuclear projects (Pickering A RTS and Pickering A&B Retube) and has implemented an extensive planning effort with its prime contractors during which OPG is: • Locking down project scope well in advance of starting construction; • Engaging in a robust pre-outage inspection campaign that utilizes the units' maintenance and Vacuum Building outages; • Executing refurbishment and improvements to the reliability of the fuel handling machines that service the station; • Planning and executing pre-requisite work that will support the refurbishment as well as unit life extension prior to the start of Unit 2's outage; this should provide a testing ground for the Execution Phase; • Building a full-scale mockup of the DNGS reactor and vault that will be used for training and proving the tools needed for the removal and replacement of the reactors' internals; • Fully developing engineering and planning of the work so that it is 100% complete prior to the start of construction; • Developing a Release Quality Estimate (RQE) in phases that incorporates a high-confidence budget and schedule for the work; • "Unlapping" Unit 2 from Unit 1 so that the focus can be entirely on the planning and construction of a single unit and so that OPG can gain confidence and lessons learned in completing the work;

	• Utilizing target price contracts for the Execution Phase that are based on developing cooperation and transparency with key vendors; • Negotiating various off-ramps and stages into the RFR contract with SNC/Aecon, such that SNC/Aecon securing the Execution Phase contract depends on its performance in the Planning Phase and the quality of its estimate and schedule for execution; and • Changing its procurement practices for the Balance of Plant ("BOP") work that increases the chances of meeting schedule via direct award of work packages to the ESMSA vendors.
Potential Gaps:	➢ Incentives in the RFR contract were developed and established on the basis of four unit performance, allowing the RFR contractor to make-up cost overruns and schedule delays to the first unit on subsequent units. However, the LTEP prioritizes the urgency of a success on Unit 2. ➢ F&I work is behind schedule and is diverting management attention. The ESMSA contractors may require additional review of incentives and conditions for performance on BOP work.
BMcD/Modus Observations and Recommendations:	With respect to the SNC/Aecon RFR Contract, we recommend revisiting the contractual incentives that were negotiated in 2011-12. The LTEP represents a major strategic revision for the DR Project, such that emphasis on unit-over-unit improvement is much less of a consideration that optimizing performance on Unit 2. Moreover, with the award of the Turbine Generator performance to SNC/Aecon, there are additional opportunities to increase the efficiency and lower the overall cost of SNC/Aecon's work. Similar reviews should be undertaken with the ESMSA vendors to ensure all performance incentives are aligned with the current DR Project goals.
2. **Developing contingency plans to mitigate risks**	
Current Initiatives:	OPG has considered and developed what appear to be reasonable contingency plans needed to mitigate project risks[1] including: • OPG's decision to "unlap" Unit 2 from the other units' refurbishment, which predated the LTEP, was intended to mitigate the risk of performance and provide the DR Team with singular focus on one unit's refurbishment at a time. • OPG's significant investment in engineering and planning the work in the Definition Phase is the direct result of OPEX from Pickering Unit 4. • OPG has made a sizeable investment with the reactor mock-up, during which SNC/Aecon will perform full integration and commissioning testing of the tools needed for refurbishment. The results of those tests will be incorporated into the Tooling Performance Guarantee with SNC/Aecon. • The DR Team has developed and implemented a Risk Management Program that is being used to evaluate and prioritize project- related risks and management issues.
Potential Gaps:	➢ SNC/Aecon contract was set-up with the intent of monetizing contingency as part of the target price and not before, and there is currently some ambiguity regarding the pricing of risk in the target price.

[1] BMcD/Modus has been asked by NOC to evaluate or otherwise assess any aspects of supply.

	➢ OPG's project risk management identification requires additional leadership, visibility and focus. ➢ OPG's transition to actively managing the EPC contractors' engineering work will require significant focus.
BMcD/Modus Observations and Recommendations:	Our recommendations regarding risk and contingency have been discussed in prior reports. The DR Team's senior management is acting on these recommendations.
3. **Entrench appropriate and realistic off-ramps and scoping**	
Current Initiatives:	• OPG has engaged in a deliberate process with numerous off-ramps for the Definition Phase. This process includes significant BOD oversight and approval of yearly releases of funding, and these funding releases and related details are being vetted by Independent Oversight. • The yearly release strategy and gating process for funding individual project initiatives has wide visibility and adherence within the DR Team. [redacted] • OPG has fully examined the scope of the Unit 2 refurbishment project and redistributed or cancelled work based on OPG's regulatory commitments. • As part of scope review, OPG has designated scope in AISC programs for the station which will be performed over a longer period of time. • OPG simplified the scope of the Turbine Generator work by delaying the installation of the turbine controls for Unit 2 until a future outage.
Potential Gaps:	➢ Finalizing the scope recommendations of the Blue Ribbon Panel and fully documenting those decisions for future prudence review. ➢ Ensuring the scope that is required for refurbishment, though performed outside of the DR Project, is staffed, funded and executable.
BMcD/Modus Observations and Recommendations:	In general, we see that OPG has set up the Project with appropriate measures to reduce or eliminate scope depending on the Shareholder's future needs. Unlapping Unit 2 also provides the DR Team an opportunity to incorporate lessons learned into subsequent units.
4. **Require OPG to hold its contractors accountable to the nuclear refurbishment schedule and price**	
Current Initiatives:	• Contracts with major vendors are being developed and vetted utilizing a deliberate, staged and gated process with requirements for budget, schedule and scope identification at each gate. • The terms and conditions of OPG's contracts generally conform to the industry, and the contracts have specific negotiated incentives and disincentives that are calculated toward promoting the contractors' (and OPG's) responsible management of the work. • OPG has chosen to perform the work in the Execution Phase on a target price basis which increases the contractors' transparency. This will enhance OPG's ability to resolve issues as they arise.

	• OPG is implementing a detailed, integrated Level 3 schedule that will encompass all of the contractors' and OPG's work, as well as a rolled-up Level 2 C&C Schedule that is used as a higher level interfacing tool. The schedule allows for planning and coordination of the work. • OPG has implemented cost control systems that are geared toward holding contractors accountable. These systems include earned value and budget controls through the gate process. In addition, OPG's Corporate Finance has increased its focus and resources to handle the volume of the DR Project's work. • OPG performs analyses of all pricing and check estimates for the contractors' work. These estimates are provided by an independent vendor with experience in the industry. • OPG's senior management has established separate regular steering committees with each of the major vendors' executives which provide senior leadership with a forum to discuss progress, potential and real issues impacting performance and commercial issues. These forums are an essential ingredient in managing contractors' work. • OPG has an opportunity through the Campus Plan work to test many of its core processes and controls.
Potential Gaps:	➢ The gate process is very good in principle although it would benefit from some additional focus and attention in practice. BMcD/Modus's recommendations in this regard were part of our 3Q 2013 report to NOC. ➢ The estimating process may require some changes depending on the result of the root cause evaluation of Campus Plan budget variances. ➢ DR Team's project controls are in an early stage of development and require testing and adherence by the major contractors. In particular, the earned value system will require significant testing and oversight as different pieces of the DR Project progress. ➢ F&I work is not using all of the DR Project's core processes, and those it is using lack consistent adherence.
BMcD/Modus Observations and Recommendations:	The DR Team has struggled with defining its "oversight" role of the contractors. As we have noted in prior reports, since OPG is ultimately responsible for the Project's outcome, it must actively manage the work of its contractors, which requires a detailed understanding of the contractors' work status and the removing of any barriers to performance as quickly and prudently as possible. Active management, however, does not include interfering with or re-performing the work for the contractors. Finding this balance is a difficult task for an owner, particularly an owner such as OPG who has self-performed and self-managed so much of its past large capital projects. The tools the DR Team will rely upon, including the P6 schedule and Proliance, will need significant attention and ongoing maintenance.
5. **Make site, project management, regulatory requirements and supply considerations, and cost and risk containment, the primary factors in developing the implementation plan.**	
Current Initiatives:	• OPG's plan for RQE assumes that all of the factors listed will be fully considered, planned and budgeted in advance of execution of the work. OPG will invest $2.4 billion in upfront planning and site preparations prior to the breaker of Unit 2 opening in October 2016.

	• Taking lessons from Pickering A, the DR Team has committed to completing the identification of all regulatory requirements well in advance of final design and construction. • OPG has also committed to the completion of design, proving of the RFR tools and completing procurement of all necessary components one full year before breaker open. • OPG has implemented project controls and risk management programs and will continue to refine these tools as the outage nears. • OPG has established hard dates for procurement and delivery of all long lead items. • OPG has retained external oversight and engaged other corporate functions in providing input and assurance that the DR Team is meeting its commitments.
Potential Gaps:	None at this time.
BMcD/Modus Observations and Recommendations:	While OPG's plans for the Definition Phase are robust, execution of these plans will require significant and ongoing effort.
6. **Take smaller initial steps to ensure there is an opportunity to incorporate lessons learned from refurbishment including collaboration by operators.**	
Current Initiatives:	• OPG management approved the unlapping of Unit 2 in advance of the LTEP. As noted, the revised plan will allow for a more measured approach and singular focus on one unit refurbishment at a time. • OPG has filled key positions in its project management team with individuals with direct experience of prior CANDU refurbishments. • OPG has contracted with SNC/Aecon, whose subsidiary, CANDU Energy (formerly AECL), has been associated with each of the prior refurbishments. • SNC/Aecon has invested in studying lessons learned and OPEX from these prior projects and incorporated those into the RFR project. The basis of SNC/Aecon's estimate for DNGS is these past projects with specific understanding and elimination of the issues that caused prior cost and schedule overruns. • The scope rationalization and elimination of Turbine Generator controls installation for Unit 2 should allow the DR Project to establish considerable construction float for BOP work. • OPG has initiated contact with Bruce Power.
Potential Gaps:	None at this time.
BMcD/Modus Observations and Recommendations:	OPG's management has taken reasonable steps to ensure that the DR Project is proceeding along a deliberate path for success. Execution to that plan is not guaranteed but will be enhanced by the work that OPG has done to date. OPG should continue to explore ways to collaborate with Bruce Power that will be beneficial to both organizations.

In summary, BMcD/Modus believes that OPG is taking prudent steps in fulfilling the LTEP's principles, and these steps largely predated the LTEP's publication. Management also appears to understand the challenges ahead.

III. Major Projects – Summary of Key Risks

A. Retube & Feeder Replacement

1. Work Status – Tooling, Definition and Mock-up

[redacted]

The following is the current performance trend for the three major procurements that BMcD/Modus began tracking in 3Q 2013:

[redacted]

[redacted]

[redacted]

2. SNC/Aecon Class 3 Estimate Status

[redacted]

[redacted]

The DR Team will have a better idea of exactly how [redacted] in its Class 3 Estimate preparation in the next 4 to 6 weeks. Assuming the recovery of the estimate target [redacted] BMcD/Modus encourages OPG to:

- Maintain the level of focus on SNC/Aecon's progress and refresh the projected completion dates based on that progress;
- Review mitigation for receiving the Class 3 Estimate later than planned, which could impact the DR Team's initial preparation of the 4d Cost Estimate;
- Request SNC/Aecon to provide all needed resources from its team OPG will need for its review and vetting of the Class 3 Estimate so that OPG's work will not be an excuse for SNC/Aecon's delays; and
- Have SNC/Aecon provide its assessment of project contingency, which is currently not required under the RFR Contract until the end of Class 2.

[redacted]

3. RFR Commercial Risks

As noted above, at the time OPG and SNC/Aecon negotiated the RFR Contract, it could not have taken into account recent events—in particular the unlapping of Unit 2 and many of the principles identified in the LTEP. The major provisions that the DR Team should review include:

- Performance incentives for unit-over-unit improvement – to the extent that unlapping and the LTEP have increased emphasis on maximum performance in the first unit, the parties should weigh whether the provisions that incentivize SNC/Aecon to improve from one unit to the next will promote the proper focus on successfully completing the first Unit;
- Cost and Schedule incentives and disincentives should be reviewed under the same light;
- With the award of the Turbine Generator performance work to SNC/Aecon, there are potential economies of scale that could lessen the Project's cost and risk;
- OPG and SNC/Aecon also need to agree on the RFR project risks, which risks will be shifted to the contractor, and whether such risks will be covered by the base cost (including the target price neutral band), contingency or allowed contract changes.

Because the Execution Phase contract has not technically been awarded, engaging in these discussions should just be part of the final target price negotiations. OPG should consider the timing of starting these discussions so that the current Class 3 Estimate can incorporate the necessary considerations going forward.

B. Campus Plan

The F&I Campus Plan Projects remain a significant risk to the DR Project. Through January 29, 2014, each of the 15 refurbishment prerequisite projects that are underway (including SIOs), are behind schedule, over budget or both. Some of these projects must complete prior to the VBO outage; others are not essential until Unit 2 breaker-open. However, to date, these projects appear to have been impacted by a combination of poor upfront scoping, engineering delays, lack of planning, insufficient scheduling, and significant misassumptions regarding cost and budget.

The most notable of these projects is the D20 Storage Facility, which has been delayed by unforeseen underground conditions, incomplete scoping of the work, and engineering progress. The following highlight some of the issues the project has encountered:

- Engineering for the D20 Storage Facility was scheduled to be completed by spring of 2013; now that projection is July 2014, over one full year late.
- Late tie-ins to the low pressure service water line have already resulted in a 2 month delay to the Tritium Removal Facility ("TRF") Outage completion. The D20 Storage Facility's delays have the potential to ripple into the construction of the Retube Waste Processing Building, which is being impacted by the waste pile from D20 Storage Facility's excavation.
- All of the schedule float for D20 Storage Facility has been used and if the delays are not mitigated, it will delay breaker open on Unit 2 in 2016. The current completion date for the D20 Storage Facility is projected to be April 2016, which is 6-7 months later than planned and a 3-month delay to the critical path. The operations team needs to receive this building in January 2016 in order to complete commissioning in time for breaker open.
- The budget for the D20 Storage Facility will be exceeded due to increased costs for removal of the soil, delays to the start of the caissons and other scope issues; the DR Team is currently reviewing the extent of the budget overrun.

BMcD/Modus is currently examining the root causes of the significant challenges to the D20 Storage Facility and other F&I projects that are pre-requisites to the DR Project. We have discovered some significant facts that could explain why these projects are so far off their schedule and cost goals:

- The schedule for all the Campus Plan work was initially premised on a DR Project breaker open date of October 2015. When the DR Project's start was postponed one year, these projects had more time but didn't have an additional year of float. However, not only does it appear that some of the original scheduling assumptions were erroneous, the P&M organization did not take advantage of the additional time to improve its front-end planning and reduce the overall performance risk of this work. Instead, work packages and projects simply sat in place and were not aggressively advanced.
- The D20 Storage Facility was the first EPC ESMSA project and the learning curve has been particularly steep. The P&M team appears to have underestimated the impact of the new contracting methodology for performing the work, and has been over-reliant on the ESMSA contractors.
- Initial scope identification was very limited and left open key aspects of the design. The DR Team, having observed the problems with the D20 Storage Facility, changed the process for scope identification for the other modification work, resulting in the development of the MDP packages.
- P&M accepted vendors' quotes for the work that were widely disparate, without a full understanding of what was causing the price differences. Furthermore, even though the work ultimately was to be performed on a cost

reimbursable basis, P&M significantly weighted the bid evaluation towards the lowest priced estimate, discounting a bidder's experience, qualifications and understanding of the work.

