December 21, 2019

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.

Yours truly,

[Original signed by]

Matt Kirk

Att.

cc: Cathy Nguyen, OEB
Stephanie Chan, OEB

FILED DECEMBER 21, 2019

Darlington Refurbishment Program Annual Report

2019 REPORT

AS PER DECISION AND ORDER IN EB-2016-0152

TABLE OF CONTENTS

INTRODUCTION **2**
EXECUTIVE SUMMARY 2
DARLINGTON REFURBISHMENT THRU UNIT 2 STATUS **3**
OVERVIEW 3
PROGRESS 3
SAFETY 4
Performance Metrics Summary 4
Campaigns, Programs And Initiatives 5
RADIOLOGICAL SAFETY 5
Performance Metrics Summary 6
QUALITY 6
SCHEDULE 6
Performance Metrics Summary 7
COST 8
Performance Metrics Summary 8
ENGINEERING 10
PROCUREMENT 11
Procurement Status For Unit 3 11
CONSTRUCTION 11
Construction Progress Summary 11
Labour Relations Issues Summary 11
Environmental Issues Summary 11
TESTING, START-UP AND COMMISSIONING 11
Return-To-Service 11
RTS Risks For Unit 2 12
PROGRAM RISKS AND RISK MANAGEMENT 12
STAFFING 13
Refurbishment Resources 13
Efforts To Fill Open Positions 13

ONTARIO POWER GENERATION

OPG Confidential Exclusive

FOR INFORMATION to the Ontario Energy Board

December 21st, 2019

DARLINGTON REFURBISHMENT PROGRAM

INTRODUCTION

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

Unless otherwise noted, this report includes a summary and a review of the Program performance through September 30th, 2019.

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 RQE, the refurbishment of the first unit (Unit 2) was to start in the fall of 2016 and be returned-to-service in the first quarter of 2020, with the last unit scheduled to be completed by 2026. The RQE formed the basis of OPG's May 2016 pre-filed evidence in EB-2016-0152. Since the development of the RQE in November 2015, OPG continued detailed planning and preparations for execution of Unit 2 and established a Unit 2 Execution Estimate (U2EE). This estimate was approved by OPG's Board of Directors in August 2016 and has been used to establish Unit 2 project baselines for cost and schedule monitoring. Details of the U2EE were provided in EB-2016-0152, Exhibit L, Tab 4.3, Schedule 1, Staff-055. Detailed planning associated with U2EE confirmed that the overall program and associated contingencies were within the $12.8 billion RQE, but resulted in a $89 million increase specific to program costs for Unit 2 and the Early In-service Work and Campus Plan projects. 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 U2EE.

OPG commenced the refurbishment of Unit 2 in October 2016. The refurbishment of Unit 2 was divided into segments of work that focus on the various stages that Unit 2 must go through prior to returning to service. The first segment, which included the de-fuelling of the reactor and the physical separation of Unit 2 from the three operating units, was completed in the first half of 2017 in accordance with the original High Confidence Schedule. The second major segment, which included the disassembly and removal of the existing reactor components, was completed in May 2018 in accordance with the original High Confidence Schedule. The third major segment involving the installation and reassembly of reactor components was completed in October 2019.

Unit 2 is now scheduled to be returned-to-service in the second quarter of 2020 because of challenges associated with the third major segment.

[1] EB-2016-0152, Decisions with Reasons, dated December 28th, 2018, p.44, Table 16.

Unit 2 is currently in the fourth major segment; fuel load and restoring systems in order to bring the unit back online. As of November 5th, 2019, 40 of 58 systems have been returned-to-service.

Preparations for the refurbishment of Unit 3 have been progressing well. Thousands of lessons learned from the refurbishment of Unit 2 have been applied during the planning stage of Unit 3. These lessons have helped to streamline and improve planning for cost and schedule performance in preparation for the execution phase. Design and engineering are 90% complete. Comprehensive Work Packages continue to progress as planned and long lead material procurement is on track with no risks to execution. All pre-requisite projects are currently on track for completion in advance of their need dates.

