# DARLINGTON REFURBISHMENT PROJECT UPDATE

## 1.0 PURPOSE

The purpose of this exhibit is to update the evidence related to OPG's Facilities and Infrastructure Projects or "Campus Plan Projects" (Ex. D2-2-1, Pages 22-23), and in particular, the Heavy Water Storage and Drum Handling Facility ("$D_2O$ Storage") project and the Auxiliary Heating System ("AHS") project. These two projects represent less than five percent of the total planned expenditures for the Darlington Refurbishment Project.

The revenue requirement impacts resulting from this update are not material. Accordingly, OPG is not requesting any changes to its proposed test period payment amounts as a result of this update.

This exhibit also presents the findings of Burns & McDonnell Canada Ltd. and Modus Strategic Solutions Canada Company ("BMcD/Modus") in respect of these projects and their relationship to the Darlington Refurbishment Project ("DRP") in general.

## 2.0 BACKGROUND

In its Application OPG sought, among other things, a finding that its commercial and contracting strategies for the Darlington Refurbishment Project (the "DRP") are reasonable and an approval of certain test period in-service capital additions from a set of Facilities and Infrastructure Projects.

In its September filing (Ex. D2-2-1), OPG provided evidence in respect of the commercial and contracting model for the DRP's major work packages of Retube and Feeder Replacement, Fuel Handling, Turbine Generators, Steam Generators and Balance of Plant. This evidence included an endorsement of OPG's commercial and contracting model by Concentric Energy Advisors. This endorsement continues and as such, except for the update to capital expenditure and in-service timing and amounts related primarily to the $D_2O$ Storage

and AHS, OPG continues to rely on its evidence set out in Ex. D2-2-1 relating to the DRP Commercial and Contracting Strategy/Model.

Capital in-service information was also provided in Ex. D2-2-1 for purposes of establishing capital in-service additions for certain prerequisite projects commenced in advance of the DRP as part of the Facilities and Infrastructure projects, or as they are also known "Campus Plan Projects". Further, in Ex. N1-1-1, OPG provided an update on the capital in-service additions based on OPG's updated business case as filed in Ex. D2-2-1, Attachment 5, however, these updated additions were not included in the updated proposed revenue requirement or payment amounts set out in that exhibit.

Overall, this evidence showed that the Darlington Refurbishment Project was progressing well and that OPG had already successfully completed a number of major project components such as: the Darlington Energy Complex; certain support infrastructure required for the project; contracts for the major work programs; and significant regulatory and planning milestones such as the submission of the Integrated Implementation Plan and the Global Assessment Report.

The evidence filed to date also showed that OPG was pursuing the Darlington Refurbishment Project in a manner consistent with the Government's Long Term Energy Plan ("LTEP"). Namely, its approach incorporated the seven principles set out in the LTEP. OPG has also incorporated off-ramps into its contracts that limit OPG's and ratepayers' financial exposure should a decision be made not to continue the DRP after the first unit is refurbished.

From its experience in managing large complex projects and from benchmarking and assessing the lessons learned by others who have managed large projects, OPG has learned the importance of strong control processes and third-party oversight. To be effective, this input must apply a critical lens on areas where problems have developed, or could develop. This allows OPG to implement timely corrective actions.

In keeping with this approach, BMcD/Modus was retained by OPG's Board of Directors Nuclear Oversight Committee (the "NOC") in February 2013 to provide external independent oversight of the DRP. OPG sought external oversight that would be pointed and balanced.

BMcD/Modus' thorough, candid reports have assisted OPG in implementing timely corrective actions.

This external oversight is complemented by the Darlington Refurbishment team's ("DR Team") existing continuous self-assessment and improvement approach. OPG regularly conducts self-assessments and evaluations of challenging conditions, and has initiated management actions in response to those assessments. The DR Team also actively identifies and incorporates lessons learned from other large nuclear and non-nuclear projects, internal and external to OPG.

As part of its engagement by the NOC, BMcD/Modus has produced five oversight reports to date. The BMcD/Modus reports of May 13, 2014 and June 26, 2014 are key for the purposes of this exhibit. The BMcD/Modus June 26, 2014 report includes the remaining reports as an appendix. As such, all five BMcD/Modus reports are attached to this Ex. D2-2-2.

The first report, dated August 13, 2013, established a base line against which BMcD/Modus would assess the evolution of the DRP. Subsequent reports dated November 12, 2013 and March 2, 2014 considered the evolution of the DRP through part of the Definition Stage. While identifying concerns or risks that normally arise in respect of the early stages of a mega-project like the DRP, the reports were generally positive with respect to the evolution of the DRP as it progresses to the point of a release quality estimate ("RQE") and continued to support OPG's commercial strategies and contracting model.