- P&M assumed that the accepted vendor quote it received could be termed a "Class 2 Estimate" even though engineering had not for advanced commensurate with such a classification. Thus, the contingency released at the D20 Storage Facility's Gate 3b was insufficient [redacted] to cover the known risks, many of which have already materialized.
- P&M's management was not aggressive enough in requiring the ESMSA contractors to submit reliable Level 3 schedules for performance of the work. Currently there are only 4 schedules loaded into the C&C Schedule from F&I work that have sufficient Level 3 detail. Moreover, it doesn't appear that P&M looked at the composite workload on each of the ESMSA contractors until the DR Team required P&M to integrate its schedules in the fall of 2013.
- F&I schedules currently carry unrealistic float, are tied improperly to ending milestones, and utilize incorrect milestones.
- There may be commercial issues getting in the way of the [redacted]. The ESMSA contractors had initially complained that the secondary compete process made it impossible for them to plan for the proper size and scale of their operations. In addition, the incentives to manage the engineering process [redacted]

In summary, BMcD/Modus has found that P&M has clearly struggled with how to manage the ESMSA contractors in an EPC arrangement. As noted above, BMcD/Modus is currently examining the root causes of these issues. We expect to arrive at more definitive conclusions by the next NOC meeting.

In the meantime, the DR Project's and P&M's senior management have taken the initiative to call a summit with the ESMSA contractors to further examine and clear barriers to success that are impacting both the F&I and Balance of Plant ("BOP") work. In addition, P&M's and the DR Team's senior leadership are taking action to turn the performance around, including:

- Co-locating OPG engineering resources at the vendor's shops to answer questions and oversee development of the detailed design work and institute regular Steering Committee meetings with project leadership to remove performance barriers.
- Continuing integration of all of the F&I pre-requisite work into a single schedule so that the ESMSA's can properly plan and resource load the work and OPG can manage the contractors' work load and performance. As part of this schedule development, BMcD/Modus sees a critical need for the DR Team, P&M and Plant Operations to conduct a joint review to confirm the latest possible delivery dates for all F&I work. Such a review needs to incorporate requisite commissioning time and resources needed for completion of the work, as well as spread resources in an efficient manner.
- Complete the work allocation to each of the ESMSA vendors so that they can properly plan their work. The DR Team has attempted to allocate the work evenly, though it may become necessary to shift work based on performance and resource availability. This becomes a more complex issue with the BOP work scope also needing attention in the coming months.
- Provide additional and focused project management support from OPG to clear barriers to engineering and execution work.
- Engage in constructive high-level dialogue with the ESMSA's senior management.

OPG Management is taking action to turn around the Campus Plan work, including bringing in new leadership for P&M and fostering greater integration between the F&I and DR Project work. The visibility of the issues P&M has encountered will help the BOP, Islanding and Services projects work with the ESMSA contractors.

C. Balance of Plant and Other Projects

In our 4Q 2013 Report, we discussed the impact of the review by the Blue Ribbon Panel of DR Project scope. The final recommendations have been made and have been reviewed through the Project Scope Review Board process. As noted on our prior reports, the process OPG used for this review was robust and consistent with the DR Project's management processes. With scope essentially locked down, the attention of the BOP, Services and Islanding projects shift to allocating the work to the performing contractors (mostly ESMSA or SNC/Aecon), completing detailed engineering and establishing target price budgets for the work. Some early indications of scope/pricing from the ESMSA have been mixed. [redacted] The DR Team has rejected these proposals and clarified its requirements, which is delaying the issuance of this work package. The DR Team has increased the time for verifying estimates (from one week to two weeks) to ensure the contractors' pricing and scope are properly aligned. We have recommended the DR Team further align this process by requiring the ESMSA provide its detailed estimates in a manner that facilitates comparison with the internal check estimates from Faithful & Gould. These actions should improve the quality of future ESMSA estimates, though this bears close attention.

IV. Functional Groups Update

A. Engineering

1. Scope Definition

The DR Team has placed significant emphasis on defining scope well in advance of RQE and has set critical milestones for measuring scope definition. One such goal is achieving "Health of Scope" to support detailed design work. The DR Team reports that it is on target to achieve Health of Scope 4, in which all modification work will be known, by the October 2014 milestone. The team's ability to meet this milestone was greatly enhanced by the work of the Blue Ribbon Panel.

Through the end of January, 2014, Engineering had completed 112 Modification Design Packages with 27 known packages remaining. This represents excellent progress over the last year, and the May 2014 milestone for completing MDPs should be met.

2. Planning of Engineering Work

As recommended in the BMcD/Modus 4Q 2013 report, OPG's Engineering attention has shifted from the Definition Phase to planning the next design phases, utilizing the Construction Industry Institute's ("CII") ***Front End Planning for Revamp and Renovation Projects*** as a source of industry best practices. OPG's focus on planning has initiated a 'bottom-up' work hour estimating process for engineering activities that will lead to a more precise resource forecast. Engineering also initiated the use of an engineering deliverables-based blackout chart, the development of which has identified additional issues with the integrated Level 3 schedule that should enhance the coordination of interrelated activities.

Engineering's focus on planning has also brought attention on the engineering partners of the ESMSA vendors who are responsible for the detail design phase for BOP and F&I work. [redacted] The DR Team is now taking a much more active role in the management and execution of the F&I projects, and has sought alignment between OPG and the ESMSA's engineering companies' senior management.

The EPC requirements in the ESMSA contracts have compelled constructors and engineering companies who were not previously partnered, to join forces. In our experience, joint ventures of this nature can take several years and several project cycles to mature. The ESMSA joint ventures are still on the early part of this learning curve. The shift within OPG to greater reliance upon external service providers has resulted in some duplication of work effort, churn and [redacted] along with OPG's late recognition of its essential role in managing these vendors. OPG Engineering is moving away from a culture of "observation at a distance" to a much more proactive engagement and active management of the engineering service providers. We continue to encourage this shift in role and perspective.

B. Project Controls

1. Schedule

As discussed above, the DR Team's project controls staff has developed a plan for integration of the prerequisite F&I work, calling for full development and integration of the Level 3 schedules for all sub-projects by the responsible ESMSA vendor. This integrated schedule, database in combination with the DR Project integrated schedule, will allow for timely project status and schedule analysis as well as a more cohesive decision making process regarding work flow and resources. This technique is being put in place and utilized by P&M for all of the F&I projects allowing for composite resource analysis, most importantly by the ESMSA vendor resources. Because this process is vitally important to the success of the DR Project, compliance by the P&M organization (including the ESMSA vendors) is imperative.

Until this quarter, the P&M organization has had little success accomplishing the development and integration of the ESMSA vendor schedules. In fact, the number of vendor-developed Level 3 schedules has lagged significantly behind the work. The lack of properly developed, integrated and resource loaded Level 3 schedules has made it impossible to evaluate ESMSA resource needs critical to the DR Project. Furthermore, the lack of an integrated schedule has made critical analysis of the potential impact of delays to the DR Project milestones impossible, and perpetuated the assumption that the F&I work had months of float.

Recent success by the teams working to implement the schedule integration plan has been encouraging and ESMSA scheduling work is improving. P&M and DR Team leadership are now providing clear and concise definition of the division of responsibility between the DR Team, P&M project management and the ESMSA vendors and improving the working model. Meanwhile, the DR Team has identified the points of impact at which the F&I projects could cause delay or changes in execution methodology. These points are now set in the Refurbishment schedules awaiting work ties by the ESMSA vendors so that impacts can be evaluated.

To further facilitate the schedule development, BMcD/Modus recommends that a composite team (DR Team, P&M and Plant Operations) review the F&I schedules developed to date in conjunction with a re-evaluation of the impact points and milestones critical for delivery of the prerequisite projects. This analysis will comprise a review of individual project logic combined with an evaluation of the proper inter-project and milestone logic, sometimes termed a "backwards pass" analysis. This review should also develop a prescriptive plan for final F&I schedule development aligned with the current Level 3 DR Project compliance requirements. The project controls team should prepare a follow-up analysis that focuses on resource loading by the ESMSA vendors. Studies determining regional resource availability requisite with the project needs shall be conducted parallel to this development. Prompt identification of issues related to resource availability have to be quickly identified and fact based in order to properly address and/or provide mitigating actions to alleviate.

2. Project Cost/Estimating

As noted, BMcD/Modus is currently examining the root causes of the budget variances apparent in some of the F&I work. As part of this analysis we will review the initial pricing responses on BOP work to see if they suffer from some of the same noted deficiencies. The DR Team prepares independent estimates of the work for planning and budgeting, as well as providing a check against the contractors' pricing. For the BOP work, these estimates will form the first check against the completeness of the contractor's budget; thus if these estimates are wrong, this would greatly complicate development of the 4d estimate and RQE. We are also examining the commercial risks present in the ESMSA contracts to test if there are provisions that are causing poor behavior by the two contractors. We expect to arrive at more definitive conclusions by the next NOC meeting. The project controls team and the estimating vendor (F&G) are performing their own series of self-assessments and quality reviews on the estimating process.

3. Risk Management Program

As a part of our commitments under the 2014 Assurance Plan, we performed a detailed assessment of the Darlington Refurbishment's Risk Management Program in the fourth quarter of 2013. The purpose of this assessment was to review

the status of the areas identified for improvement in our August 13, 2013 comprehensive Project Assessment Report. From Mid-July through the end of December, BMcD/Modus monitored and assessed the DR Team's actions regarding the Risk Management Program and note progress in line with our initial observations and recommendations. Although the DR Team still has work to do to effectively implement the program, numerous improvements have been initiated that address matters such as:

- Greater emphasis on risk identification clarity and the progressive elimination of "business as usual" items from the Risk Registers;
- Some formal training has been conducted;
- Improvement to the Risk Register Reports;
- Consolidation and clarification of the applicable risk procedures; and
- The Risk Group has taken a more aggressive role in managing the Risk Management Program.

However, the DR Team has not completed implementation of these essential improvements. The DR Team needs to continue to scrub and clean the risk registers in order to make them an effective tool. The risk reporting tool is somewhat cumbersome and is difficult for end users to sort and analyze information; thereby hindering the effective development and management of mitigating actions. The DR Team has commenced some formal training on the Risk Management Program, however, there needs to be more as evidenced by the current state of the Project Risk Registers. While we have seen some evidence that the Planning and Controls Risk Group has taken a more active role with respect to the implementation and management of the Risk Management Program, we would recommend much more attention in this regard. Additionally, we have not seen much improvement with respect to the identification of opportunities or the development of useful metrics. **Attachment B** to this report is a table which shows the trending on the various areas of the Risk Management Program.

V. Other Project Risks

A. Project Team Development

Some of OPG's procedural and process changes in response to the Auditor General's Report have increased the risk of key personnel leaving the project and will make the hiring and retention of experienced resources more difficult for the DR Project. Enterprise Risk Management carries the retention of key personnel as the biggest program risk to the DR Project, and we would agree that it is certainly among the DR Project's biggest challenges.

BMcD/Modus has pulsed the succession and workforce planning as well as the current and projected staffing levels and found that the DR Team's management is properly focused on this risk. However, the team could benefit from more formal procedural guidance. The unlapping of Unit 2 has also relieved some pressure for immediately staffing the Project Team for the next units.

B. Program Management Plan Development

BMcD/Modus monitored the 4Q 2013 update of the DR Team's Program Management Plan ("PgMP"), the primary purpose of which is to demonstrate how the project will be planned, executed, monitored, controlled and closed. A well-constructed PgMP provides a descriptive link between the Project Charter and the lower level procedures; thus, it should be an informative guide for team members and stakeholders alike and subsequent revisions should provide a progressive elaboration of the program management team's plans as they continue to develop.

We found the current state of the DR Team's PgMP to be lacking in detail and clarity. The individual work plans within the PgMP were of inconsistent quality and depth, and these plans were not integrated in a comprehensive fashion. Moreover, the PgMP did not eliminate many of the procedures that are no longer needed or applicable for this work. We would recommend that management make completing the PgMP a priority.

