December 31, 2020

VIA EMAIL

Christine E. Long
Registrar and Board Secretary
Ontario Energy Board
P.O. Box 2319
2300 Yonge Street, Suite 2700
Toronto, ON
M4P 1E4

Dear Ms. Long:

Re: OPG Reporting and Record Keeping Requirements

Further to the OEB's direction in EB-2016-0152 (Decision and Order, pp. 44-45), please find attached the Darlington Refurbishment Program Annual Report.

Thank you,

Christopher Deschenes

Att.

cc: Nancy Marconi, OEB
Christopher Kerr, OEB

FILED DECEMBER 31, 2020

Darlington Refurbishment Program Annual Report

2020 REPORT

AS PER DECISION AND ORDER IN EB-2016-0152

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ONTARIO POWER GENERATION

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FOR INFORMATION to the Ontario Energy Board

December 31, 2020

DARLINGTON REFURBISHMENT PROGRAM

INTRODUCTION

This report provides the status of the Darlington Refurbishment Program, hereafter referred to as the "Program".

Unless otherwise noted, this report includes a summary and a review of the Program performance through September 30, 2020.

This is an annual report to be provided by Ontario Power Generation (OPG) to the Ontario Energy Board (OEB) pursuant to the OEB's decision and order in EB-2016-0152.[1]

EXECUTIVE SUMMARY

The Darlington Refurbishment Program is a multi-year, multi-phase, mega-project that will enable the Darlington Generating Station ("Darlington") to continue safe and reliable operation until approximately 2055. The Program includes the replacement of life-limiting critical components, the completion of upgrades to meet applicable regulatory requirements, and the rehabilitation of components at Darlington's four units.

The Release Quality Estimate (RQE) for the four-unit refurbishment is $12.8 Billion. Under the RQE, the refurbishment of the first unit (Unit 2) was to start in October of 2016 and be returned-to-service in the first quarter of 2020, with the last unit (Unit 4) scheduled to be completed in 2026. The RQE formed the basis of OPG's May 2016 pre-filed evidence in EB-2016-0152. After the development of the RQE, OPG continued detailed planning and preparations for execution of Unit 2 and established a Unit 2 Execution Estimate (U2EE), which was approved by OPG's Board of Directors in August 2016. The U2EE was a more refined estimate as compared to the RQE and was used to establish Unit 2 project baselines for cost and schedule monitoring. Therefore, OPG measured its performance over the Unit 2 refurbishment against the U2EE. Details of the U2EE were provided in EB-2016-0152 Ex. L-4.3-1, Staff-055. Detailed planning associated with the U2EE confirmed that the High Confidence schedule duration remained at 40 months as it was at RQE, and that the overall Program estimate remained $12.8 Billion as it was at RQE. U2EE planning also resulted in an $89 Million increase specific to program costs for Unit 2 and the Early In-Service ("EIS") projects and Campus Plan projects (i.e. the Safety Improvement Opportunities ("SIO"), and Facilities and Infrastructure Projects ("F&IP")). The OEB approved OPG's nuclear revenue requirements in EB-2016-0152 based on the earlier RQE forecasts per Ex. N2-1-1 in that proceeding, as opposed to the U2EE.

OPG commenced the refurbishment of Unit 2 in October 2016. In its 2019 DRP Annual Report to the OEB, OPG had discussed that, while the first two segments of the Unit 2 refurbishment outage had been completed in accordance with OPG's High Confidence Schedule, OPG encountered challenges in the third major segment involving the installation and reassembly of reactor components. The 2019 DRP Annual Report also noted that, as a result, the High Confidence scheduled completion of Unit 2 was revised from Q1 2020 to Q2 2020.

Unit 2 was successfully returned to service on June 4, 2020. Of note, the final two-and-a-half months of the Unit 2 refurbishment execution were completed under the state of emergency declared in Ontario on March 17, 2020, in response to the COVID-19 pandemic.

Safety performance on the refurbishment of Unit 2 continued to be significantly better than the average construction industry performance in Ontario.

[1] EB-2016-0152, Decision and Order, dated December 28, 2017, p.44, Table 16.

The total capital and operations, maintenance and administration (OM&A) cost through Unit 2, including all EIS and Campus Plan projects (but excluding the Heavy Water Storage and Drum Handing Facility ("D2O Storage Project")) was $5.7 Billion. This amount is $133 Million above the amounts approved by the OEB. Unit 2 (excluding Definition Phase) was returned to service on budget compared to the U2EE at a total cost of $3,417 Million, and $11 Million over the RQE forecast of $3,406 Million.