DARLINGTON REFURBISHMENT THRU UNIT 2 STATUS

OVERVIEW

Key Program highlights include:

- SAFETY: Safety performance continues to be almost 10 times better than the average construction industry performance in Ontario. The Program has worked 19.8 Million hours since October 2016 and has incurred only one Lost Time Injury.[2]
- QUALITY: The Program's quality performance remains good overall. There were 3 high level quality events on Unit 2 refurbishment that impacted the High Confidence Schedule. All quality events have been resolved.
- SCHEDULE: Execution of the Unit 2 refurbishment is currently 89% complete and the work not associated with critical path is 96% complete. The Return-to-Service (RTS) date has moved from Q1 2020 to Q2 2020.
- COST: Life-to-date (LTD) Unit 2 and Early In-Service and Campus Plan projects (excluding the Heavy Water Storage Facility (HWSF)) costs are $5.4 billion. While Unit 2 and Early In-Service and Campus Plan projects are forecasting to be $137 million over the OEB-approved amounts, Unit 2 is forecasting to be completed on budget relative to U2EE. The overall Program, including Unit 2, remains within the $12.8 billion RQE budget. A detailed explanation for the $137 million variance is set out in the Cost section below.

PROGRESS

The following is a status summary as of September 30th, 2019, of the major work completed since the last report to the OEB in December 2018:

- Reactor assembly is nearly complete – installation of new Fuel Channels, Feeders, and Reactivity Mechanisms is complete.
- Turbine Generator (TG) overhaul is complete.
- Steam Generator work is complete and the Condensate System is in-service.
- Service Water and Electrical Systems are complete and in-service.
- RTS

  Work on the Moderator and End Shield Cooling Systems is complete and the systems have been filled and returned to service.

[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.

- Facilities & Infrastructure Projects (F&IP) and Safety Improvement Opportunities (SIO).

  All F&IP and SIO projects were placed in service with the exception of the HWSF. The Shield Tank Overpressure Protection (STOP) installation was completed on Unit 2 in Q2 2019.

- Integrated Implementation Plan (IIP).

  Annual IIP tasks are commitments to the Canadian Nuclear Safety Committee (CNSC). All 50 tasks committed for 2018 were completed by December 13th, 2018. Eighty-five of the 99 IIP tasks committed for 2019 were completed and the remaining 14 are tied to the RTS schedule with the appropriate approvals in progress.

SAFETY

Safety is a priority for OPG. Due to 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 2019, the Program reported a Total Recordable Injury Frequency (TRIF) of 0.49 against its internal target of 0.37 as a result of two medically treated injuries. The TRIF rate has been progressively improving throughout 2019 due to ongoing safety initiatives that target and mitigate negative safety trends. Despite the Program work being executed by contractors and trades in a very complex construction environment, OPG purposefully set the same challenging targets for the Program as for its operations and expects the same level of performance from the Program. This expectation has resulted in a Program safety performance that is almost 10 times better than the overall construction industry average as illustrated in Table 1.

After 3,426 days and 15.5 million hours worked, the Program incurred its first Lost Time Injury (LTI) in May 2019 on Unit 2 involving a worker who tripped.

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			2019		
Category	**Measure**	**2016**	**2017**	**2018**	**Sep YTD[2]**	**OPG Target[3]**	**Ontario Construction Industry[4]**
Safety	Total Recordable Injury Frequency (per 200k hours)[1]	0.64	0.49	0.39	0.49	0.37	4.68
	Lost time Due to Injuries	0	0	0	1	0	N/A

Notes:
1 TRIF is the average number of fatalities, LTIs, medical treatment injuries and restricted work injuries per 200,000 hours worked.
2 Year-to-Date (YTD)
3 OPG sets very challenging targets for its operations and expects the same level of performance from the Program.
4 This rating is the most current safety rating for the Ontario Construction Industry.