Concerns were identified by OPG regarding the $D_2O$ storage and AHS projects. As a result, OPG asked BMcD/Modus to carry out a "root cause" investigation into the challenges faced by the projects. The fourth BMcD/Modus report dated May 13, 2014 reported on the root cause investigation. The report identified deficiencies in, and raised serious concerns regarding, the execution of the $D_2O$ Storage and AHS projects and raised concerns about their potential impact on the DRP schedule and costs. The report identified that OPG had already taken corrective action with respect to the projects and BMcD/Modus went on to make further observations and recommendations.

In order to independently assess the integrity of the DRP and its progress to RQE and schedule in light of BMcD/Modus' findings, OPG's NOC obtained a fifth report dated June 26, 2014 from BMcD/Modus.

In its June 26, 2014 report, BMcD/Modus stated the following conclusions regarding the DRP in general:

- "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 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."

With respect to the DRP's cost range of $6 to $10 Billion, OPG believes that the cost variances from the Campus Plan Projects will be approximately $200 to $300 Million which equates to approximately 2% to 3% of the DRP's total $10 Billion high confidence estimate. Considering the level of contingency and management reserve within the high confidence estimate, OPG remains confident that the cost of the DRP will remain less than $10 Billion ($2013), excluding capitalized interest and future inflation.

With respect to incorporating lessons learned, BMcD/Modus noted that the DR Team has taken action on many of the items it raised. BMcD/Modus noted that OPG has either: already taken action on the recommendations as written by BMcD/Modus; or, has identified how the DR Team plans to address the recommendations in the future. BMcD/Modus expressed its satisfaction with the DR Team's response to its recommendations.

## 3.0 IN-SERVICE AMOUNTS

The Facilities and Infrastructure Projects, or Campus Plan Projects, consist of new facilities and infrastructure together with upgrades to existing facilities and infrastructure. They are required to directly support the current operation of Darlington, the refurbishment outages, and operation of the station after refurbishment. Safety Improvement Projects are modifications committed to in the DRP Environmental Assessment.

Table 1 provides a summary of the Facility and Infrastructure, safety improvement, and other station modification in-service amounts, for the 2014 to 2015 period. The table provides the amounts included in the original September 2013 filing in Ex. D2-2-1; the amounts discussed in the 1st Impact Statement filed in December 2013 in Ex. N1-1-1 and Ex. D2-2-1, Attachment 5; as well as the currently forecast amounts (Ex. D2-2-2).

**Table 1 – DRP In-Service Amounts**

| $ millions | Originally Filed Exhibit D2-2-1 | | | As updated Exhibit N1-1-1 and D2-2-1 Attachment 5 | | | As Updated Exhibit D2-2-2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Final In-Service Date | 2014 | 2015 | Final In-Service Date | 2014 | 2015 | Final In-Service Date | 2014 | 2015 |
| Darlington OSB Refurbishment | Jul-15 | - | 29.7 | Oct-15 | - | 37.7 | Aug-15 | - | 45.1 |
| D2O Storage Facility | Apr-15 | - | 83.5 | Oct-15 | - | 94.2 | Jan-17 | 15.5 | 1.0 |
| DN Auxiliary Heating System | Mar-15 | - | 36.3 | Apr-15 | - | 43.5 | Mar-15 | - | 75.3 |
| Water & Sewer | Nov-14 | 12.2 | - | Nov-13 | - | - | Nov-15 | 22.6 | 6.6 |
| Elec Power Distribution System | Apr-15 | 4.4 | 6.2 | Jun-14 | 10.0 | - | Nov-14 | 12.0 | - |
| Darlington Energy Complex | Jul-13 | - | - | Jul-14 | 6.0 | - | Jul-15 | 2.1 | 4.1 |
| RFR Island Support Annex | Apr-16 | - | - | May-15 | - | 25.4 | Apr-16 | - | - |
| Other Campus Plan projects | various | - | - | various | 10.2 | - | various | 15.1 | 7.6 |
| Safety Improvement Opportunities | various | - | 42.7 | various | - | 90.5 | various | - | 83.0 |
| Other Station Modifications | various | 2.1 | 11.1 | various | - | 18.7 | various | - | - |
| **Total** | | **18.7** | **209.4** | | **26.1** | **309.9** | | **67.2** | **222.7** |

As indicated in Ex. N1-1-1, the in-service additions to rate base have increased for 2014 from $18.7 Million to $26.1 Million and for 2015 from $209.4 Million to $309.9 Million. The key driver, as reported in Ex. N1-1-1, of the higher in-service additions was earlier assumed in-service dates for certain safety improvement projects, including the Emergency Power Generator ("EPG") project and the Containment Filtered Venting System ("CFSV") project. These earlier in-service dates reflect commitments that OPG has made to the CNSC to have these projects in-service prior to the commencement of the refurbishment. Other contributors to the change include higher in-service additions for the Heavy Water Storage and Drum Handling Facility and the Re-tube and Feeder Replacement Island Support Annex.