Successful completion of the Unit 2 refurbishment on budget and with a schedule variance of just over three months represented a significant achievement in mega-project execution for OPG.

During the course of the Unit 2 refurbishment OPG captured thousands of lessons learned and identified several strategic improvements, which have been incorporated into the planning and execution of the refurbishments of Units 3, 1, and 4 (the "Remaining Units") and are expected to result in unit-over-unit efficiencies.

While not included in EB-2016-0152 approved amounts, the D2O Storage Project is a F&IP needed for the overlapping refurbishments of the Remaining Units. The D2O Storage Project is available to support the refurbishment of the Remaining Units and is expected to be closed out within the $510 Million budget.

Beginning in March 2020, OPG has taken a number of actions in response to the COVID-19 pandemic, including deferring the start of Unit 3 refurbishment during the height of the pandemic's initial onset in the spring of 2020, to help protect the safety of the workers and the operation of the station. The planned start dates of Units 1 and 4 were correspondingly deferred to maintain the same degree of overlap in the refurbishment schedule.

Based on impacts experienced to date, incremental costs of approximately $150 Million have been forecasted as a result of the actions OPG has taken on the Program in response to the COVID-19 pandemic. Because of inherent uncertainties associated with the pandemic, OPG is monitoring, tracking and assessing related expenditures separately from the baseline project budget, which does not include contingency for 'black swan' events such as a pandemic. OPG will continue to seek ways to manage and explore potential efficiencies during the execution of the Remaining Units refurbishments in an effort to complete the Program inclusive of COVID-19 cost impacts within the $12.8 Billion budget.

The Unit 3 Execution Estimate (U3EE) was completed in advance of the start of the refurbishment outage on Unit 3, and incorporated many lessons learned and strategic improvements. The final U3EE was approved by OPG's Board of Directors in August 2020, and included the deferred starts to the refurbishment outages of the Remaining Units as a result of actions taken in response to the COVID-19 pandemic. The final U3EE has been used to establish Unit 3 project cost and schedule baselines against which performance on the refurbishment outage of Unit 3 is being measured. Per the U3EE, the budget to complete the Program remains $12.8 Billion, excluding cost impacts of the COVID-19 pandemic, and the Program is expected to be completed by Q4 2026.

On September 3, 2020, OPG commenced defueling of the Unit 3 reactor, marking the start of Unit 3 refurbishment execution. Defueling of the Unit 3 reactor was completed on November 28, 2020, ahead of schedule. Unit 3 is projected to be completed by Q1 2024.

Planning for the refurbishments of Units 1 and 4 is progressing well. Work planning, design engineering, material procurement, and pre-requisite work for Units 1 and 4 continues on plan, with completion of the execution estimates for Units 1 and 4 planned for 2021 and 2023, respectively. The Units 1 and 4 refurbishment outages are currently planned to start in Q1 2022 and Q3 2023 with return to service expected in Q2 2025 and Q4 2026, respectively.

DARLINGTON REFURBISHMENT PROGRAM STATUS

OVERVIEW

Key Program highlights include:

- **SAFETY:** Safety performance continues to be significantly better than the average construction industry performance in Ontario. The Program is approaching 27 Million hours worked with only one Lost Time Injury[2] since the start of the Program.
- **QUALITY:** As part the quality management program used to identify issues during refurbishment execution and through return-to-service, there were four additional Significant Quality Events identified on Unit 2 since OPG's 2019 DRP Annual Report. These were corrected prior to the return to service of Unit 2, and as a result, the quality of work on the completed Unit 2 was excellent. The quality of work on Unit 3 execution has been excellent to date.
- **SCHEDULE:** Unit 2 was returned to service on June 4, 2020, just over three months later than the U2EE High Confidence Schedule and approximately three weeks ahead of OPG's revised High Confidence Schedule. Unit 3 refurbishment execution commenced on September 3, 2020. The first segment of the Unit 3 refurbishment, defueling, was completed on November 28, 2020, ahead of schedule. Installation of the Accessibility Platform Trolley and End Fitting Seal Caps began immediately after defuel and was completed on December 4, 2020, ahead of schedule. Critical path work is now progressing through installation of the bulkheads, which started on December 4, 2020. Unit 3 is projected to be returned to service by Q1 2024.
- **COST:** The total capital and OM&A cost through Unit 2, including all EIS and Campus Plan projects (but excluding the D2O Storage Project) was $5.7 Billion. This amount is $133 Million above the amounts approved by the OEB. Unit 2 (excluding Definition Phase) was returned to service on budget compared to the U2EE at a total cost of $3,417 Million, and $11 Million over the RQE forecast of $3,406 Million.