Attachment A

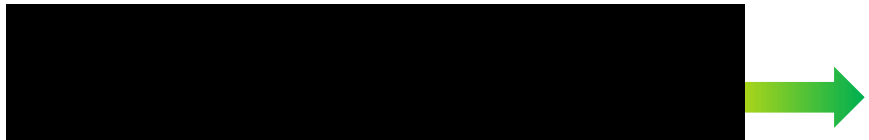
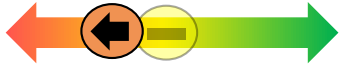
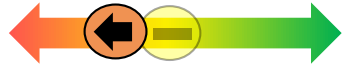
1Q Risk Perspective

Report to Nuclear Oversight Committee

1st Quarter 2014

Darlington Nuclear Refurbishment Project

Attachment A – 1Q 2014 Risk Perspective

Area	Observations	High / Medium / Low	Current Status / Mitigation
RFR	**SNC/Aecon Performance**: Largest Program risk due to overall risk to the DR Project and OPEX		[redacted] ▸ Tooling and procurement recovery plan in place, showing improvements ▸ Mock-up is substantially complete
	Class 3 Estimate: Progression to RQE requires SNC/Aecon's Class 3 Estimate to be thoroughly vetted		▸ Completing estimate to OPG standards by May 15, 2014 will be challenging [redacted] ▸ Monetizing contingency remains a risk
	[redacted]		[redacted]
	RFR Commercial Risks: Contract provisions currently in place may not drive desired performance		▸ Negotiation of the Execution Phase target price should revisit incentives and disincentives
Campus Plan	[redacted]		▸ Lessons learned are being collected and disseminated ▸ Project costs are increasing and likely to exceed budget [redacted] ▸ DR Team is reviewing extent of D20 budget overruns ▸ Similar trends are being observed with several other F&I projects; budgeting process is being investigated
	Engineering and Planning: D20 provides key lessons learned for remaining Campus Plan and BOP		▸ Engineering is co-locating with ESMSA vendors ▸ Clarification of RFPs and process ongoing ▸ Modifications to planning and scheduling underway
BOP	[redacted]		▸ Allocation of work underway; some issues with cost/scope estimates [redacted]
Engineering	**Scope Review**: Urgency mounting for scope review; planning/prep underway for work that may be eliminated; concerns regarding scope		▸ PSRB has approved final scope recommendations ▸ Final scope closure report has yet to be issued
	Planning of Engineering Work: Engineering work was not well understood and is poorly planned		▸ "Bottoms-up" estimating process initiated for engineering activities ▸ Increased focus placed on engineering planning for the design phase; new progress tracking mechanisms in place ▸ OPG has fostered alignment with the senior management levels of the ESMSA engineering vendors

Attachment A – 1Q 2014 Risk Perspective

Area	Observations	High / Medium / Low	Current Status / Mitigation
Project Controls	**Continued Schedule Development**: Schedule approach was unproven; integration at appropriate level at risk		▸ Project Team is moving toward industry-wide recommended practices for scheduling ▸ Substantial work remains to populate detailed level 3 schedule
	Progress Towards RQE: The plan for developing RQE is being developed.		▸ RQE development remains essentially on schedule, but will be heavily reliant on the quality of the various inputs. ▸ The DR Team has assigned a manager for the planning and development of the multiple pieces that must come together for RQE.
	Risk Management Program: Risk registers require scrubbing; monitoring tools are cumbersome		▸ DR Team is cleaning up the risk register and improving reporting ▸ Risk Group is taking a more active role in managing the Risk Program ▸ Risk training is being conducted

Attachment B

Summary Table from Risk Assessment Assurance Report

Report to Nuclear Oversight Committee

1st Quarter 2014

Darlington Nuclear Refurbishment Project

Attachment B

Summary Table From Risk Assessment Assurance Report

Area	Observation No.	Comments	Change from Previous Assessment
Risk Register Reporting Limitations	1	Migration to SharePoint and Excel reporting tool have increased reporting functionality, but there are still limitations.	⇧
Lack of Clarity of Risk Titles and Descriptions	2	Significant progress has been made by the DR Team over the last several months on this issue. Current TCD to complete updating of all risks is January 31, 2014.	⇧
Numerous Entries in the Risk Registers are not "Risks", but Business as Usual "Issues"	3	Significant progress has been made by the DR Team over the last several months on this issue. Current TCD to complete updating of all risks is January 31, 2014.	⇧
Lack of Appropriate Risk Management Program Staffing & Leadership	4	There will be some significant changes to the Risk Group in January. This issue will have to be monitored once the new team is in place.	⇔
Risk Management Program Training	5	There has been a concerted effort to implement formal training by the Risk Group	⇧
Missing Identification of "Opportunities"	6	There has been no effort to identify opportunities within the risk register.	⇔
Weak Risk Responses	7	The key to a successful Risk Management Program (and overall project success) includes the thoughtful development of effective Risk Responses (e.g. mitigating) actions. Based solely on a review of the Risk Registers, many risk responses appear to be perfunctory and ineffective.	⇧
Long Periods Between Risk Register Reviews and Updates	8	Efforts to update all risks have caused more frequent review of risks. OPG should consider having ROC meetings more frequently than once per quarter.	⇧
Risk Oversight Committee Effectiveness	9	Three meetings have been held to date and, as the risk program matures, they are progressively improving by focusing less on process and more on substance.	⇧
Lack of Trending and Other High-Level Metrics	10	There was no change as of the end of December. However, we have noted some improvement in this area in the last couple of weeks. New metrics are being developed, but not yet rolled out.	⇔

Legend: ⇧ = improved, compared to Project Assessment
⇩ = weaker, compared to Project Assessment
⇔ = no change, compared to Project Assessment
⇔ = no change

Exhibit 4

2Q 2014 Report

Supplemental Report to
Nuclear Oversight Committee

2nd Quarter 2014

Darlington Nuclear Refurbishment Project

Report to Nuclear Oversight Committee

2nd Quarter 2014

Darlington Nuclear Refurbishment Project

Burns & McDonnell
Modus Strategic Solutions

May 13, 2014

I. Executive Summary

Burns & McDonnell Canada Ltd. and Modus Strategic Solutions Canada Company ("BMcD/Modus") provide the following Quarterly Report to the Nuclear Oversight Committee of the OPG Board of Directors ("NOC") regarding the status of the Darlington Nuclear Generating Station's Refurbishment Project ("Project" or "DR Project") as of April 30, 2014. The DR Project continues to advance toward its major goal of producing a Release Quality Estimate ("RQE") for final Board of Directors and Shareholder approval by October 15, 2015.

BMcD/Modus has continued to stress the importance for OPG to embrace its role as the integrator of the work and to actively manage the multiple contractors. To this end, the DR Team has made a significant shift in engineering strategy and will now directly manage and supervise the engineering service providers, rather than continuing the previous "hands-off" oversight approach. This is a bold but necessary move and one that is endorsed by BMcD/Modus. If OPG manages this transition well, we would expect a significant increase in engineering efficiency.

Pursuant to the Project's Assurance Plan approved by the Audit & Finance Committee, BMcD/Modus has prepared independent reports documenting the DR Team's status as well as further recommendations for improvement. This quarter we have issued Assurance Reports based upon our detailed review of: 1) DR Project Schedule Process and Development; 2) the 2013-2014 Business Plan as it relates to the latest project estimate (the "4c Estimate") and 3) Scope Status and Process. Upcoming reports will focus on our review of the Campus Plan cost and schedule overruns, 4d Cost Estimate vetting and RQE preparation. These full reports will be available for the NOC's review. In addition to our regular, everyday contact with the Project Team, we will continue to meet periodically with the Refurbishment Project Executive Team ("RPET") to discuss our reports to NOC and our Assurance Reports in order to clarify any recommendations and engage in discussion of appropriate actions. We are also coordinating our efforts with Internal Audit so that we meet our assurance commitments in an efficient and effective manner.

Much of our focus in this quarter's report was on evaluating the performance of the pre-requisite Facilities and Infrastructure projects ("F&I" or "Campus Plan Projects"). The Campus Plan Projects remain a significant risk to the Refurbishment Project, and provides important lessons learned for the DR Project.

The following is a brief summary of the DR Project's most significant developments over the last quarter:

- **Campus Plan Performance Project Risk:** Many of the Campus Plan Projects are forecasted to complete significantly beyond the approved budgets and schedules. In fact, schedule adherence is so poor that the Campus Plan work poses multiple threats to the start of Refurbishment. Over the last quarter, BMcD/Modus has engaged in a thorough review of several key Campus Plan projects in an attempt to identify trends and understand the causes of these cost and schedule overruns. Our findings show that the predominant cause was OPG's Projects & Modifications ("P&M") organization, who is managing this work for the DR Project, incorrectly applied an "oversight" project management approach for its EPC contracting strategy, leading to a series of cascading management failures and contractor performance issues, including misunderstandings of scope, uncontrolled scope creep, poor quality cost estimates, unrealistic and incorrect schedules and an inability to manage known risks, additional costs and delays. For multiple reasons described herein, P&M was completely overwhelmed in trying to manage Campus Plan Projects – in particular, the two largest of these projects, the D2O Storage Facility and Auxiliary Heat Steam Plant ("AHS") which were the "pilot" projects for this new contracting model.

  Simultaneous to our review, the P&M team's new leadership has taken aggressive action to correct as many of the major issues as possible. In acknowledgement of many of our recommendations and as a result of its own findings, P&M, the performing Extended Services Master Service Agreement ("ESMSA") contractors and the DR Team are developing more realistic project schedules for each scope of work that will account for need dates, available resources and optimal work flow. Senior management has committed to a full reforecast of the cost of each of the Campus Plan Projects, starting with the two most notable problem projects, the D2O Storage Facility

and AHS. P&M's and the DR Team's senior leadership instructed their managers to actively manage the work henceforth through increased collaboration with the contractors. In particular, OPG's engineering team will be taking on a much more active role in directly managing the remaining engineering work. While these measures are much more likely to be successful, the damage to a certain extent cannot be fully mitigated, as the affected Campus Plan Projects will cost more, finish later and pose a much greater threat to Refurbishment than management initially realized; this is in large part due to the unrealistic nature of P&M's initial project budgets and the way in which scope crept into these projects after these initial budgets were approved. We recommend that OPG look at the impact of these Campus Plan Projects on the Definition Phase budget as soon as possible. Moreover, P&M can only hope to recover these Campus Plan Projects if it receives support from OPG's corporate functions, from whom P&M will require fast action and some needed modifications to processes. Our team has been engaged in closely monitoring the recovery plan and will continue to report on P&M's progress. Our observations and recommendations with respect to the Campus Plan performance to date are summarized in this report and will be the subject of an Assurance Report we intend to issue at the conclusion of the 2nd Quarter.

- **RQE Preparation**: RQE development remains essentially on schedule, though the development of the 4d Cost Estimate will be a good test of the DR Team's preparation. Senior management has introduced two new controls to the Project to aid in this endeavor: 1) an Options Review Board chaired by the Senior VP of Refurbishment that is vetting the maturing plans for each scope of work, and 2) a Readiness Schedule and related process which will hold the project managers accountable for meeting interim preparation milestones. These are good measures that will provide additional confidence for RQE. In addition, all of the major Project Bundles except for the Steam Generator Project will be going through Gate 3 prior to the fall of 2015, which should provide the DR Team with an opportunity to re-examine these sub-projects' business cases including scope alternatives, status, methods of delivery, cost estimates, schedules and risks. Strengthening the gate process as we have recommended will provide further levels of vetting for the work planning and should streamline the DR Team's approach to the 4d Cost Estimate.

- **Retube & Feeder Replacement Project Risks**: The RFR project remains the DR Project's most notable ongoing risk, with respect to the Execution Phase as it represents the majority of the work on the Critical Path. [redacted] trends during the Definition Phase needs to be taken into account in the vetting of its Class 3 Estimate[1] (an estimate with an expected accuracy range of between -10% on the low side and +30% on the high side after the application of contingency) and OPG's confidence level for the Execution Phase. Through March 31, 2014, the contract is underspent by $9 M against plan, though this gap is closing. Additionally, [redacted] and aspects of its recovery plan dates are being challenged by further supplier delays. [redacted] and is reassigning work to different suppliers, though the impacts of [redacted] could be felt in the tool performance guarantee period. OPG's RFR team is closely monitoring these events [redacted]

  With respect to the Class 3 Estimate preparation, SNC/Aecon met its internal goal of March 15, 2014 to produce construction work packages ("CWP's") and has progressed with its other key deliverables, including the detailed Level 4 schedule. However, the compressed time frame during which SNC/Aecon produced all of these estimate components has put the onus on OPG to review, comment and rationalize SNC/Aecon's estimate by June 15, 2014, which will take considerable effort and coordination. Ultimately, SNC/Aecon must provide OPG with comfort that the Class 3 Estimate meets its committed level of accuracy. Equally important is how the Class 3

[1] Estimate accuracy is classified per the Association for the Advancement of Cost Engineering International (AACEi) standards Class 1 through 5. Class 1 is the most accurate.

Estimate forms the platform from which the Class 2 Estimate (with an expected accuracy range of -5% to +20%) will be developed for RQE. As discussed below, there are some commercial opportunities OPG must weigh that could impact the cost estimate as well. Given its high importance to the overall project, BMcD/Modus sees OPG arriving at an appropriate comfort level with the Class 3 Estimate as essential to tightening the project's cost estimate, and we would recommend the team take any reasonable time and action needed to reach that level of comfort.

- **Commercial Risks:** The Project Team has taken our recommendation to review commercial incentives and disincentives in the Project's major contracts in light of some changed planning basis and assumptions—including the Shareholder's mandates set forth in the LTEP, the unlapping strategy and the evidence to date of contractor performance. The DR Team took an action to develop a negotiation strategy with SNC/Aecon that will take into account the impact on their work caused by the unlapping Unit 2, prioritization of Unit 2 performance, potential for economies of scale with the Turbine Generator work and other key considerations. Regarding the ESMSA, senior management is instituting a number of changes to managing and executing the EPC model that has proven to be ineffective at driving performance, cost and schedule compliance and reducing OPG's risk. It was evident from the F&I Projects that the ESMSA's management of the engineering process was at the root of many failures, and OPG theoretically has both the expertise and the essential knowledge needed to more effectively manage this work. Going-forward, it is OPG's intention to take a much stronger role in managing and directing the engineering portion of the work. In doing so, it will be important to for OPG to understand and communicate the impact of the shifting of risk for this added responsibility as well as any impact to warranties provided by the contractors. The success of this new strategy will depend on OPG's ability to attract and retain talent and OPG's ability to drive change down through its organization to implement a new project management philosophy.

Other ongoing challenges to the DR Project include the development of the DR Team for the Execution Phase, further refinement of the Risk Management Program and Fuel Handling work. Attachment "A" provides an update regarding the DR Project's risks.

II. Summary of Campus Plan Root Cause

A. Overview

The Campus Plan Projects consist of 26 separate scopes of "pre-requisite" work that are needed to support the DR Project or the station's operations during construction. These projects are being managed by OPG's P&M organization. Prior to this Campus Plan work, P&M executed capital projects for the stations, with annual budgets of approximately $300M. With the advent of the DGNS Refurbishment Project, senior management sought to use P&M to develop and oversee all of the Campus Plan Projects, allowing the DR Team to focus on planning for the DR Execution Phase. The inclusion of the Campus Plan Projects caused P&M's portfolio to increase by four to five times, and the scale and technical complexity of this work was unprecedented for this organization. At the same time, OPG was under pressure to decrease its staff in line with the Shareholder's requests. As with many utilities in the US, OPG who had once had a very large construction unit that built the current stations and Bruce, and as recently as Pickering A Unit 1 RTS Project in the mid-2000's had considerable in-house construction, planning, procurement and engineering resources, was shrinking even further and the capability for managing and directing large capital projects was sacrificed.

From 2010 until July 2013, P&M was led by its former VP Mike Peckham. Terry Murphy ultimately succeeded Mr. Peckham in January 2014. P&M's governance, including most of its business and management processes, were separately developed and maintained from those used by the Refurbishment Project. Also, P&M negotiated and utilized the Extended Service Master Services Agreement ("ESMSA") contract and the two "ESMSA Contractor" consortiums led by Black & McDonald and ES Fox. The ESMSA contract is actually a mix of multiple standard form agreements that could be used in combination depending on the circumstances – e.g. there are separate forms for engineering, procurement and construction that could be combined into an "EPC" contract. The business deals with the ESMSA Contractors were

the result of a competitive process which resulted in the contractors agreeing to some unique provisions that are used for all contracted work with these vendors. As an example, when used as an EPC, the contractors who lead these consortia are required to bid engineering work on a fixed-price basis [redacted] The construction work is all cost reimbursable target price, and the performance incentives include up to a 50% reduction of profit, though this and some other disincentives built into the contract have proven thus far to be much less effective in practice than concept at driving the contractors' behavior and performance.