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

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 contractor partners launched in 2019:

- **Implementation of Cut Resistant Liners in Containment (January 2019)**

  After observing a trend related to cuts and punctures through radiation personal protective equipment inside the Unit 2 vault, Conventional Safety and OPG Refurbishment Maintenance explored and implemented new and improved gloves to replace cotton liners in order to reduce the injury frequency. Cut resistant liners are now available to staff.

- **2019 Heat Stress Campaign (April 2019)**

  The primary purpose of this campaign was to build upon previous campaigns to further increase worker awareness and ensure workers in the field could recognize signs and symptoms of heat stress.

- **RTS Self-Assessment & Subsequent Actions (May 2019)**

  An RTS Self-Assessment was completed by Conventional Safety and focused on all initial work tasks associated with returning Unit 2 back to service. The goal of the self-assessment was to evaluate any conventional safety hazards and/or areas of concern in order to provide accompanying recommendations and/or actions. The self-assessment was completed in May 2019 and all actions are complete with ongoing checks and communications until U2 RTS is complete.

- **Falling/Dropped Objects Corporate Initiative (May 2019)**

  In late 2018 and early 2019, there was an increased number of dropped object events across OPG. Additional barriers, including the use of tool tethers and a revised falling objects control checklist were rolled out in the Program in order to reduce the likelihood of dropped object events. The Program is considering the installation of alternative debris netting.

- **Safety Stand-down (May 2019)**

  A stand-down was initiated on May 20th, 2019 following a series of safety incidents. All trade staff were sent home for a 24 hour period and an action plan was developed with a focus on increased Supervisor oversight in the field and safety communications. Since the stand-down, the Program has seen a significant improvement to the reinforcement of safety behaviours.

- **Working at Heights (August 2019)**

  A Working at Heights Self-Assessment was completed by Conventional Safety in order to identify the safe work planning process and any potential deficiencies involved with working at heights inside the Unit 2 vault.

RADIOLOGICAL SAFETY

OPG's Radiological Protection (RP) program meets regulatory requirements and industry standards. The program is implemented across OPG's fleet, including in the Program. 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) RP program. Additionally, many improvements have been made in the course of the refurbishment of Unit 2, allowing many lessons learned to be applied to the planning of the remaining units.

The Collective Radiological Exposure (CRE) actual at the end of 2018 was marginally above target due to the longer durations in the vault required to complete Upper Feeder and Fuel Channel installations. All

other metrics are at or better than target. The 2019 performance also is above target and is again attributable to longer durations in the vault related to the feeder program extension. The Refurb ALARA committee is monitoring and challenging RP performance to ensure ALARA principles continue to apply with the objective of reducing dose 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						
	2017 Year End		2018 Year End		2019 End of Q3	
	Actual	Target	Actual	Target	Actual	Target
CRE (person-rem)[1]	1144	1383	784	770	434	413
Unplanned Exposures	0	0	0	0	0	0

Note 1 A lower number represents a lower amount of radiological exposure.

QUALITY

The refurbishment of Unit 2 involved many thousands of removal and installation activities which were required to be executed with a high degree of precision. Many of the installation activities involved 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. Given the number of tasks, Unit 2's Quality performance has been good overall.

As of September 30th, there have been 5 Significant Quality Events. The most significant impact to the project is attributed to a higher than planned weld rework rate during the installation of Lower Feeders. All issues were resolved and lessons learned from these issues were incorporated into planning for the remaining units.

SCHEDULE

OPG measures Program progress against two schedules:

1. A High Confidence Schedule; and
2. A shorter "Working Schedule" that excludes contingency.

The difference between these two schedules is that the High Confidence Schedule includes additional contingency amounts that were quantified based on detailed analysis of risks. 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 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.

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

PERFORMANCE METRICS SUMMARY

As a result of the challenges encountered on the Feeder installation series, the remaining schedule for Unit 2 was reassessed. This assessment indicated a potential 4 month extension to schedule in returning Unit 2 to full power, therefore the High Confidence date for completion of Unit 2 was revised from Q1 2020 to Q2 2020.