  The cost to complete the D2O Storage Project, which is the last F&IP project to be completed for the Program, is forecasted at $510 Million, in line with the revised budget. The D2O Storage Project was not included in EB-2016-0152 approved amounts, but is included within the $12.8 Billion Program estimate.

  Excluding COVID-19 impacts, life-to-date expenditures are $769 Million for Unit 3, $194 Million for Unit 1, and $137 Million for Unit 4.

PROGRESS

The following is a status summary, as of September 30, 2020, of the major work completed since the 2019 DRP Annual Report filed December 21st, 2019:

- Unit 2 reactor re-assembly was completed on December 21, 2019.
- Unit 2 vault restoration was completed on March 26, 2020.
- All 58 out of 58 systems for Unit 2 were declared available for service on May 12, 2020.
- Unit 2 was returned to service on June 4, 2020.
- Defueling of the Unit 3 reactor commenced on September 3, 2020 and was completed on November 28, 2020, ahead of schedule.
- The D2O Storage Project was made available to support the refurbishments of the Remaining Units.

[2] A Lost Time Injury is a work injury that results in lost days (minimum of one) beyond the date of injury as a direct result of a safety incident.

- The installation of the Accessibility Platform Trolley and End Fitting Seal Caps began immediately after defuel and was completed on December 4, 2020, ahead of schedule.
- All 93 Integrated Implementation Plan ("IIP") tasks required to return Unit 2 to service are complete. All remaining IIP tasks, including 28 for Unit 3, are tracking to the current plan approved by the Canadian Nuclear Safety Commission (CNSC).

SAFETY

Safety is a priority for OPG. Because of this focus on safety, OPG has one of the lowest injury rates in the Canadian electricity sector.[3] In order to maintain this safety performance, OPG continues to set challenging targets for its day-to-day operations. In Q3 2020, the Program reported a Total Recordable Injury Frequency (TRIF) of 0.20 against its internal target of 0.40 as a result of three medically treated injuries in Q1 2020. OPG sets very challenging targets for all aspects of its operations and the Program. This expectation has resulted in a Program safety performance that is significantly better than the overall construction industry average as illustrated in Table 1.

The Program is approaching a total of 27 Million hours worked with only one Lost Time Injury, which occurred in May 2019 on Unit 2. There have been no Lost Time Injuries in 2020.

OPG employs a variety of leading indicators to ensure that issues are addressed before incidents occur. OPG's practice of proactively tracking events where no injuries occur, but where there is potential for harm, is one example of a leading indicator. OPG carefully logs and reviews each of these incidents and implements corrective actions to prevent future incidents.

PERFORMANCE METRICS SUMMARY

Table 1 provides a summary of the Program's safety performance and includes OPG and contractor employees.

Table 1 – Safety Performance Metrics								
		Historical Actuals				2020		
Category	**Measure**	**2016**	**2017**	**2018**	**2019**	**Sep YTD[2]**	**OPG Target**	**Ontario Construction Industry[3]**
Safety	TRIF (per 200k hours)[1]	0.64	0.49	0.39	0.52	0.20	0.40	5.06
	Lost Time Injuries	0	0	0	1	0	0	N/A

Notes:
1 TRIF is the average number of fatalities, Lost Time Injuries, medical treatment injuries and restricted work injuries per 200,000 hours worked.
2 Year-to-Date (YTD).
3 This rating is the most current safety rating for the Ontario Construction Industry (current as of 2019 year end).

CAMPAIGNS, PROGRAMS AND INITIATIVES

OPG's safety performance is underpinned by the practice of monitoring low level precursor issues and proactively taking action to reduce the risk of serious events from occurring. The following are the key safety campaigns, programs and initiatives that OPG and its vendor partners launched in 2020:

[3] Compared to the Infrastructure Health and Safety Association injury rate.