The impetus for having P&M execute the Campus Plan work was that through the Definition Phase of Refurbishment, the DR Team was not assembled as an execution organization, but a planning one. P&M was an existing service resource with some experience in managing the ESMSA contractors. P&M's work on the Campus Plan Projects is funded by Refurbishment and it must report its progress to Refurbishment, though these business units are otherwise autonomous. Until recently, other than these approvals and the fact that both organizations use the ESMSA Contractors, there was very little else in common between Refurbishment and P&M, including the project management procedures utilized for their respective projects. P&M's project management procedures were not developed to manage multi-year projects of the size and scope of some of the Campus Plan Projects. Over the last several months, P&M has begun to manage the Campus Plan projects in accordance with the project management procedures developed for the DR Project in an attempt to implement industry-standard risk, cost and schedule controls. Additionally, the new VP has implemented a series of organizational and strategic initiatives with the goal of improving performance.

As of April 2, 2014, the Campus Plan Projects are estimated to cost in aggregate approximately [redacted] (an increase of [redacted] over the Board of Directors approved 2014 Business Case release for this work) and the work varies widely in size and complexity. The performance of the work is largely split between the two ESMSA contractors, Black & McDonald and ES Fox. Deadlines for completion of these Projects vary based on the project's and stations' needs; AHS is scheduled to be complete prior to the DNGS Vacuum Building Outage ("VBO") in mid-April 2015, while all the remaining work is scheduled to be completed one year later, in April 2016, to allow enough time for commissioning prior to the October 2016 Refurbishment Project's breaker open milestone. Many of these Campus Plan Projects involve the construction of commercial buildings that are made more complex because of their location on or adjacent to the nuclear island, which impacts their associated design requirements for such things as nuclear safety, security, and seismic requirements. Additionally, these are brownfield projects on a site where soil quality issues and underground interferences are the norm and coordination with the operation of DNGS must be managed.

Over the last quarter, BMcD/Modus has engaged in a number of activities related to the Campus Plan Projects. In this regard, we have:

- Reviewed the reasons for significant cost variances in five of the largest Campus Plan and Prerequisite Projects: D20 Storage Facility; Auxiliary Heat System Building ("AHS"); Water & Sewer; RFR Island Annex Building ("RFRISA"); and Retube Waste Processing Building ("RWPB"). Our goal was to determine the root cause of the Campus Plan Projects' variances so that past mistakes will not be repeated. We chose to examine the RWPB, which is being built by SNC/Aecon and managed by the DR Team, for a real-time direct comparison with the ESMSA-managed projects.
- Reviewed the Campus Plan Projects' schedules prepared by the vendors to identify any major gaps. This review led our team to make a series of recommendations to the P&M and DR Teams, and our subsequent monitoring of progress of the vendors' ongoing redevelopment of their detailed schedules for each of the major projects.
- Examined the risk management process within the P&M organization, including its ability to properly identify, avoid, mitigate and monetize risk.
- Reviewed the design and scoping process and identified the causes for the extreme inaccuracy of the vendors' engineering cost and schedule estimates.

- Reviewed the management structure and capabilities of the P&M team that started this work down the current path. We have also spent time with P&M's new VP and members of P&M's restructured leadership team to convey our findings and recommendations and gauge the effectiveness of P&M's current initiatives to improve performance and mitigate these earlier management failures.

As noted, these Campus Plan Projects have been plagued by myriad problems that have resulted in significant schedule and cost variances. Our findings show that the predominant cause of these overruns was P&M's original strategy to use a project "oversight" management model for the EPC contracting strategy utilized by OPG that was inappropriate in application and lead to a series of cascading management failures and contractor performance issues. The oversight management model employed a disengaged, "hands-off" approach by the P&M organization which caused the fledgling P&M organization to: (1) wrongly assume that the contractors understood the scope on the basis of performance specifications that outlined scope initial requirements; (2) utilize inexperienced project managers; (3) allow Operations & Maintenance and other OPG stakeholders to initiate scope changes to these projects long after the conceptual design period ended; (4) to accept the poor schedules and cost estimates by the contractors without appropriate vetting and challenge, and which were not updated to incorporate the impact of scope changes on a timely basis; and (5) to inaccurately or untimely report the projects' progress, risks and cost and schedule overruns to the DR Team and senior management.

B. OPG Contractor Management and Contractor Performance

1. Summary

Based on the information we have reviewed, it is apparent that P&M put excessive faith in the ESMSA Contractors' ability to perform this work and an over-reliance on the perceived ability of the EPC contracting model to shift project risk to the contractor and alleviate the need for active project management. As a result, OPG chose to provide oversight of the contractor's work at arms-length. In a recent self-assessment related to the D2O Storage Project's delays, the P&M Project team ("P&M Team") noted that at the onset of the Project, P&M believed "the EPC Process" would mitigate known risks via "project efficiency gains due to the expertise and autonomy of the contractor."[2] This exemplified OPG management's initial hands-off approach to project management that P&M piloted under which the contractor was given autonomy to develop its own scope requirements without process monitoring. As noted in P&M's self-assessment, this model resulted in "unclear expectations, re-work, frustration."[3] P&M's error was misunderstanding the essential nature of the ESMSA contracts, which are not fixed-price EPC contracts that shift all risk and responsibility for performance to the contractors (nor were they ever meant to be). The majority of the Campus Plan Project's execution cost is being performed on a cost-reimbursable target price, where contractors have only a portion of their fee at risk in the event that the target price is exceeded. In our experience, the nature of this work (refurbishment and construction of new facilities on an operating nuclear site) and the fact that the contract is cost reimbursable, require the owner to engage in active management of the contractors and coordinate interfaces. This means providing very specific instructions to lock down scope at the project's conceptual design phase and holding the contractors accountable on a daily basis to meet expected cost and schedule. Moreover, it is apparent that the P&M Team did not have the necessary experience, training or internal management direction to properly manage this work. Attachment B is a matrix that provides a summary of our observations regarding the five major ongoing F&I Projects. This matrix shows, among other things, that in the management of the work, P&M:

- Routinely accepted poor quality schedules and cost estimates without adequate vetting;
- Mischaracterized the nature of these estimates by assuming anything provided by a contractor was at a very high level of maturity (Class 3/2) when such estimates were based on conceptual (at best) engineering, meaning these estimates could not have been better than Class 5 (-50% to +100%) in nature;

[2] SCR Number D-2013-19100, January 22, 2014.
[3] Id.

- Failed to establish accountability standards for the contractors;
- Failed to identify or mitigate known risks;
- Did not effectively react to problems when they materialized and accurately and timely report the extent of cost overruns, schedule delays and scope increases to senior management;
- The P&M Team did not seek to lock down the scope at start of this work and allowed the "customer" – Operations and Maintenance – to make significant changes to the design that were not properly understood, quantified or captured in subsequent reports to senior management; and
- The ESMSA contractors contributed to the problem by not transparently reporting or timely identifying how these projects were evolving and failing to provide any reliable metrics—cost, schedule or otherwise – that informed OPG of these brewing problems.

2. Indicative Projects - D2O Storage and Auxiliary Heat

In our analysis, BMcD/Modus examined five separate projects in detail, and each exhibited some or all of the management issues to some extent. Attachment C is a brief summary of each of these projects' cost overruns.

The management failures we observed were most evident and acute with the D2O Storage and AHS projects. These projects were the "pilot" EPC projects for the ESMSA contractors—[redacted]. With D2O Storage, the contractor was given the autonomy to develop its own design solutions on the basis of a set of performance specifications, while AHS suffered from scope confusion and untimely decisions. The contractors' design progressed slowly and the ultimate design for each building was considerably different—more complex, larger and more difficult to construct—than OPG had originally conceived, due largely to post-award scope creep. In both cases, P&M sought the Board's full funding approval at a point when very little design was done, only to have to later seek additional funds from the Board once design had matured.

a. The Flawed Bidding/Estimating Process

P&M's management failures can be seen throughout the planning and execution phase of the project. Notable from OPG's initial negotiation and acceptance of bids for this work is P&M's mischaracterization of the vendors' estimates in the approved Business Case Summaries ("BCS"). In August 2011, OPG produced a BCS for D2O Storage that estimated its cost at $210.6M, including $165.8M in project cost and $44.7M in contingency. At the project's next gate in June 2012, the estimated cost had dropped from $210M to $108M. However, BMcD/Modus could not find any attempt by P&M to rationalize or otherwise explain how the cost estimate for this building was cut virtually in half from one approval gate to the next. Moreover, the estimate for design and construction was $52.2M, which P&M characterized as a "Class 2 Estimate" despite the fact that at the time of the estimate, [redacted] had little experience with this type of construction and had performed no engineering or scope definition. Thus, this estimate was more likely a Class 5 Estimate. In retrospect, it is likely that the initial $210M estimate was more accurate; however, it is certainly clear that the approved $108M estimate should not have had any greater accuracy attributed to it, since it was not based on a significantly greater level of project maturity. Likewise, the AHS BCS was termed a "Class 3" Estimate, though it was similarly immature.

This estimate classification drove P&M to vastly underestimate the amount of contingency associated with each package. There is no evidence that P&M engaged in the type of vetting of the estimates that we would expect on projects of these size and importance. From interviews with the current P&M staff and the contractors, it appears that these initial BCS estimates were poorly characterized as part of a deliberate management strategy directed by the former VP of P&M. P&M's managers told us that the contractors were challenged to reduce their bid prices and remove all contingencies for unknowns, despite the extreme immaturity of project definition underlying their respective bids. As an example, [redacted] was told to remove from its contract price any contingency for unforeseen soil conditions, even though there was a high likelihood that there would be contaminated soil issues.

Moreover, P&M clearly overvalued price as a consideration in the contractor selection process, especially in light of the fact that the work was going to be performed on a cost-reimbursable basis and the bid prices were not binding.

P&M gave only token consideration to determining which contractor had a better approach for executing the work. P&M chose the "low bidder" even though the other contractor's qualifications and project approach were viewed more favorably. Thus, P&M created the conditions for a perfect storm of cost and schedule overruns. Because the work is largely based on a cost-reimbursable target price with no caps on size, P&M's artificial beating down the contractors' prices in the bid phase was a Pyrrhic victory: P&M's actions did not reduce cost and only served to deprive senior management of realistic cost projections for this work. The budgets for these and other F&I projects were nothing more than paper barriers that were easily surmounted as the design work continued to generate more complex (and expensive) work.

b. Lack of an Integrated Schedule

Until April 2014, the P&M project teams for D20 and AHS were working without a reliable, integrated Level 3 Schedule. Many on the project and throughout the OPG organization were given a false impression that the Campus Plan Projects, and D20 in particular, had a year of float, and so on-going delays had no impact on the Project. The delays to D2O Storage's schedule were not forecasted by the project team and were simply reported after the fact. By this point, the schedule had already slipped so that engineering was on its way to an 18-month projected overrun of an original 11-month schedule. However, without a resource-loaded, level 3 schedule, it was impossible to assess the status of the project, let alone calculate with any accuracy any remaining float.

One of the strategic initiatives was implemented by the new P&M VP was to improve the projects' schedules. This endeavor allowed the project team to see that D20 Storage was actually projected to be completed on April 26, 2016, more than a year after the original April 15, 2015 deadline. Furthermore, once known risks are factored in, it is likely that the D20 project can only achieve this revised date if some of the schedule durations are accelerated—at an additional cost. Even then, these efforts will not improve completion of the schedule by much, but will increase the probability that the April 2016 date can be met. However, none of this would be known if efforts had not been made to improve the schedule.

c. Risk Management

Based on our observations, it appears that all P&M's identification of risks is a "check-the-box" activity due the fact that having a list of risks is a prerequisite to obtaining a funding release. P&M does not actively manage its on-going risks as a part of an effective risk management program. As an example, the risk sections of the D20 and AHS BCSs consist of lists of potential risks and some evaluation of their nature, but it is not apparent that these risks in any way influenced the calculation of these projects' contingency, nor are there any regular reviews or updates of these risks until required to do so in order to pass a gate and obtain a funding release. Once a project obtains full funding for execution, very little, if any, attention is paid to day-to-day risk management, including the ongoing identification of new risks and opportunities as well as the formalized implementation of risk mitigation strategies. Additionally, there is no structured or defined risk program management oversight (such as the NR Risk Oversight Committee).

A recent self-assessment performed by the NR Management Systems Oversight group (SA RF13-000855 dated January 20, 2014) identified perceptions (opinions) of several P&M managers that included the following: "[D]evelopment and use of a Risk Register is seen as purely administrative and not adding value to the Project Managers." This suggests a lack of understanding of the value of a risk management program or lack of acceptance, which can be addressed by effective training and indoctrination. However, risk management training is virtually non-existent in the P&M organization in distinct contrast to several years ago when quarterly workshops were regularly conducted.

d. The Gate Process and Failure to Report Cost and Schedule Increases to Senior Management

BMcD/Modus next explored the relative effectiveness of the gate process for this work, and found that while the process in concept is a good one, it suffers from problems in execution. The BCS documents for D2O Storage and AHS were inconsistent in presentation of key information on cost, risk and scope. As these projects progressed, P&M's management failed to provide visibility to OPG management of the extent or nature of project cost increases. Most notably, P&M failed to update its project reports during the design phase to reflect cost increases due to scope changes in the projects.

AHS provides a critical example. On November 12, 2012, P&M presented its Gate 3A package for approval and full funding release (except for a small portion of costs to be approved in 2014). The P&M Team's gate presentation characterized the AHS cost estimate as a Class 3 estimate in the amount of $45.6 M. P&M included $6.5M of contingency in the $45.6M estimate, of which $3M was identified as having a 100% chance of occurrence. P&M expressed an "85% confidence level" in this cost estimate and assessed there were 146 days of schedule contingency in the estimate—despite the fact that the full scope of the project was not known at that time because detailed engineering had not started. The option of building a new AHS was preferred over seven alternatives, based primarily on the projected cost. At the time of this gate, the project had spent $1.46M.

Between this gate and January 2014, [redacted] engaged in the design of the AHS, scope changes caused the cost to increase from the initial $45.6M estimate to $79.9M. This cost increase is largely attributable to two causes: (1) remediation of contaminated soil that as of the time of bid was known by both OPG and the contractor to be of poor quality; and, (2) prescriptive design requirements that served to make a stock steam boiler design follow nuclear Engineering Change Control ("ECC") processes, which caused an increase in the size, complexity and nature of the work. Moreover, these design requirements and the overall length of the design phase, coupled with the soil issues, has frittered away virtually every day of float.