As provided in this exhibit, the current forecast of in-service additions has increased for 2014 from $26.1 Million to $67.2 Million and decreased for 2015 from $309.9 Million to $222.7 Million. The key drivers of these changes to the in-service amounts were:

- A revision to the in-service dates for the Heavy Water Storage and Drum Handling Facility due to project engineering and construction delays.

- A revision to the in-service dates for the Re-tube and Feeder Replacement Island Support Annex, the Containment Filtered Venting System and the Fuel Inspection Facility, contained within Other Station Modifications, based on an improved understanding of the schedule.

- An improved understanding of the project estimate for the Auxiliary Heating System, OSB Refurbishment, and Third Emergency Power Generator projects as a result of further project development.

- Advanced in-service dates to the test period for the Powerhouse Steam Venting System, a safety improvement project.

- The inclusion of two new safety improvement projects including the Shield Tank Overpressure Protection and Emergency Cooling Water projects.

- Deferred in service amounts from 2013 for the Water and Sewer project, as a result of construction delays.

The resulting impact to the 2014 and 2015 capital expenditures, as reported in Ex. D2-2-1, Table 1, are an increase in 2014 from $765.0M to $839.9M, an increase of $74.9M, and an increase in 2015 from $736.0M to $842.5M, an increase of $106.5M. The total projected capital increase, relative to Ex. D2-2-1, in the rate period is $213.2M. The changes in in-service additions for Facilities and Infrastructure projects plus the related timing changes increase the 2014 Revenue Requirement by approximately $3M and the 2015 Revenue Requirement by approximately $9M. Since these changes are not material, OPG is not proposing any changes in its proposed payment amounts due to these updated in-service amounts.

## 4.0 OVERSIGHT PROCESSES

OPG is committed to ongoing assessments of DRP activities, including external independent critical assessments that provide insights and opportunities for lessons learned. This includes the reports prepared by BMcD/Modus on behalf of the NOC.

### 4.1 Nuclear Oversight Committee

The Nuclear Oversight Committee ("NOC") is a sub-committee of the OPG Board of Directors (Ex. D2-2-1 Attachment 4-1, Appendix A, Program Organization Structure). Its mandate includes reporting to the OPG Board of Directors regarding the progress of the DRP with respect to project risk, development and execution performance. It performs this by:

- Reviewing and monitoring the definition, development and risk management of the Refurbishment Program;
- Monitoring progress of the Refurbishment Program against targets, including cost, schedule, financing and risk;
- Reviewing execution performance of the Refurbishment Program.

In February 2013, OPG awarded a contract for independent external oversight services to Burns & McDonnell Canada, Ltd. together with its subcontractor, Modus Strategic Solutions (Canada). As part of the DRP oversight structure, the OPG Board retained BMcD/Modus to provide it with regular reporting on the status, processes, procedures and approach taken by OPG's project team and OPG's contractors performing the Refurbishment Program.

## 5.0 BMCD/MODUS FINDINGS AND OPG RESPONSES

The focus of this Ex. D2-2-2 is the BMcD/Modus report dated May 13, 2014 and the Supplemental report dated June 26, 2014.

### 5.1 2nd Quarter 2014 Report – May 13, 2014

In this report, BMcD/Modus performed a detailed assessment of cost and schedule variances associated with the $D_2O$ storage and AHS projects. This assessment was initially not within BMcD/Modus' scope of review. However, it was undertaken at the request of senior management. BMcD/Modus found that the $D_2O$ and AHS projects variances were caused by initial poor cost and schedule estimates.

In the May 2014 report, BMcD/Modus made some key observations noting that OPG's Projects and Modifications ("P&M") organization, incorrectly applied an "oversight" project management approach for its Engineer – Procure - Construct ("EPC") contracting strategy.

Ultimately, this resulted in poor scope definition and cost estimate quality, incorrect schedules and an inability to manage risks, all resulting in increased costs and delays.

It is important to note the separate organizational components that are involved in the DRP. The Darlington Refurbishment Team ("DR Team") is responsible for planning and executing the bulk of the DRP work (e.g., re-tube and feeder replacement, turbine generators, steam generators, fuel handling, etc.). Projects and Modifications is responsible for completing the Campus Plan and other prerequisite projects. The DR Team and P&M are organizationally separate and have different processes. As a result, issues that have arisen from the different areas of responsibility of the DR Team and P&M have manifested themselves differently.