- **Response to COVID-19**

  OPG remains focused on mitigating risks to its workers and operations, including the DRP, posed by the COVID-19 pandemic. To date, OPG's emergency preparedness and implementation of enhanced safety measures have allowed essential workers and support staff to keep working safely, including in advancing the DRP. OPG has also been able to keep non-plant employees working from home, where possible. When conditions temporarily improve and risks reduce, these employees return to the worksites with COVID-19 safety protocols in place.

  The protocols implemented by OPG include:

  1. Physical distancing through reduced/amended capacity in certain buildings, staggered schedules and staggered lunches and breaks.
  2. Use of face coverings.
  3. Increased number of hand sanitizing stations and portable hand washing units.
  4. Increased cleaning of major touch points.
  5. Comprehensive response procedures including screening/identification/isolation procedures for suspected cases along with deep clean protocols.
  6. Ongoing monitoring, review and preparation for any continued COVID-19 impacts, taking into account operating experience, lessons learned and public health guidelines.

- **Unit 3 Proactive Human Performance and Safety Plan**

  Completed in August 2020, this initiative involved a multi-disciplinary team consisting of OPG and vendor subject matter experts assembling to analyze the human performance, safety and quality events and lessons learned from Unit 2. This initiative included mapping these events onto the Unit 3 schedule and developing actions to prevent recurrence of similar events on Unit 3.

- **Self-Assessments and Surveillances**

  In addition to lessons learned, OPG's Health and Safety group conducts a number of self-assessments and surveillances on higher risk areas to ensure improvements are incorporated into planning to reduce the risk of injury. Examples of self-assessments and surveillances performed in 2020 include:

  - Material Handling Surveillance
  - Falling Objects Department Self-Assessment
  - Heat Stress Snapshot Self-Assessment
  - Confined Space Surveillance

RADIOLOGICAL SAFETY

OPG's Radiological Protection (RP) program continues to meet regulatory requirements and industry standards. No worker has received a dose above either regulatory limits or OPG's more stringent internal targets. This performance is a result of OPG's robust nuclear safety culture and its "As Low as Reasonably Achievable" (ALARA) radiological safety principles. Lessons learned on Unit 2 have been incorporated into training and into enhanced radiological safety measures on Unit 3. The Program's ALARA committee continues to monitor and challenge RP performance to ensure ALARA principles result in lower doses to workers.

PERFORMANCE METRICS SUMMARY

Table 2 provides a summary of the program radiological safety performance and includes both OPG and contractor employees.

Table 2 – Radiological Safety Performance Metrics						
	2018 Year End		2019 Year End		2020 End of Q3	
	Actual	Target	Actual	Target	Actual[2]	Target[2]
CRE (person-rem)[1]	784	770	520	430	80.1	245
Unplanned Exposures	0	0	0	0	0	0

Notes:
1 A lower number represents a lower amount of radiological exposure.
2 CRE Actual is well below Target due to the deferral of Unit 3 refurbishment execution in response to the pandemic; the Target will be revised for 2021.

QUALITY

Refurbishment of a Darlington unit involves many thousands of removal and installation activities which are required to be executed with a high degree of precision. Many of the installation activities involve precision fit-up tasks and critical and highly technical welding operations. A certain amount of rework is to be expected on a program of this nature.

As part the quality management program, which is used to identify issues during refurbishment execution and through return to service, there were four additional Significant Quality Events identified on Unit 2 since OPG's 2019 DRP Annual Report. These events were corrected prior to the return to service of Unit 2. As a result, the quality of work on the completed Unit 2 was excellent. The quality of work on Unit 3 execution has been excellent to date with no Significant Quality Events.

SCHEDULE

OPG measures Program progress against two schedules:

1. A High Confidence Schedule; and
2. A shorter Working Schedule.

The difference between these two schedules is that the High Confidence Schedule includes additional contingency amounts quantified based on detailed risk analysis. These contingency amounts are expected to be utilized over the course of the Program. The Working Schedule is used to calculate performance metrics, for example, the Schedule Performance Index (SPI)[4], and manage day-to-day activities, allowing for early escalation of issues. The use of a Working Schedule and High Confidence Schedule is an industry leading best practice for large and complex projects.

PERFORMANCE METRICS SUMMARY

As discussed in the 2019 DRP Annual Report, OPG adjusted the Program schedule to account for the minor delay of Unit 2 returning to service from Q1 to Q2 2020.

Unit 2 was successfully returned to service on June 4, 2020, just over three months later than the U2EE High Confidence Schedule and approximately three weeks ahead of OPG's revised High Confidence Schedule.