The fact this project had so substantially changed from the original BCS was not accurately or timely reported to management. The failure of the gate process was that the Gate Review Board members did not provide adequate oversight in ensuring that the AHS project team had a reliable estimate, schedule, and well-defined scope prior to approving the gate and recommending a funding release. As of January 2014, P&M had already expended nearly $20M, or more than half the approved budget excluding contingency, even though the design was not complete and no construction had begun. However, during this entire time, P&M's estimate at completion ("EAC") in all of the DR Project's and Campus Plan reports ***never varied*** from the approved BCS amount. Moreover, the DR Project's Program Status Report for March 2014 showed the AHS at 49% spent with a CPI of 1.10 and an SPI of 1.0, clearly not an accurate representation of the Project's status. Part of this failure was based upon some of the P&M project managers' mistaken belief that the reported EAC amounts should not be changed until additional funds had been approved for the projects. This lack of accurate reporting has deprived senior management and the Board the option of revisiting the original BCS analysis in order to determine if building a new AHS facility continues to be the preferred option—and if not, change course. This is particularly true in light of the fact that as of November 2012, three of the competing options to building AHS were priced at less than $50 M.

D2O Storage provides a very similar example at a much higher overall cost. The cost variance progression from D2O Storage began with an original approved BCS of $110M, based upon estimated contractor costs of approximately $77.8 Million. [redacted] and design solution were both preferred but [redacted] was chosen entirely because its price was $30M less even before P&M further drove [redacted] estimate down.

D2O Storage's engineering effort was originally scheduled for 11 months, and was supposed to be completed by July 2013. However, even today, engineering is not complete and is projecting to extend to a total duration of 29 months. The P&M team provided sporadic updates to the design milestones as they continued to be missed but failed to convey the potential consequence. In August 2013, P&M reported that CNO Milestone 73472M0015, "D2O Modifications –

Detailed Design Complete" was expected to miss its planned completion date of August 21, 2013 **by four months** though stated, "there is no impact to the critical path."[4] As of this same meeting, an action was recorded to "confirm the timing for integration" of the D2O Storage schedule into the master C&C Schedule, the follow-up to which indicated that the schedule would not be available for integration because "it falls short of our requirements for several parameters."

In September 2013, P&M reported in the Program Status Report that:

> Due to the change in design for the connection of the new tanks to the existing, significant additional design work is required. This change of design was required to address water hammer issues with the initial plans which could not be resolved without a significant change in design. A new underground tunnel connecting the two buildings will now be utilized to connect the two buildings.[5]

However, this "significant" design change was not highlighted as a major risk item in P&M's reporting, and P&M maintained the same EAC for D2O Storage despite having this information in hand. P&M also maintained that there was no impact to the critical path, even though P&M again admitted that the vendor had yet to produce a detailed schedule, which begs the question how could one arrive at such a conclusion regarding float without a reliable schedule.

P&M first reported a variance to the D2O Storage budget in October 2013, which coincided with months of mitigating adverse soil conditions and failing to meet the schedule for tie-ins for the TRF outage. Black & McDonald presented a high-level cost estimate that showed approximately $49M of increases in foundation work and engineering in October 2013, though this estimate was characterized as a work in progress. This estimate was increased by $5M in December 2013. P&M finally updated the D2O Storage EAC in the January 2014 DR Program Status Report from $95M to $122.7M, though simultaneously, P&M issued a report to the Nuclear Executive Committee ("NEC") showing a forecasted EAC of $152M. Thus, P&M's first reporting to senior management and other OPG stakeholders of any impact of the design changes that had been brewing for nearly two years was inconsistent at best.

In January 2014, Bill Robinson [redacted] to update its costs. [redacted] committed to an estimate of [redacted] (compared to its original contract of [redacted]), which with OPG's costs was ranged by P&M at a total of [redacted], including OPG contingency and financing costs. After coming on board, P&M's new VP required [redacted] to prepare a bottoms-up, high confidence schedule and budget based on the high level of engineering completion. [redacted]

Moreover, throughout 2011-13, P&M did not [redacted] update costs and provide visibility to the cost of these design changes as they were occurring; thus, [redacted] P&M's management allowed [redacted]

[4] DN Refurbishment Program Status Report Meeting, August 21, 2013
[5] DN Refurbishment Program Status Report Meeting, September 18, 2013

[redacted] and incorporate a flood of OPG stakeholder generated late design changes without adequate checks and balances or understanding of the magnitude of these changes.

As a direct consequence of P&M's failure to report these cost and schedule variances, senior management was deprived of the ability to:

- Stop the design changes that led to these increases;
- Stop the project entirely and resort to one of the other evaluated options;
- Identify and characterize the cost increases that are not related to Refurbishment and subject these changes to the same value-enhancing criteria as the remainder of the DR Project's work; and
- Mitigate the impact of the schedule delays and overruns.

Thus, the consequences to OPG are two projects that may cause external stakeholders to question OPG's management prudence.

e. Vendor Performance Issues

[redacted]

[redacted]

3. Current Schedule Status

P&M's effort to recover these projects began with finally getting the vendors to develop resource loaded, integrated Level 3 schedules, with focus on developing template schedules for D2O Storage and AHS. These schedules are portraying the following significant challenges:

- The AHS project is currently projecting about 3 months behind schedule which will delay the VBO outage. The schedule is currently being impacted by late design, with some twenty outstanding design changes that [redacted] needs to process. This late design could impact the schedule to September 2014 and beyond and frustrate both procurement and construction, which have essentially no float. Based on our review of this schedule, attempts to accelerate the work to recover this time could be ineffective. Instead, BMcD/Modus recommends P&M, in concert with the Station, look to: (1) eliminate these multiple design changes; and (2) rationalize and potentially reduce the time needed to commission the AHS. If these upfront and follow-on tasks can be reduced in duration, the project will regain some much needed time for construction.

- D2O Storage is more complicated. The combination of underground utilities and poor soil conditions, design changes, engineering delays and contractor performance has pushed D2O Storage to a projected completion of April 15, 2016, which has no float to OPG's need date. In analyzing the current status of the work, we have determined that: (1) while engineering has driven significant delays to date, accelerating its final completion will not result in improvement to the overall completion date; (2) the current March 2015 completion date for concrete and foundation work, including drilling and setting caissons, needs to be improved by as much as possible and ideally to complete prior to the onset of winter conditions in 2014; (3) the current duration for building on top of the completed foundations, including structural steel erection, building enclosure and mechanical piping, is a scant 5 ½ months and needs to be substantially improved. Based on this status, we recommend OPG examine: (1) value engineer the foundations and structural design, with the goal to eliminate as much of the building's complexity as possible – the office space and associated concrete structure may be over-designed based on non-Refurbishment requirements added during the attenuated design phase; (2) value engineer the building's piping design, which similarly increased due to ASIC and Station needs; (3) accelerate the caisson drilling so that rebar and foundation work can recover essential lost time.

OPG should also examine other options in light of the overruns on these projects, as less permanent solutions that were narrowly rejected in the upfront BCS may now prove to be more economical solutions. At a minimum, we recommend OPG examine and parse the costs associated with non-Refurbishment scope that was added by OPG's other stakeholders and consider capitalizing those costs separately from Refurbishment for purposes of future rate recovery. In any event, whichever course OPG choses with these buildings, it is imperative that it act quickly and definitively.

4. Corrective Actions by P&M Team

OPG senior management has taken definitive action to turn around the Campus Plan work, including bringing in new leadership for P&M and fostering greater integration between the P&M Campus Plan and DR Project work. The visibility of the issues P&M has encountered will help the BOP, Islanding and Services projects work more effectively with the ESMSA contractors.

P&M's and the DR Team's senior leadership are fostering a more collaborative and cooperative effort between OPG and the contractors, known as the "Collaborative Approach." Essential parts of this Collaborative Approach include:

- For the remaining Campus Plan Projects and BOP work, the OPG teams and the vendors working "shoulder-to-shoulder" to develop project scope basis and corresponding cost estimates. The ESMSA vendors have agreed to perform the work on an open-book, split cost basis. Relieving the ESMSA of the secondary compete bidding

process through direct assignment of the work should expedite the process, though the funding for this phase of the collaboration has been slow to arrive.

- OPG's Refurbishment Engineering and Design Authority directly managing and supervising the engineering work to reduce scope creep, unnecessary management and supervision costs and delays due to churn. This will include co-locating OPG engineering resources at the vendor's shops to answer questions and involve themselves in the development of the detailed design work and institute regular Steering Committee meetings with project leadership to remove performance barriers.
- Continuing integration of all of the Campus Plan pre-requisite work into a single integrated schedule so that the ESMSA's can properly plan and resource load the work and OPG can manage the contractors' work load and performance.
- Complete the work allocation to each of the ESMSA vendors so that they can properly plan their work. The DR Team has attempted to allocate the work evenly, though it may become necessary to shift work based on performance and resource availability. This becomes a more complex issue with the BOP work scope also needing attention in the coming months.
- Provide additional and focused project management support from OPG to clear barriers to engineering and execution work.
- Engage in constructive high-level dialogue with the ESMSA's senior management on a regular basis. P&M has established weekly meetings with each contractor that senior management attends to deal with any barriers and discuss status of the key projects. OPG has also established a monthly ESMSA Summit that allows for OPG to air and discuss issues with senior management of both contractors together. These meetings have had an immediate and measureable impact on both OPG's and the ESMSA's performance.

These changes will not fully recover the work in progress – in particular D2O Storage and AHS – but should provide some needed relief and better approaches for the remaining Campus Plan Projects.

For P&M, the recent changes in its senior leadership as well as the increased integration with the DR Team are taking root and providing visible benefits. P&M's VP is working through the multiple issues caused by the "hands-off" project management approach. The P&M staff has begun to accept the changes and is becoming motivated to correct its past problems, though the need for continual guidance and mentoring is evident. P&M will need corporate support to execute a full turn-around as discussed below. The DR Team's engineering organization is poised to take on active management of the ESMSA's engineering shops, which is diametrically opposite to how these projects were initially conceived. P&M's problems are now visible, as is the recovery the new team is trying to make, and the DR Team must recognize that P&M needs its support or the Refurbishment of Unit 2 is very much at risk.

5. Lessons Learned and Recommendations

Based on our root cause findings, BMcD/Modus's recommendations to OPG are somewhat different for P&M, which is in full recovery mode, versus Refurbishment, which has time (though not much) to incorporate lessons learned from the Campus Plan Projects into its program. For P&M, our recommendations focus on speeding the pace of the recovery, while for the DR Team, these Campus Plan Projects need to be a vivid reminder of what can happen if and when contractors are not actively managed. Ultimately, there are two major questions for the DR Project as a whole: (1) Can P&M succeed in completing the Campus Plan Projects on-time and within reasonable (though much higher than originally considered) cost parameters; and (2) whether the same issues we found related to the mismanagement of the Campus Plan Projects are a threat to the DR Project's BOP work and if so, to take strong and decisive action for eliminating the threat.

Regarding the Campus Plan Projects, we believe these can be turned around to support the VBO and breaker open, though at a higher cost that will require greater management focus than ever anticipated. Moreover, to facilitate this recovery, OPG will likely have to make some accommodations to its normal course of business:

- **Hiring practices will require increased flexibility** – P&M's ranks are filled with inexperienced personnel who need guidance. OPG needs to recognize that the P&M organization urgently needs qualified people to fill significant management positions in project management, project controls and field supervision that are open at this time. Moreover, because P&M is a business unit with an expected expiration date, it makes for a difficult sell to OPG employees. In our experience, business units such as P&M would not be subjected to the same rules as the company-at-large for the hiring of temporary or transitory employees. Moreover, companies usually provide incentives for employees to work in transitional project environments because it forms a valuable learning experience. Such moves are needed and, in our view, completely justifiable in light of industry best practices. It is likely that Refurbishment will need similar changes to allow the development of its Execution Phase team.

- **Operations & Maintenance's and other OPG stakeholders' ability to change project scope must be contained** – As noted, the processes in place for the Campus Plan Projects allowed Operations & Maintenance and various other OPG stakeholders to make scope and resultant design changes that caused significant increases to the Campus Plan Projects after the conclusion of the conceptual design phase. These changes have crept into cost estimates over time. The appropriate time to add scope to projects is the conceptual design phase, subject to the approval of the authorized stakeholders, not after the project has been approved and passed through multiple gates including approval at the Board of Directors level. The process needs change to eliminate the consideration of major post-award design changes that increase project costs or extend project schedules.

- **Scope of work for Campus Plan and DR Projects needs frequent re-examination -** As a general principle, management prudence requires that scope and objectives be periodically examined in light of current circumstances. Where OPG has information that shows projects trending above approved budgets and beyond schedule milestones, it is prudent to examine both the cause of the overruns and any reasonable alternatives that can be justified based on a renewed net present value calculation. Thus, we recommend that OPG senior management take a second look at the scope and question its value, including re-examining (as necessary) alternative ways to accomplish the originally intended scope of work.

  Similarly, where the root cause of the overruns appears to be the insertion of nuclear processes where such are not typically applicable or necessary (i.e. for commercial buildings), OPG senior management should take action to rescale and change the scope of such projects. This may require OPG's senior management to the CNSC to allow changes to its regulatory commitments if such commitments are so costly as to make them unreasonable.

  Finally, as noted, if there are reasonable and prudent costs for non-Refurbishment related enhancements that are being spent by Refurbishment, OPG should consider capitalizing such costs separately from the DR Project. As an example, many of the value enhancing changes to D2O Storage were apparently made to handle and process water for non-Refurbishment purposes. These costs may ultimately have been prudently incurred but are likely in the wrong cost bucket for purposes of cost recovery.

- **Supply Chain and Finance need to streamline controls to accommodate changes** – The potential for the Campus Plan and BOP projects to rationalize the scope, develop more realistic cost estimates and schedules and model risk depends on the success of the collaborative process. Initiating this process will require some changes in the Supply Chain and Finance processes to allow for timely award of the work and prompt payment to the ESMSA contractors during the concept development phase. The benefit of this collaboration should be seen as projects reach their subsequent gates, they should be in much better shape with better defined and controlled scope, more accurate cost estimates and more achievable schedule goals. The ESMSA vendors will need appropriate funding to meet these goals. Finance has already moved forward with some measures that will enhance the cash flowing of the contractors' work. Additionally, the Supply Chain procedures with respect to change orders or contract amendments are cumbersome, time consuming, and reduce the project teams' accountability for managing costs. We would expect the project team to have the ability to negotiate and approve change orders directly with the contractor with appropriate controls.

- **Risk Management needs immediate attention** – Risk management was not taken seriously in the P&M organization, thus many of the problems that have emerged were hidden below the surface. P&M needs a different approach which the DR risk management team is helping to facilitate: (1) the P&M team needs to monetize risks for future gates on a deterministic basis; (2) risks need to be managed on a day-to-day basis as a part of project management; (3) a better understanding of the ESMSA Contractors' risk management programs is needed; (4) formalized risk training is needed within the P&M organization. Most importantly, there needs to be a culture shift towards recognizing risk management as an important aspect of maintaining cost and schedule. This culture shift can only be driven from the top of the organization. Refurbishment has made many strides in improving the risk management program and their improvements should form OPEX for P&M.