Projects and Modifications had not initially adopted many of the procedures developed by the DR Team. As the Campus Plan Projects were to occur in advance of the primary focus areas of the DRP, P&M was chosen to manage the projects since the DR Team was at the early stages of being organized. Projects and Modifications is a longstanding organization within OPG that is responsible for numerous minor maintenance and modification projects that are discrete and that collectively form a portfolio that typically totals in the range of $200 – $300 million per year. Both OPG and BMcD/Modus are of a view that had the Campus Plan Projects been of the same size and complexity as a typical modification project, there would have been a much greater likelihood of success.

Projects and Modifications initially approached the Extended Services Master Services Agreements that underpinned the Campus Plan Projects as general commercial arrangements and not as EPC contracts. The fundamental difference being that major EPC contracts require more direct and intrusive management by P&M as the owner. This is in contrast to the management of EPC contracting for the DRP's major scopes of work that are being actively managed by the DRP Team as owner.

The Campus Plan Projects have been a source of lessons learned for OPG. Recovery plans are now in place and OPG has adopted the recommendations of BMcD/Modus as described below.

In summary, BMcD/Modus concluded in its May 13, 2014 report that the predominant cause for the $D_2O$ and AHS projects being forecasted to be completed significantly beyond approved budgets and schedules was P&M's incorrect application of the "oversight" project management approach for its EPC contracting strategy. This led to a series of management lapses and contractor issues related to scope, cost estimates and risk management.

In this regard, BMcD/Modus indicated that simultaneous with its review leading to the May 13, 2014 report, the P&M's team's new leadership has taken aggressive action to correct as many of the major issues as possible. BMcD/Modus stated:

> *"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 $D_2O$ 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."*

In this regard, OPG has added new measures to ensure a common project management and controls approach in keeping with best practices. For example, actions taken to course correct where issues were identified included:

- Changes in leadership of the ancillary project team in 2012 and 2013 to ensure the right level of management control and staff development occurred in the project groups;
- A more intrusive approach to contractor management including both collaborative front end planning and real-time oversight to improve performance;
- Additional training, management processes and reporting mechanisms;

- Earlier identification processes for all subsidiary project costs to ensure more accurate early cost estimates that reflect the full scope of work required.

### 5.2 2nd Quarter 2014 Supplemental Report – June 26, 2014

BMcD/Modus was requested by NOC to provide a Supplemental Report to the May 13, 2014 Report to contextualize the findings presented in that report and the earlier BMcD/Modus' reports and to report on OPG's response to the findings.

Both the NOC and senior OPG management have taken the May 13 report very seriously. As noted the NOC caused a supplemental June 26, 2014 report by BMcD/Modus to be prepared. As part of the June 26, 2014 report, OPG has asked BMcD/Modus 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;
- Whether the Refurbishment Project's and Campus Plan Projects' contractors are incorporating lessons learned into their methods for planning, estimating, scheduling and executing the work; and
- Whether the P&M and the DR Team are committed to transparent reporting of the Refurbishment Project's progress.

BMcD/Modus has noted the majority of the cost increases with $D_2O$ Storage and AHS projects are due to the maturation of these projects' scope definition, scope management, flawed estimates or unforeseen conditions during construction. In other words, the increased budgets are simply reflective of the true project costs had they been estimated properly at the outset. BMcD/Modus acknowledges that under the current Refurbishment Project leadership, these cost estimates would not have been presented to the Board of Directors 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 avoid any repeated issues in the estimating of the remaining work.

With respect to OPG's commercial and contracting strategy model, BMcD/Modus had no issue with the project delivery approach (multiple-prime EPC, target price). BMcD/Modus stated that they 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, BMcD/Modus believes that target pricing in this context is appropriate — particularly prior to the completion of detailed engineering where a contractor would add a large premium to accept pricing risk. BMcD/Modus clarified their criticism in the May 13, 2014 report, which stems mainly from the fact that the project management strategy originally employed by P&M 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.

BMcD/Modus acknowledges that "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."

According to BMcD/Modus, "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."

Furthermore, BMcD/Modus stated that: "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 $D_2O$ Storage and AHS projects represent a trend or a systemic failure for the Refurbishment Project."

OPG intends to take into account BMcD/Modus findings regarding the issues related to the Campus Plan Projects and is working to implement all of the lessons learned from these projects. A summary of BMcD/Modus' significant findings in its May 13, 2014 Report together with OPG's responses to those findings is set out starting at p. 19 of BMcD/Modus' June 26, 2014 report.

# LIST OF ATTACHMENTS

**Attachment 1**

Modus/Burns & McDonnell, Supplemental Report to Nuclear Oversight Committee, 2nd Quarter 2014, June 26, 2014 (inclusive of Modus/Burns and McDonnell Reports August 13, 2013; November 12, 2013; March 4, 2014; and May 13, 2014)