[4] This strategy provides an early indication of potential risks or issues and allows OPG to proactively manage Program performance.

Table 3 provides a summary of the Unit 2 schedule performance relative to the RQE/U2EE Working Schedule and High Confidence Schedule.

Table 3 – Unit 2 Schedule Performance Metrics					
Measure	**2016 Year End Actual**	**2017 Year End Actual**	**2018 Q3 Actual**	**2019 Q3 Actual**	**2020 Q2 Actual**
Days Ahead of / Behind High Confidence Schedule LTD[1]	28 Days Ahead	10 Days Ahead	33 Days Ahead	72 Days Behind	98 Days Behind
Critical Path Days Ahead of / Behind Working Schedule LTD[3]	19 Days Ahead	47 Days Behind	50 Days Behind	206 Days Behind	259 Days Behind
SPI [2]	0.97	0.94	0.92	0.89	1.00
Forecast Working Schedule Completion Date [3]	31-Aug-2019	5-Nov-2019	8-Nov-2019	20-May-2020	Completed 4-Jun-2020

Notes:
1 Days Ahead/Behind is calculated as progress for all work currently completed relative to the LTD allotment of Contingency Days available in the High Confidence Schedule.
2 SPI is calculated for construction, commissioning and inspection work packages only against the Working Schedule.
3 Critical Path Days Ahead/Behind and Early Forecast Completion Date are calculated as progress for all work currently completed relative to the Working Schedule and does not consider projected gains or losses for future work.

Beginning in March 2020, OPG took a number of actions in response to the COVID-19 pandemic, including deferring the start of Unit 3 refurbishment during the height of the pandemic's initial onset in the spring of 2020, to help protect the safety of the workers and the operation of the station. The planned start dates of Units 1 and 4 were correspondingly deferred to maintain the same degree of overlap in the schedule.

Table 4 provides the current planned and forecast key milestone completion dates for Unit 3.

Table 4 – Key Unit 3 Milestone Status		
Key Milestone	**High Confidence Schedule Planned Completion**	**Forecast**
Segment 1 [Defuel / Lead In] Complete	February 12th, 2021	February 12th, 2021
Segment 2 [Removal] Complete	January 11th, 2022	January 11th, 2022
Segment 3 [Install] Complete	April 7th, 2023	April 7th, 2023
Segment 4 [Lead Out / RTS] Complete	January 2nd , 2024	January 2nd , 2024

COST

Total Program expenditures to date are $7.3 Billion with the current estimate to complete the Program at $5.5 Billion (excluding COVID-19 impacts). The total capital and OM&A cost through Unit 2, including all EIS and Campus Plan projects (but excluding the D2O Storage Project) was $5.7 Billion.

As set out in OPG's 2019 DRP Annual Report, after the approval of the RQE in 2015, OPG established the U2EE in August 2016. Detailed planning associated with U2EE confirmed that the overall Program and associated contingencies were within the $12.8 Billion set at RQE, and resulted in an increase specific to Program costs for Unit 2 and the EIS and Campus Plan projects. The U2EE established the detailed cost and schedule baselines against which OPG measured Unit 2 performance. OPG provided details of the U2EE in EB-2016-0152 (Ex. L-4.3-1, Staff-055).

The OEB approved revenue requirement in EB-2016-0152 was based on the earlier RQE forecasts per Exhibit N2, Tab 1, Schedule 1 in that proceeding, as opposed to the more refined U2EE. Based on the forecast total cost at completion for Unit 2, the $133 Million variance to OEB-approved amounts, which is largely the same as the forecast variance in the 2019 DRP Annual Report, is attributed to:

- $89 Million difference between RQE and U2EE for planned increases to Unit 2, and EIS and Campus Plan projects, and
- $44 Million variance above U2EE for the EIS and Campus Plan projects.

Unit 2 (excluding Definition Phase) was returned to service on budget compared to the U2EE at a total cost of $3,417 Million, and $11 Million over the RQE forecast of $3,406 Million.

The D2O Storage Project, which is the last F&IP to be completed for the Program, was made available for service in 2020 with minor close-out costs expected to be completed in 2021. The cost to complete the D2O Storage Project is forecast at $510 Million, in line with the revised budget. The D2O Storage Project was not included in EB-2016-0152 approved amounts, but is within the $12.8 Billion estimate to complete the Program.

Table 5 provides a summary of the cost performance metrics for thru Unit 2 and Unit 3.