- [redacted] – The current time needed to in-process workers and management personnel alike is frustrating the OPG project teams and the ESMSA contractors. The reported average time [redacted] Moreover, there are [redacted] preventing or complicating the contractors' use of essential project-based systems [redacted] are notable examples. BMcD/Modus certainly sees the need for [redacted] though in our experience with other nuclear utilities there are readymade solutions for these issues that OPG has been slow to adopt. These issues will cause continued risk to the DR Project if not fixed.

- [redacted] OPG should examine the possibility of assigning Refurbishment BOP scope [redacted] the DR Project where this makes economic and strategic sense.

- **Project estimating needs significant improvement** – As discussed throughout this report, BMcD/Modus has significant concerns that need to be addressed with the performance of project estimating by both the contractors and P&M's team. BMcD/Modus recommends that P&M should make changes, and Refurbishment should examine and potentially refine its processes for the following:

    - Check estimates be developed in the same format as estimates provided by vendors – the templates should be developed by OPG and provided to vendors prior to bid, and any submitted bid not utilizing the approved template is noncompliant;

    - All estimates need to be fully vetted and understood, regardless of whether the quoted price is more or less than the expected cost. Drivers of variances (both positive and negative) between bid and check estimates need to be investigated and understood by the Project Teams;

    - Contractors need to be trained in the method of estimating that OPG finds acceptable. The current process [redacted] is using for developing its estimate includes upfront vetting by OPG of the contractor's specific processes and ongoing, real-time review of estimating product in a collaborative manner. These are principles that can be easily applied to the rest of the DR Project's work;

    - Estimates and project metrics/reports must incorporate accurate past, current and forecast cost information. The team needs to receive appropriately detailed contractor cost reports which, coupled with a resource loaded schedule, will enable them to properly status and forecast contractor performance;

    - P&M needs to standardize an EAC process so that all project teams follow the same basic procedures on a consistent basis. A seminar or workshop should be considered so that project team members are taught the fundamentals for preparing a reliable EAC; and

  - OPG needs to examine staffing and resources. Currently, there is only one dedicated cost estimator for all of P&M's work. The DR Team has already taken action to increase staffing levels and add experienced personnel, and P&M needs to do the same.

- **Project Reporting must be accurate, timely and convey information critical to senior management for decision-making** – As noted, the reports P&M provided to senior management on the Campus Plan projects were inaccurate and not updated in a timely manner to enable prudent decision-making. Our examination of P&M's reporting shows a general desire to produce large volumes of surface-level reports that are completely inadequate for managing the work, all the while P&M ignored such critical metrics as an accurate Estimate at Completion (EAC) and detailed schedule of work. Any tendency to "turn everything green" when such is not the case must be resisted - prudent management of complex projects requires full transparency and visibility of anything that is not going well so it can be addressed and fixed. P&M and the DR Team need to increase the focus on accurate, concise reporting with an emphasis on forecasting.

- **P&M needs to break down the silos**—All of the Campus Plan Projects are being performed by two contractors. However all of the Campus Plan work has been managed as 26 separate projects. All of the project management functions—i.e. schedule, cost and risk need to be managed through an integrated approach so that resources and management focus can be applied appropriately. We recommend that P&M look at its organizational structure to optimize the ability of its project managers to have more direct accountability. This may require more and different resources.

- **Campus Plan Projects will require a full rebaseline of cost and schedule** – Irrespective of when these projects' next gates occur, each of the Campus Plan Projects and, likely, each of the P&M non-Refurbishment projects at DNGS and Pickering, will require a full, bottoms-up rebaseline of costs and schedules. With the examples cited herein, BMcD/Modus cannot ascribe any confidence to any project estimate that was developed by P&M's former regime. Bill Robinson has made this commitment and appropriate focus will need to be applied. P&M needs to perform this reforecast on an urgent basis.

With respect to the Refurbishment portion of the DR Project, BMcD/Modus's monitoring of the BOP work to date shows that OPG has spent considerable time and effort in a robust scope definition process that addresses most of the external OPG stakeholder-driven scope issues in a manner that is consistent with the DR Project's charter. The DR Team has embedded in the organization a Director of Maintenance and a team to work our operational concerns and has an independent Design Authority. Moreover, as stated, the DR Team had already acted to safeguard against some of the problems seen in the early Campus Plan Project, notably; (1) the DR Project's institution more thorough scope definition to contractors via the MDPs the engineering team developed was a direct consequence of the OPEX from D2O Storage from over a year ago; (2) it is also apparent to us that while the DR Team had started down the same management path as P&M, it was able to put on the brakes and change course at a much earlier stage. Nonetheless, in light of our review of the Campus Plan Projects, we recommend that the DR Team perform a detailed self-assessment that considers the ways in which the Campus Plan Projects management failures might apply to Refurbishment.

III. RQE Preparation

With this report, BMcD/Modus will begin a dedicated section for assessing the status of the DR Team's activities that specifically lead to the development of the RQE budget and associated schedule for the October 15, 2015 deadline. With respect to RQE planning, the DR Team has started its specific planning efforts, though soon there needs to be a greater focus on the specific deliverables, the timing of their preparation and a thorough understanding of how the many components will be compiled into a comprehensive estimate. Project Controls has named a manager for this effort and an activity schedule is being developed for incorporation into the Project's plan.

The most imminent upcoming RQE-related tasks relate to the development of the 4d Release Cost Estimate for the 2015 Business Plan ("4d Cost Estimate") that will be prepared for the Board's approval at the November 2014 meeting. The 4d Cost Estimate effort should also provide a template for many of the activities needed for RQE. In this section, we will

also report on the maturity of the DR Project's development of the project's integrated schedule, which is an important component to providing a reliable RQE.

A. 4d Cost Estimate

In our Initial Project Assessment, we recommended that OPG consider the 4d Cost Estimate as a "dry run" for RQE. This recommendation has been embraced by senior management. As part of our 4th Quarter 2013 Report, BMcD/Modus provided the DR Team with specific recommendations on the development of its cost estimates and lessons learned from last year's 4c Cost Estimate, which we refresh here with some additional observations:

- **Organization of the 4d Cost Estimate**: The DR Team is getting organized for the 4d Cost Estimate effort, which will be considerable. Project Controls has begun with the predecessor work the projects will need to develop their various estimates and is in the process of developing a schedule for these activities. Based on last year's approach to the 4c Cost Estimate, we see more activity occurring at a similar stage though we are still concerned that the development of 4d Cost Estimate will run into summer, during which time very little can be finalized due to the critical individuals taking vacation.
- **Projectizing Costs**: The DR Team is moving toward "projectizing" the functional costs, i.e. attempting to bucket as much of the cost of the functional work as a distinct part of the sub-projects' cost. This is an appropriate methodology and should provide a more accurate cost picture, though the DR Team needs to develop some clear guidelines for how this will be accomplished. Also, since this will mean functional cost centers from the 4c Cost Estimate will be distributed differently, the DR Team should provide traceability between the two phases of the estimate.
- **Bottoms-up Approach**: Given the increase in project maturity since the 4c Cost Estimate, a bottoms-up approach to many elements of the 4d Cost Estimate is appropriate. To the extent that projects have recently passed through a gate, the associated gate documentation should reflect this approach. However, a gate review should not be viewed by the DR Team as an opportunity to reset the clock and the budget on projects that are in trouble. The DR Team should review its processes for rebaselining at gates so that projects that are projecting to over-spend or run late are not given proverbial "get out of jail free" passes.
- **Re-examine Scope and Commitments**: As the Definition Phase has unfolded, it has become apparent that the cost estimates for many scopes of work have greatly exceeded the 4c Cost Estimate. In particular, F&I projects have changed in scope, execution strategy and cost, and many of the BOP projects are showing similar signs, such that the increases in cost would likely run at or above any alternative. The recently initiated Options Review Board (discussed below) has the potential to be a good control to catch projects with wide variances at an earlier stage. As noted above, BMcD/Modus believes that the periodic reexamination of principles on a project as an essential ingredient to prudent management. Thus, we recommend that OPG re-analyze any scope item with a wide cost variance over its 4c Cost Estimate budget allowance by re-reviewing the requirements and any alternatives, including canceling the scope entirely, on the basis of the least-cost alternative at this time. Had this methodology been followed with the F&I Projects, it is now apparent that OPG would have considered different alternatives for a number of projects. OPG should also review such alternatives when a regulatory commitment is at the root of a significant cost increase, as once the extent of the cost increases are fully known, it is possible the regulator would entertain alternatives as well.
- **Increase Efficacy of Project Estimating**: As discussed in the Campus Plan section of our report, BMcD/Modus is concerned that OPG's ability to develop check estimates is challenged by resources and work volume. To the extent that OPG's check estimates are intended to be a control mechanism, these estimates need to be executed with the same information and level of rigor that the contractors/project teams are developing. From our observations to date, the current method used for check estimates at Class 4/5 level: (1) includes the use of too many factors and factored values for check estimates at the Class 3/2 level; (2) suffer from a general lack of transparency of the root sources of information; (3) utilize non-standardized estimating templates despite OPG's investment in the US Cost estimating platform. As the DR Project moves to the next phase of maturity, so

should the estimating work. We have also observed that the check estimates have gaps and errors that should not occur if the estimates had been performed by qualified, experienced individuals. Moreover, it is becoming evident that estimating is becoming a choke point to the point of causing notable delays in the procurement schedule, and its importance will only increase as time goes on. Thus, we have recommended that OPG examine its vendor's [redacted] resources, experience level and ability to support the increase in both the volume and efficacy of the estimates it is preparing. In addition, we recommend OPG utilize the collaborative estimating/vetting approach that it has initiated with the ESMSA vendors and with SNC/Aecon for each of the DR Project's other scopes of work. The DR Team is already acting on these recommendations.

Considering the increased focus on the DR Project from its external stakeholders, it is very likely the development of 4d Cost Estimate will receive significant scrutiny. Therefore, the DR Team needs to organize its efforts, develop appropriate expectations for the deliverables and intensify its efforts as soon as possible.

B. Schedule

A high-confidence RQE depends on a reliable integrated schedule. In our past reports, BMcD/Modus has identified several concerns and observations with respect to the development of the DR Project Schedule and the Project Schedule Management Program. Over the last few months, the DR Team has made significant strides in addressing many of the issues we have raised. While much work remains to be done, the DR Team has moved forward with a significant number of initiatives calculated to improve both the DR Schedule and the Schedule Management Program, including:

- The DR Team now sees itself as a project management team and is putting programs in place to properly manage its contractors;
- The DR Team has abandoned earlier questionable scheduling methods in favor of developing a fully integrated Level 3 resource loaded schedule that automatically rolls-up to form a Level 2 depiction of the work;
- P&M is becoming the "beta" group for testing the basic standards for managing the Level 3 with the Campus Plan Projects;
- OPG has developed standards for required resource loading of the Level 3 schedules by OPG and the contractors; and
- Detailed schedules for sub-projects that are not let are represented by placeholder activities to be replaced once a contractor is in place.

While these changes are positive, we have made additional observations that should be addressed by OPG in order to improve the reliability of the integrated project schedule, including:

- Development of an improved set of metrics for monitoring the schedule is imperative. As part of the effort to improve the Level 3 integrated scheduling process, a set of metrics needs to be established to categorically monitor improvements made by the Project Teams and their respective contractors.

- Currently, the DR Team is making manual adjustments the cash flows in Proliance, rather than having it be an automated function tying the cost estimates to the P6 dates for cash flow analysis. Ultimately, work hours in cost estimates and schedules must balance and the Work Breakdown Structure ("WBS") should be the binding mechanism. The DR Team is planning on automating this process though it will remain prone to error until that time.

- OPG needs to speed contractors' access to the scheduling network. The OPG and the contractors need to all work from the same network (preferably OPG's or an third party network) in order to operate in a common environment. However, OPG is not granting the contractors network access in a timely manner. Improvements in time and better standards for control of the databases need to be established.

IV. Major Projects – Summary of Key Risks

A. Retube & Feeder Replacement

1. Work Status – Tooling, Definition and Mock-up

Through March 31, 2014, the RFR contract is underspent by $9 M against plan, though this gap is closing. Additionally, [redacted] Definition and Tooling phases of its work, the mock-up reached substantial completion in March and is ready to receive, test and integrate tooling.

The tooling recovery plan that was initiated at the end of 2013, however, is currently challenged to achieve its August 2014 target. Tooling engineering is now critical path and the tooling design complete milestone for June 15, 2014 will likely be missed while the follow-on milestones for prototypes complete and qualification complete are in jeopardy as well. [redacted] additional mitigation plans and is making reasonable attempts to recover the time lost. The OPG team continues [redacted] and is holding them accountable to meet the deadlines. [redacted] will be felt in the development of the Class 2 estimate. To mitigate [redacted], OPG's project team is requiring [redacted] develop a clear plan for monitoring tool testing and productivity in the mock-up to ensure this process moves smoothly and that all the required information is captured and incorporated into the estimate.

[redacted] However, OPG's team plans to dispute any charges advanced by [redacted] for the Definition Phase that were caused [redacted]

[redacted] These activities will require close monitoring as the Definition phase moves toward the Class 2 estimate over the next year.

2. Class 3 Estimate and Level 4 Schedule

[redacted] significantly increased its production in order to meet this date and, in the process, compressed delivery, creating a large bow-wave of work for OPG to review.

Since our 1Q 2014 report, OPG's estimating group has struggled to keep up with SNC/Aecon's pace and its review and analysis of the variance reports, estimates, and mini-reports that will ultimately comprise the Class 3 estimate is proceeding slowly. BMcD/Modus's concern is that the sheer volume of reports provided by SNC/Aecon, essentially all at once, will result in errors or that OPG will be challenged to make sense of the data. Ultimately, SNC/Aecon should be tasked with providing an explanation of how the products satisfy the requirements of a Class 3 estimate. Per the Class 3 Estimate Plan, SNC/Aecon's commitment for this Class 3 Estimate should include:

- Completed CWPs formulated for DNGS;
- Variance reports showing differences between the OPEX driven Class 4 estimate and the current estimate;
- A Level 4 execution schedule;
- Detailed reports characterizing how SNC/Aecon prepared the estimate; and
- A well-defined risk register.

All of these SNC/Aecon products will require time for OPG to review and in this case it is our opinion that it is better to provide an extension of time than rush the review of such important material in order to meet a previously set deadline.

Concurrent with the development of the Class 3 estimate, SNC/Aecon is developing its Level 4 execution schedule. The first draft of this schedule was delivered on April 15, 2014 and ongoing review sessions are being held to refine it. [redacted] OPG is continuing to review and recommend changes prior to the delivery of the Schedule mini-report for the Class 3 estimate on April 30, 2014.