Table 5 – Cost Performance Metrics for Thru Unit 2 and Unit 3 [1]

Unit	CPI	LTD Q3 2020 Actual Cost	Current Estimate to Complete	Current Estimate at Completion
Thru Unit 2	0.92	$5.7 Billion	$0.0 Billion	$5.7 Billion
Unit 3	1.00	$0.8 Billion	$1.8 Billion	$2.6 Billion

Note:
1 Program expenditures include capital and OM&A costs consistent with OEB-approved amounts.

In its EB-2016-0152 Decision and Order dated December 28, 2017, the OEB included Actual Versus Forecast Cumulative Capital Costs as part of OPG's annual reporting requirements. This requirement was further defined in JT1.17C in the same proceeding as quarterly cost flows for the Unit 2 in-service amount of $4,800 Million approved by the OEB. **Table 6** and **Figure 1** provide this information:

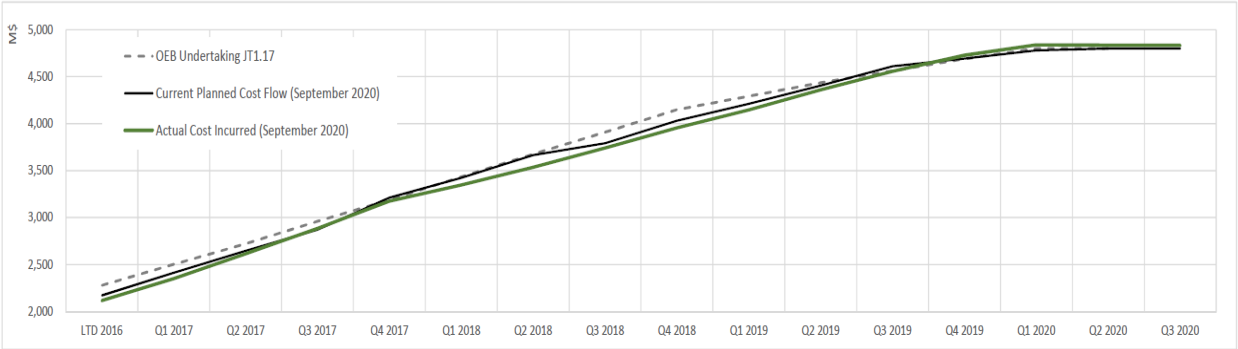
Table 6 provides a summary of the Actual vs. Forecast Cumulative Capital Costs.

Table 6 – Actual vs. Forecast Cumulative Capital Costs		
M$	**OEB Undertaking JT 1.17C (Forecast)**	**Actual Cost Incurred[1]**
LTD 2016	2,280	2,118
Q1 2017	2,501	2,350
Q2 2017	2,721	2,616
Q3 2017	2,960	2,886
Q4 2017	3,188	3,175
Q1 2018	3,433	3,348
Q2 2018	3,674	3,536
Q3 2018	3,909	3,742
Q4 2018	4,147	3,955
Q1 2019	4,292	4,146
Q2 2019	4,435	4,360
Q3 2019	4,563	4,557
Q4 2019	4,689	4,727
Q1 2020	4,800	4,839
Q2 2020	4,800	4,837
Q3 2020	4,800	4,837
Total	4,800	4,837

Note:

1 Includes new EIS projects brought into service prior to the refurbished Unit 2. These projects were originally scheduled to be placed in service with Unit 2 as part of the $4,800.2 Million OEB-approved amount. Also includes the Low Pressure Service Water project delayed from early in-service.

Figure 1 – Actual vs. Cumulative Capital Cost Curve



Per the U3EE approved by OPG's Board of Directors in August 2020, the estimated cost to complete the refurbishment of Unit 3 is $2,559 Million. Based on the U3EE, the estimated cost to complete the refurbishments of Unit 1 and Unit 4 are $1,954 Million and $2,106 Million, respectively. These figures exclude any COVID-19 impacts.

Excluding COVID-19 impacts, life-to-date expenditures are $769 Million for Unit 3, $194 Million for Unit 1, and $137 Million for Unit 4, and the overall Program estimate remains within the $12.8 Billion RQE budget.

OPG will continue to monitor, track and explore potential efficiencies during the execution of the Remaining Units refurbishments in an effort to complete the Program inclusive of COVID-19 cost impacts within the $12.8 Billion budget.

ENGINEERING

Unit 3 design engineering is 99% complete. The last remaining design engineering package is related to fire protection and is on track to be completed ahead of the need date.

Units 1 and 4 design engineering continues to progress well at 89% and 65% complete, respectively.

Major engineering accomplishments in the period include:

- Successfully returned all Unit 2 systems to service and completed 58 system available for service reports. 14 systems were improved from their previous system health rating, while other systems maintained their high performance.
- Several Unit 2 complex modifications were put in service including:
    - Auxiliary shutdown cooling pumps modifications, which enhances the independence and diversity of heat sinks for use during outages, and minimizes susceptibility to common mode failure.
    - Four heat transport system liquid relief valves modifications, which mitigated a water hammer issue.
    - A new emergency heat sink system to improve the make-up capability to the primary heat transport system in the event of a beyond design basis accident.
- Lessons learned and strategic improvements from Unit 2 were incorporated into subsequent unit designs, including incorporating field initiated changes (e.g. modified work table, pressure tube & calandria tube removal, and film forming amines, as discussed below):
    - To enable a greater degree of parallel work during the installation of calandria tubes, OPG acquired and tested a modified work table, which effectively doubles the number of installation tools available.
    - For the Remaining Units, the pressure tubes and calandria tubes will be removed simultaneously, using new tooling. This initiative is estimated to significantly reduce the critical path durations on each of these units compared to Unit 2.
    - Implemented a chemical protective film known as “film form amines” for the conventional side lay-up, a first-of-a-kind for OPG. Implementing this modification helps to avoid opening a large number systems for dehumidification which is necessary to preserve the asset during layup.
- In addition, in order to mitigate risks on the first-of-a-kind Unit 3 Turbine Generator controls upgrade project, Engineering has designed and installed a standalone full scope maintenance simulator. This will be used during refurbishment commissioning, and for testing/training both during and also post refurbishment.

PROCUREMENT

PROCUREMENT STATUS FOR UNIT 3

At the end of Q3 2020, 97% of Purchase Orders were issued and 92% of the requested materials for Unit 3 refurbishment were on site, with delivery of the remaining material items on track to meet the planned need dates.

PROCUREMENT STATUS FOR UNIT 1

At the end of Q3 2020, 80% of Purchase Orders were issued and 73% of all the requested materials for Unit 1 refurbishment were on site, with delivery of the remaining material items on track to meet the planned need dates.

PROCUREMENT STATUS FOR UNIT 4

The procurement process of long lead materials for Unit 4 refurbishment is in progress and on track to meet the planned need dates.

CONSTRUCTION

CONSTRUCTION PROGRESS SUMMARY

As of September 30, 2020, the execution of Unit 3 is 10% complete and non-critical path activities are 15% complete. The following major accomplishments occurred within the period:

- Application of permits for the Turbine Generator work and the degassing of the Unit 3 generator were completed.
- Steam Generator layup skids were commissioned as scheduled in August 2020.
- Turbine Hall Lunch Trailer was completed and declared available for occupancy.
- The pre-requisite portion of the Unit Power Electrical Distribution System project was completed on September 30, 2020.
- The Unit 3 work program continues with key work including:
    - Unit 3 Weather Enclosure
    - Temporary Power Distribution System
    - Re-tube Control Centre Internals
    - Radiation Protection Instrument and Dosimetry Centre
    - Full commissioning of the Remaining Units refurbishment Breathing Air System
- Defueling of the Unit 3 reactor commenced on September 3, 2020 and was completed on November 28, 2020, ahead of schedule.
- The installation of Accessibility Platform Trolley and End Fitting Seal Caps began immediately after defuel and was completed on December 4, 2020, ahead of schedule.
- Critical path work is progressing through the installation of bulkheads, which started on December 4, 2020.

LABOUR RELATIONS ISSUES SUMMARY

There have been no labour relations impacts on the Program to date and OPG is proactively taking steps to mitigate any risks of future issues.

ENVIRONMENTAL ISSUES SUMMARY

In 2020, the Program continues to have excellent environmental performance with no reportable spills or infractions. Emissions are better than target and well below regulatory limits.

TESTING, START-UP AND COMMISSIONING

RETURN-TO-SERVICE

All 58 out of 58 systems on Unit 2 were declared available for service on May 12, 2020. Unit 2 was returned to service on June 4, 2020.