Looking forward from Class 3, it is important for OPG and SNC/Aecon to align around the plan and start preparing for the Class 2 estimate. As we have noted in prior reports, after SNC/Aecon completed the Class 4 estimate, there was a long period with no activity that only served to compress the preparation time for the Class 3 estimate, and that compression is at the root of the current need to rush through its approvals. As the Class 3 report is being developed, the team should endeavor to complete the Class 2 estimate plan so that any opportunities or progression points are identified early. In addition, the tool testing and productivity plan should be incorporated with the Class 2 estimate plan so that results are properly incorporated into the schedule and estimate. SNC/Aecon and OPG need to maintain focus on the finished product and what it means to be Class 2 RQE ready.

3. RWPB Building

The RWPB is being performed under many of the same conditions as the Campus Plan Projects as a pre-requisite to Refurbishment but by SNC/Aecon, the contractor performing the RFR retube work, rather than the ESMSA contractors. RWPB is facing very some familiar issues to those described above for D2O and AHS. The start of work is currently being impacted by the soil that was excavated from D2O Storage. There is a possibility the soil is contaminated, which has resulted in additional testing. In addition, the building has or will encounter plant operation coordination, and seismic issues have delayed foundation design and pushed out engineering. As of this report, engineering design complete is showing 43 days of negative float and installation/commissioning is showing an October 24, 2016 completion date. Although this schedule is immature and based on very preliminary engineering, the original plan was completion in June 2016 allowing three months before breaker open. It is vital for SNC/Aecon to utilize the lessons that are being learned from the F&I work in order to keep this building within a reasonable cost and schedule envelope. In addition, if there are cost increases, the Options Review Board should test the decisions being made with regard to building design in light of the fact that it is a temporary building that will be housing heavily contaminated materials. Further, the building should avoid any element of gold plating or permanent design.

4. RFR Commercial Risks

We recommended in our last report that the DR Team review some major provisions of the RFR contract in order to ensure that it will drive the proper behavior from SNC/Aecon in order to achieve success on the first unit and that OPG will be able to establish that it adequately and prudently considered the principles set forth in the government's Long Term Energy Plan ("LTEP")—primarily success on the first unit and ensuring appropriate risk shifting. This included re-visiting: (1) the performance incentives for unit-over-unit improvement as an incentive to the contractor to meet an aggressive schedule for the first unit; (2) whether the cost and schedule incentives/disincentives would drive the right contractor behavior; (3) the treatment and monetization of identified risks; and (4) whether to negotiate a guaranteed maximum price ("GMAX") once engineering is complete. In addition, OPG and SNC/Aecon will need to incorporate the

maturing Turbine Generator work into the estimate where economies of scale in project management and other areas are identified. To date, DR senior management has acknowledged that this is an important exercise that must be done with some sense of urgency. However, this sentiment has not been communicated to those individuals tasked with performing the review, who appear not to understand its purpose and are reluctant to even consider the need to modify any portion of the contract.

B. Balance of Plant and Other Projects

The BOP work should be the direct beneficiary of any lessons learned from the Campus Plan/F&I work. The majority of the BOP work will be performed by the ESMSA contractors based on direct assignment of the work packages. This methodology should readily lend itself to a cooperative, interactive process between OPG and the vendors that should, in theory, eliminate many of the issues we have observed with the F&I work.

With the awards of the containment isolation and Turbine Generator performance work to SNC/Aecon, OPG should consider the benefits of SNC/Aecon treating its overall scope of work as one contract. There are certain economies of scale that can be achieved – plus benefits associated with workforce assignment flexibility and dose management. The DR Team would also benefit from consolidating all of the work in the vault into a single subproject to better manage the critical path and subcritical path interferences.

V. Functional Groups Update

A. Engineering

1. Revised Plan for ESMSA Engineering

Amongst other conclusions, the BMcD/Modus Initial Project Assessment (August 13, 2013) recommended improvements to engineering metrics and a close look at the turn-around times for the review, comment and approval cycles. The need for "active management" of the engineering work along with a greater focus on front-end planning was introduced in the BMcD/Modus 4Q 2013 report and expanded upon in our 1Q 2014 report. We continue to stress the importance for OPG to shift their role and perspective from the culture of 'observation at a distance' to a much more proactive engagement and active management of the engineering service providers. We also continue to stress the importance of thorough front-end planning.

Since our last report the DR Team's Senior Leadership has recognized a number of deficiencies with the ESMSA design process, including:

- The quality of planning and scheduling is insufficient. There are no integrated resource loaded schedules. Schedule adherence is very poor - the execution of most of the ESMSA project engineering (e.g. D2O Storage Building, Shield Tank Overpressure Protection, Auxiliary Heating Steam, and Containment Filtered Venting System) is consistently behind plan.
- Cost estimates for the detailed engineering phase are significantly higher than anticipated, particularly given OPG's development of detailed Modification Design Packages (MDP's) that were intended to provide the vendors with specific and prescriptive requirements.
- The actual costs to date are significantly above the original budgets (planned value) for all ESMSA projects. A significant portion of these increases are driven by engineering.
- ESMSA quality programs are not aligned with OPG's quality program. The result is multiple review and comment cycles which add significant cost and time.
- OPG's intent to shift risk to the ESMSA partnerships was misplaced. The risk associated with the execution of nuclear engineering work is limited by the application of detailed regulatory and OPG standards and procedures. The execution of nuclear engineering work needs to be under the direct control of the OPG Design Authority.

- Single-point responsibility for coordination of the engineering, procurement and construction elements of these projects through these ESMSA partnerships has not been realized, leading to inefficiency, confusion and rework. Moreover, significant OPG intervention has been required to achieve the results obtained to date.

The results of these deficiencies have become clearly apparent: an inability to predict engineering performance, significant churn, poor cost performance and frustration at all levels of the collective organization. These deficiencies have driven Senior Leadership to make changes to the remaining engineering effort for the ESMSA work. These changes include:

- Shifting to a culture of 'active management' of the engineering work;
- Utilizing a collaborative front-end planning methodology for the remaining work;
- OPG taking a leadership role in developing and monitoring the engineering schedules;
- For work in progress, OPG will increase monitoring and provide ready answers through embedded staff within the engineering vendor organizations; and
- For work that has not started, OPG will provide management and direction of the engineering work.

This is a bold but necessary move and one that is endorsed by BMcD/Modus. We will continue to monitor the progress made under this revised plan and provide additional recommendations for streamlining the design process as necessary.

2. Scope Definition

Overall, as mentioned in the BMcD/Modus Assurance Report on Scope, we believe that the DR Team has taken a balanced approach to the development of the DR Project scope. The initial scope identification effort incorporated scope beyond that of refurbishment and life extension, potentially increasing the budget and project complexity. However, to balance this out, the DR Team has continuously monitored and repeatedly tested the included scope through scope reviews and de-scoping exercises. Additionally, the team has monitored scope definition through the gate review process and Health of Scope (HOS) metrics. Through this extended process we believe that the DR Team has struck an important balance between overly limiting scope (and risking scope growth during execution) and being overly-inclusive (and risking excessive project budgets).

The resultant Darlington Scope Requests (DSR's) drive engineering. Through April 24, 2014, Engineering had completed 142 MDP's. While this met OPG's goal, the number of MDP's continues to rise and is now at 161 (as compared to 139 in our last report) with 19 known packages remaining. This is particularly important considering the new path OPG has chosen to take for ESMSA engineering.

However, whereas scope definition may be sound, the development of solutions is not. As the revised plan for ESMSA engineering takes root, the DR Team also needs to examine the assumptions and engineered solutions. The DR Team's Senior Leadership initiated a new control, a monthly Options Review Board ("ORB"), the intent of which is to re-review the approaches the project teams are taking and see if the means and methods in the plan are appropriate, cost effective and still required. At the first ORB, the BOP, Shutdown/Lay-up and Services projects identified initial plans for six different scopes that needed to be reconsidered. These different subprojects suffered from many of the same problems evident with the Campus Plan Projects discussed above, though these problems are being exposed, escalated and resolved. The ORB found:

- OPG's design requirements can cause confusion, misalignment and very expensive solutions that defy common sense. As an example, based on the guidance from the original MDP, the dehumidification of the turbine deck would have cost upwards of ten times more than OPG has spent in the past performing the same work on laid-up fossil units.

- The performance specifications in some packages provided the vendors with limited guidance, and in such cases, vendors will usually take the most conservative route.
- OPG often relied on the vendors to suggest more creative solutions to their issues when OPG's team knew the best course to take all along. This was evident with the polar crane package inside the plant. OPG left it to the vendors to discern what was needed. The vendors decided to replace all of the cranes, even though OPG's team determined only refurbishment, not replacement, was required. OPG often relied on the vendors to suggest a more creative solution to their issues when OPG's team knew the best course to take all along. This was evident with the crane package for the polar cranes inside the plant. OPG left it to the vendors to discern what was needed, from which the vendors decided to replace all of the cranes, even though the needed scope determined by OPG's team was refurbishment, not replacement.

This initial ORB was a success and will be followed by further, similar reviews of planned solutions. From this and the lessons learned from the F&I work, BMcD/Modus recommends that OPG consider the aforementioned controls on scope, including: (1) reviewing the necessity of performing the work; (2) revisiting prior options; (3) refreshing the view of net present value; (4) questioning whether scopes of work that are driven by regulatory requirements and have experienced significant cost overruns are still cost effective.

In addition, the DR Team is instituting a Unit Scope Review Board that will examine each subproject's readiness at key intervals in the manner employed by the station for outage preparedness. This team will be led by the DR Team's senior management and will test whether a given project has key deliverables in place at required quality levels as it advances toward execution. We believe these tests are part of prudent management and necessary to meet the intent of the Minister of Energy's Long Term Energy Plan ("LTEP").

B. Project Controls

The DR Project's reports (namely the Program Management Report) needs attention. This report is difficult to read, contains multiple formats changes, and has, in the case of the Campus Plan Projects, erroneous and outdated information that is included without verification. The Campus Plan Projects' reporting discussed above provides a vivid example of how reports that lack accuracy and transparency mislead and deprive senior management the opportunity to make key decisions. The DR Team's Project Controls team is bringing needed QA/QC reviews and personnel to test and monitor this and other key reports' information. The tendency by the DR Team is to provide too much data in these reports so that important information is often obscured and lost in the "noise." Furthermore, metrics and reporting are supposed to provide an accurate snapshot of the status of a project. The current Project Reports need work to achieve these goals. . Project Controls is endeavoring to improve its reporting suite that both informs and allows for management focus. The team is working currently on revised versions of the "quad charts" that provide metrics and description of the projects' current focus areas. The DR Team has also agreed to abandon the quarterly produced "report card" which was ineffective at communicating the Project's status. This metric was a jumble of key performance indicators, dates, milestones, etc. and only serves to confuse rather than provide useful information.

Moreover, the DR Team's methodology for measuring earned value needs to be stress tested. The DR Project's schedule is now matured to include resource loading to allow OPG to test work hour productivity factors from information contained in the P6 schedule. As the schedule further matures, we will be providing additional focus to the coincidental development of earned value and productivity factors.

C. Supply Chain

Our observations of the P&M organization and the Campus Plan Projects have raised some concerns regarding the interface between Supply Chain and the project management team. In particular, the current procedures require that Supply Chain negotiate all change orders (also called contract amendments) on behalf of OPG. This appears to be a cumbersome process with a number of built-in walls that only cause for multiple review stages of the same information.

This process has the potential to cause delays to both the Campus Plan and DR Projects, but more importantly, it disconnects scope, schedule and cost accountability from the project team. We will be further examining these processes as the project progresses, including an upcoming Assessment of the DR Project's Change Management process.

VI. Other Project Risks

A. Project Team Development

As previously noted, Enterprise Risk Management carries the retention of key personnel as the biggest program risk to the DR Project, and we would agree that it is certainly among the DR Project's biggest challenges. The most urgent challenge in this regard is to ensure that the Project has sufficient skilled resources to manage and monitor all of the work that must precede Refurbishment, including supporting the F&I, ASIC and VBO work, while maintaining the pace of the Refurbishment's key developmental activities. In our view, the best way to address this challenge is to continue to ramp up the front end planning effort so that all the work that must be performed is known and identified by schedule window and priority. Once the total needs of the organization are better defined, OPG can address resource needs in a more comprehensive manner. BMcD/Modus also sees monitoring resources in the schedule via fully resource loaded, level 3 schedules and tracking work hours productivity factor indices as essential ingredients in understanding the resource needs for each work group, trade specialty and the like. Senior Leadership of Refurbishment and P&M have coordinated a monthly ESMSA Summit at which resource needs will be discussed in greater detail going forward.

As the DR Team focuses more on developing its team for the Execution Phase, OPG will need to obtain individuals with different skills and experience than it may have currently in-house. OPG's current hiring, banding, salary constraints and onerous, time-consuming onboarding procedures serve as a barrier to finding the necessary experienced and qualified personnel. BMcD/Modus recommends that the DR Team closely look at the optimal Execution Phase organization design so that it can properly cost-out the Execution Team in the 4d Cost Estimate and prepare to deal with the barriers to securing suitably experienced management and staff .

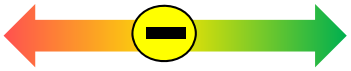
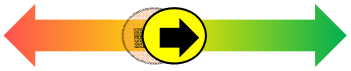
B. Program Management Plan Development

In our last report, BMcD/Modus identified some shortcomings with DR Team's Program Management Plan ("PgMP"). The DR Project's Senior Leadership has moved forward with our recommendations to progress the PgMP. Senior Leadership also led the first of what will likely be a series of meetings with key Project Team members to foster alignment of the functional groups into a "projectized" team in which the individual sub-projects will capture the majority of the cost and coordinate the activities in a more focused manner. This initiative exposed for Senior Leadership that it must go farther to communicate roles and responsibilities within this matrix organizational model.

As we noted in our last report, the PgMP is the key unifying document set for project execution; in our experience, it would be tantamount to the project bible that a new employee would use to understand his or her roles and responsibilities. In addition, with the 4d Cost Estimate beckoning, the project teams will need to know the breadth of their matrixed organization and related cost centers to properly allocate the different elements of the estimate. The Project's need for a solid PgMP is further heightened by Senior Leadership's attempts to evolve the organization for the Execution Phase.

In summary, BMcD/Modus recommends that the DR Team simplify the approach it is taking to develop the PgMP so that it is unifying document and increase collaboration across the team. We believe the current efforts of the Engineering team to provide its portion of the plan could establish a model for the other functions and projects to follow.