PROGRAM RISKS AND RISK MANAGEMENT

OPG uses a robust risk management process where risks are identified, classified, quantified and mitigated, to the extent possible. Global experience dictates that there will be uncertainties that cannot be entirely mitigated or avoided on a project of this size. As such, OPG maintains a detailed inventory of risks and contingency amounts in accordance with the recommended practices of the Association for the Advancement of Cost Engineering, a leading authority in the area of project cost estimation. These contingency amounts are expected to be used over the course of the Program.

The following three major risks are being managed by OPG:

1. **Availability of Skilled Craft Resources for the Remaining Units:** Given the increased trades demand resulting from concurrent projects at OPG, Bruce Power, and across Canada, there is a risk to ensuring sufficient skilled trades resources to execute the Program. OPG identified this risk early in the Program and has taken mitigating actions, which are tracked and regularly reported to senior management and OPG's Board of Directors.

   OPG continues to address gaps in the availability of skilled trades through continued collaboration with Bruce Power, relevant unions, other construction industry associations, educational institutions, and other stakeholders in order to help mitigate potential impacts to the Program. Examples include:

   (a) Collaboration between OPG, Bruce Power, contractors and trade unions to develop enhanced skilled trades' supply and demand data.

   (b) Initiatives to build capacity within the current supply of trades by:

   - Streamlining processes at both OPG and Bruce Power, including coordinated security processing.
   - Implementing job ready dispatch training that will allow for shared qualifications between OPG and Bruce Power.
   - Developing a hybrid shift schedule to attract and retain the right resources and implement a sustainable schedule for the duration of the Program.

   (c) Building up new sources of supply through:

   - Partnership with the OPG Indigenous Opportunities in Nuclear representatives and local indigenous employment offices focusing on ways to increase the level of interest of indigenous peoples in the trades.
   - Implementation of the Electrical Power Sector Resourcing Council to allow the hiring and movement of boilermaker Temporary Foreign Workers working in the nuclear industry (OPG and Bruce Power).
   - Establishing a boilermaker pre-apprentice program with Durham College in 2019 which saw the hiring of 100 new Boilermakers apprentices who can be referred for employment at OPG and Bruce Power.
   - Implementing a Boilermaker Helper program that will employ approximately 100 temporary Boilermaker "Helpers" for U3 that will perform work on the feeder removal series (thereby mitigating radiation dose for skilled craft that can be used later in the project).

2. **Vendor Performance:** There is a risk of a limitation of vendor resources and their capability to meet contractual obligations. OPG is mitigating this risk by ensuring vendors have a management organization with strategies, such as succession planning, to successfully execute their scope of work

regardless of internal or external changes over the life of the Program. Bi-weekly succession planning meetings are held with OPG and CanAtom.

3. **Disruption of Refurbishment Program due to COVID-19 Pandemic:** To help manage the COVID-19 risk, a number of mitigating actions are in place including:
   (a) Activation of OPG's business continuity plan and crisis management communication centre to manage the response, including the development of detailed plans to mitigate impact of any potential disruption.
   (b) Active COVID-19 daily screening.
   (c) In conjunction with the Government of Ontario, on November 25, 2020, implementation of an eight-week pilot for both OPG and vendor contract workers of the Abbott Panbio rapid antigen test as a means to screen for asymptomatic workers.

OPG is continuously monitoring the ongoing COVID-19 pandemic to determine whether the mitigation measures in place are appropriate or if adjustments are needed.

STAFFING

REFURBISHMENT RESOURCES

Table 7 provides a summary of the OPG Resources on the Program:

Table 7 – Full Time Equivalent (FTE) Resources by Year (plan vs. actual)				
Measure	**2017**	**2018**	**2019**	**2020**
Planned at RQE	740	752	758	747
Actual	779	869	854	697[1]

Note:
1 Actual FTEs for 2020 are as of September YTD.

EFFORTS TO FILL OPEN POSITIONS

OPG has a number of Talent Management programs in place to attract, retain and develop qualified personnel across the company, including for the duration of the Program. Management will continue to leverage industry best practices and utilize enterprise-wide talent and succession planning processes. This helps to ensure that employees continue to develop and improve in their current role and/or are prepared to be successful in a future role for which they have been identified as a potential succession candidate, ensuring capability is sustained throughout the Program.

OPG's Enterprise Projects Management Organization is focused on implementing a standardized and scalable project delivery model throughout the enterprise. This organization has developed a training program specifically designed to advance project management capability across the organization.