Attachment A – 1Q 2014 Risk Perspective

Area	Observations	High / Medium / Low	Current Status / Mitigation
RFR	**SNC/Aecon Performance**: Largest Program risk due to overall risk to the DR Project and OPEX.		[redacted] but impacts are limited and mitigating actions are in progress ► Tooling and procurement recovery plan in place, [redacted] ► RWPB and Definition Phase Engineering showing [redacted]
RFR	**Class 3 Estimate**: Progression to RQE requires SNC/Aecon's Class 3 Estimate to be thoroughly vetted		► Completing thorough OPG review by May 15, 2014 will be challenging ► Ultimate goal of delivery by August 2014 is acceptable ► Monetizing contingency remains a risk
RFR	**Schedule Development**: Level 4 schedule under development; requires challenge to total duration		► First draft of the Level 4 schedule [redacted] ► Continued review required from OPG project team to push SNC/Aecon for a more aggressive but achievable schedule
RFR	**RWPB Delays**: Facing similar problems that have plagued Campus Plan projects		[redacted] ► Utilize/implement lessons learned from Campus Plan work
RFR	**RFR Commercial Risks**: Contract provisions currently in place may not drive desired performance		► Negotiation of the Execution Phase target price should revisit incentives and disincentives/focus on success of the first unit
Campus Plan	[redacted] D20 Storage and AHS work is behind schedule and over budget		[redacted] ► Similar trends are being observed with several other F&I projects; budgeting process is being investigated ► Bids for remaining work are significantly higher then budgets ► Re-evaluation of business case required in light of new estimates
Campus Plan	**Engineering and Planning**: D20 provides key lessons learned for remaining Campus Plan and BOP		► Engineering is co-locating with ESMSA vendors and taking more active role in directing and managing the work ► Clarification of RFPs and process ongoing ► Modifications to planning and scheduling underway
BOP	[redacted]		► Allocation of work underway; some issues with cost/scope estimates [redacted]

Attachment A – 1Q 2014 Risk Perspective

Area	Observations	High / Medium / Low	Current Status / Mitigation
Engineering	**Scope Review**: New Options Review Board has increased scrutiny of design decisions		► Options Review Board has been effective in challenging scope decisions
	Planning of Engineering Work: Engineering work was not well understood and is poorly planned		► OPG engineering is taking more active role in directing and managing the work at the engineering studios ► "Bottoms-up" estimating process initiated for engineering activities ► Increased focus placed on engineering planning for the design phase; new progress tracking mechanisms in place
Project Controls	**Continued Schedule Development**: Schedule approach was unproven; integration at appropriate level at risk		► Project Team is moving toward industry-wide recommended practices for scheduling ► Substantial work remains to populate detailed level 3 schedule
	Progress Towards RQE: The plan for developing RQE is being developed.		► RQE development remains essentially on schedule, but will be heavily reliant on the quality of the various inputs. ► The DR Team has assigned a manager for the planning and development of the multiple pieces that must come together for RQE.
	Risk Management Program: Risk registers require scrubbing; monitoring tools are cumbersome		► DR Team is cleaning up the risk register and improving reporting ► Risk Group is taking a more active role in managing the Risk Program ► Risk training is being conducted but more is required

Project Matrix
Campus Plan
Observations/Findings

REF.	OBSERVATIONS	PROJECTS				
		Water & Sewer	D20 Storage	Aux Htg Sys	RFR Annex	* RFR Waste Storage
1	Lack of scope definition.	√	√	√	√	
2	Insufficient effort and time in creating engineering requirements.	√	√	√	√	
3	Initial Project was deferred and then reactivated over a period of years (> 5yrs).	√	√	√		
4	3rd Party Estimates - Mixed results w/F+G being significantly over or under vendor quote.	√	√	√		
5	Change in contracting strategy with Vendor from a E-PC to EPC.	√	√	√		
6	Basis of Estimates do not conform to AACE Recommended Practices.	√	√	√	√	√
7	Project Team has failed to characterize the changes/progression to the estimates from gate to gate.	√	√	√	√	
8	Mischaracterized Estimate Classification - OPG is accepting vendor quote as a "Class 2" or "Class 3 estimate when such quote does not meet the threshold for a Class 2 or 3.	√	√	√	√	√
9	Contingency calculated at [redacted] - not clear how contingency and risk assessment are linked, if at all.	√	√	√	√	
10	Risk shifting - Project Team does not fully understand the nature of target price work.	√	√	√	√	√
11	The process of bid evaluation scoring and metrics used varies among Project Teams.	√	√	√	√	√
12	The process of comparing bids and 3rd party estimates varies among Project Teams.	√	√	√	√	
13	Significant differences between Vendor Quotations (from 50% to > 100%).	√	√	√	√	
14	Vendor quotes and 3rd Party Estimates (Faithful + Gould) are not aligned for ease of comparison to facilitate a comprehensive review of differences.	√	√	√	√	
15	The contractor selection process compelled the contract to be awarded to the lowest bidder over other qualifying considerations.	√	√	√	√	
16	Risks materialized greater than expected during execution, i.e. underground utilities.	√	√	√	√	
17	Senior Management is reluctant to increase contingency on the front end despite selecting the lowest bidder.		√	√		
18	Project Manager is young and appears inexperienced to manage size of project.		√	√	√	
19	Project Team has difficulty in obtaining reliable cost and schedule data from contractor resulting in OPG's inability to effectively forecast costs to complete.	√	√	√	√	√
20	Contractor performance issues have increased costs	√		√	√	
21	OPG performance issue has increased costs, or has the potential to increase costs					√
22	Scope growth beyond what was anticipated for the project.		√	√	√	
*	*Project is in its early stages.*					

Attachment C – Summary of Cost Variances to Date for Campus Plan Projects
BMcD/Modus 2Q 2014 Report to NOC
May 13, 2014

In accordance with recommended industry practices, construction project costs should be periodically evaluated and updated in order to develop reliable estimate at completion ("EAC") forecasts. Planning for cost forecasting establishes the timing of forecasts, how forecasts are communicated or reported, methodologies and systems/tools to be used, and specific roles and responsibilities for forecasting. EACs should be prepared and issued on an established schedule that is appropriate for the pace of work on the project.

The development cycle of an EAC typically follows a set process with standard guidelines for the project team to follow. For instance, one step would be to review and rigorously vet contractor cost reports to understand the development of costs versus current budget, planned and actual productivity. Based on our review of five (5) Campus Plan Projects, it does not appear that Facilities and Infrastructure ("F&I") used a set process or guidelines to govern EAC development. When we interviewed the project teams, we discovered that each team was following its own EAC process, indicating that there was neither visibility to cost increases nor internal cost control.

To understand the impact to the project costs and EAC process, we compared the current EAC to the last approved BCS to identify the magnitude of cost increases. The following chart illustrates the cost increases on the projects[1]:

Overall Cost Variances between the Latest BCS and the Current EAC on F&I Projects

Project
D2O Storage & Drum Handling
Auxiliary Heating System
RFR Island Support Annex
Water and Sewer

We then analyzed the project documents to identify the categories of costs behind the increases identified on each of the projects as described below. We also interviewed the project teams to understand their EAC process.

D2O Storage & Drum Handling

Our analysis of the RFR Island Support Annex estimates yielded the following summary highlights:

- On this project, nearly every cost category of work has increased considerably ranging up to +537% above approved gate funds, with the exception of Phase I engineering design and award long lead procurement which was contracted on a fixed price basis.
- Engineering work is 82% complete overall versus a planned completion of 100%; 48 of 84 ECs have been issued in Passport. Engineering is forecasting that all ECs will be completed by early November 2014.

[1] The chart contains only 4 projects because Retube Waste Storage is not included; this project has not progressed beyond the definition phase.

[redacted]

Summary of D20 Storage Building Cost Variances

Cost Element	[redacted]
Underestimate of Effort	
Design Scope Growth	
Underestimate PM Plant Materials	
Client Requested Changes	
Schedule Extension & Acceleration	
Environmental Requirements	
Pipe Chase	
EPSCA	
Building Relocation	
Total	

A brief explanation of the significant changes, as reported by B&M in its updated cost estimate, is provided below:

- *Underestimate of Effort* – This cost element represents the underestimated effort required to execute the project based on the original scope of work. The staffing levels required to manage the work, generate CWPs/ ITPs and integrate the project plans into the OPG work management system were much greater than the original budgets allowed.
- *Design Scope Growth* – Represents the increased construction cost of the project from the original concept. The design engineering was a fixed price. Bidding took place on preliminary design requirements and a conceptual design report with many assumptions that were later invalidated. The absence of the MDR at the time of bidding meant that it was impractical to estimate the project beyond an AACE Class 5 quality level.
- *Underestimate of Permanent Plant Materials*
    - 367% increase in the quantity of process and service piping from 3,000M of piping to >14,000M.
    - 340% increase in the quantity of valves from 250 valves to ~1,100 valves.
    - 40 % increase to the electrical load list including additional equipment such as a UPS and Diesel generator that were not previously in the design requirements.
- *Environmental Requirements* – The project was awarded on the basis that the soil and ground water were free of contamination, an assumption that proved incorrect. Soil testing revealed the presence of tritium above acceptable levels, requiring special soil storage and operational requirements to manage the water runoff.
- *Building Relocation* – The original design concept had a new building with a "shared wall" in contact with the existing west wall of the TRF Building. However, the new foundations for the D20 interfered with the existing foundations necessitating a seven (7) meter relocation of the building to mitigate the conflict. This meant that the building now required four (4) architecturally completed sides rather than the original 3-sided finishes. More significantly, the scant pile (caisson) foundation shoring system became significantly more complex.
- *Schedule Acceleration and Extension required for:*
    - Premium time expended to recover lost time on the critical path and meet outage requirements.
    - Premium time planned critical work and make-up days for inclement weather

Auxiliary Heating System

Our analysis of the Auxiliary Heating System estimates yielded the following summary highlights:

- The current EAC was provided by the contractor just after the 4c estimate effort was complete. The contractor's EAC was provided in a high-level letter and spreadsheet form, which the project team did not dive into or vet.
- On this project, nearly every category of cost has increased significantly. The overall project, including interest and contingency is projecting an overrun of 87%.
- As of the March 2014 Program Status Report, the project is reporting 60% complete ($24M earned on a BAC of $40M).

The primary cost driver behind [redacted] in engineering costs include [redacted] of additional Phase III engineering $3M for items that were simply underestimated. For example, [redacted] the cost of working in accordance with OPG's review processes; OPG's design review and approval processes are more time consuming [redacted] The team explained that OPGs EC process is very time consuming as compared with a commercial process. In addition, lack of detail and definition of scope at the beginning impacted the quality of the estimates and bids, [redacted] estimates.

RFR Island Support Annex

Our analysis of the RFR Island Support Annex estimates yielded the following summary highlights:

- For the current EAC, the team relied on high level cost data provided by the contractor which the team did not vet. This information was used at Gate 3B in February 2014.
- The RFR Annex Project is currently projecting a project cost of $40M, or $8M over its 4c estimate of $32M at the last project gate, for an overall increase of 25%.
- As of March 2014, the project is reporting 20% complete ($7M earned of a BAC of $33M).
- The EPC portion accounts for 91% of the overrun, with engineering comprising half of the overrun, procurement and construction 40%, and OPG costs, contingency and interest making up the balance of the overrun. See the table below for additional details.

Summary of RFR Island Support Annex Variances between the Latest BCS and the Current EAC

Cost Category	[redacted]
Project Costs	
Interest	
Contingency	
Total Project Cost	

The following table briefly explains and summarizes the cost increases by $ and % of the RFR Annex Project is shown as follows:

Cost Category	[redacted]
Engineering	
Contractor Underestimate (CTP)	
OPG Scope Change (PCA)	
OPG-related cost increase (PCA)	
Subtotal	
Procurement and Construction	
Contractor Underestimate (CTP)	
OPG Scope Change (PCA)	
OPG-related cost increase (PCA)	
Subtotal	
EPC Cost Increase Subtotal	
Additional Cost Item: OPG Support	
[redacted]	
Interest	
Contingency Re-assessed	
Additional Project Cost Increase Subtotal	
Total Project Cost Increase	

This project team has done a better job of trying to allocate the cost increases between scope increases and contractor underestimates as shown above.

- [redacted] The project team feels that Engineering is approximately 80% complete though there are no metrics to confirm; 16 of 22 design packages are complete.
- [redacted] Instead, OPG's review and approval process has required much more level of effort from [redacted] than originally bid.
- [redacted] OPG expected to simply mount the camera on an existing pole [redacted] anticipating camera vibration issues engineered a new pole replacement).
- The ESMSA contract process has caused more engineering cost by shifting more risk and liability to the engineer. The work is subject to more stringent codes and is performed by different trades [redacted] That also drives up the engineering cost. The work is subject to more stringent codes and is performed by different trades [redacted]. As a result, cost overruns for engineering alone equate to an additional [redacted] per square foot in building costs.

Water and Sewer

As of December 2013 the project was reporting 81% complete ($36.9M earned on a BAC of $45.7M). The Water and Sewer Project is currently projecting a cost increase of $8.3M on a budget of $54.0M or an increase of $18% as shown below:

Cost Category	BCS/Gate 3	Current EAC	Variance	% Increase
OPG Project Management	$ 3,237	$ 3,764	$ 527	16%
OPG Engineering	$ 705	$ 688	$ (17)	-2%
OPG Other	$ 983	$ 2,298	$ 1,315	134%
Design Contracts	$ 1,510	$ 1,633	$ 123	8%
Construction Contracts	$ 32,077	$ 39,937	$ 7,860	25%
EPC Contract	$ 2,700	$ 4,707	$ 2,007	74%
Interest	$ 967	$ 1,671	$ 704	73%
Subtotal	$ 42,179	$ 54,698	$ 12,519	30%
Contingency	$ 3,524	$ 3,014	$ (510)	-14%
Total	$ 45,703	$ 57,712	$ 12,009	26%

- The major driver of this cost increase is in the cost of the construction contracts, due to contractor underestimating the value of change requests, additional change requests not identified or anticipated and increased contractor indirect costs due to schedule delays.

- On a pure percentage basis, the major driver is the OPG other costs which have proved to be higher due to underestimate of the level of effort needed from OPG's Operations Manager, Operations, Project Oversight and Field Support and Drawing Office.
- The EAC for this BCS was based on actual invoiced additional changes as well as internal OPG estimates of the cost of anticipated contract changes.
- Another increase in overall cost of these projects has been due to the nature of the underground work – unforeseen conditions, soil conditions, and undocumented actual conditions.
- Compared to the other projects, water and sewer is well underway. Phase I is 100% complete; phase II is 100% complete on engineering and 75% construction; phase III is scheduled to complete by November 2014 and construction is scheduled to complete by June 2015. However, the work is demolition of the old water treatment plant and is less complicated than the other earlier scopes.