Lessons learned from Unit 2 are being applied to the planning of the remaining units to enable unit-over-unit efficiencies. Many challenges faced on the Unit 2 refurbishment, such as the dissimilar metal welds and FME issues have been resolved, and improvements to tooling have been made, all of which are expected to lead to significant execution improvements for the remaining units.

Table 3 provides a summary of the Unit 2 schedule performance as of September 30th, 2019 relative to the Original Working Schedule.

Table 3 – Schedule Performance Metrics

Measure	2016 Year End Actual	2017 Year End Actual	2018 Q3 Actual	2019 Q3 Actual	Working Schedule Target
Days Ahead of / Behind High Confidence Schedule LTD [1]	28 Days Ahead	10 Days Ahead	33 Days Ahead	72 Days Behind	N/A
Critical Path Days Ahead of / Behind[3] Working Schedule LTD	19 Days Ahead	47 Days Behind	50 Days Behind	206 Days Behind	19-Sep-2019
SPI [2]	0.97	0.94	0.92	0.89	1.00
Early Forecast Completion Date [3]	31-Aug-2019	5-Nov-2019	8-Nov-2019	20-May-2020	N/A

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.

Table 4 provides a summary of the key Program milestones and the actual and forecast completion against the original planned completion and the revised High Confidence Schedule.

Table 4 – Key Unit 2 Milestone Status			
Key Milestone	**Original Planned Completion**	**Revised High Confidence Schedule**	**Actual/ *Forecast***
Segment 1 [Defuel] Complete	April 27th, 2017	N/A	April 9th, 2017
Segment 2 [Removal] Complete	June 2nd, 2018	N/A	May 5th, 2018
Segment 3 [Install] Complete	August 7th, 2019	December 22nd, 2019	*December 22nd, 2019*
Segment 4 [Lead Out / RTS] Complete	February 27th, 2020	June 25th, 2020	*June 25th, 2020*

COST

PERFORMANCE METRICS SUMMARY

Total Program costs are currently $6.5 billion LTD. The forecast total cost at completion for Unit 2 including all Early In-Service and Campus Plan projects, but excluding the HWSF, is expected to be $5.7 billion, which is $137 million above the amounts approved by the OEB. The overall Program continues to forecast on plan at $12.8 billion.

Following the approval of the RQE in 2015, OPG continued detailed planning and preparations for execution of Unit 2 and established the U2EE as part of its phase gate planning process. 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 Early In-service work and Campus Plan projects. This estimate, approved by OPG's Board of Directors, established the detailed cost and schedule baselines by which Unit 2 performance would be monitored.

Relative to U2EE, Unit 2 expenditures as of September 30th, 2019 are $3.2 billion and forecast to be on target to achieve the U2EE estimate of $3.4 billion at completion.

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 $137 million variance to OEB-approved amounts is attributed to:

- $89 million difference between RQE and U2EE for planned increases to Unit 2, Early In-service work, and Campus Plan projects, and
- $48 million variance above U2EE for the Early In-Service and Campus Plan projects.

As of the time of the last report, OPG was forecasting to be within the OEB-approved amounts on the basis that the Unit 2 unused contingency would be sufficient to cover the cost variances experienced on the Campus Plan projects. As a result of the challenges encountered on the Feeder installation series for Unit 2, a portion of the unused contingency was allocated to the Feeder series, which left the remaining contingency being less than the Campus Plan projects' cost variances.

Similar to SPI, Cost Performance Index (CPI) is measured against the budget that excludes contingency. The CPI for Unit 2 is 0.84.

Table 5 provides a summary of the key Program cost performance.

Table 5 – Cost Performance Metrics for Thru Unit 2 [1]			
CPI	**LTD Q3 2019 Actual Cost**	**Current Estimate to Complete**	**Current Estimate at Completion**
0.84	$5.4 Billion	$0.3 Billion	$5.7 Billion

Note
1 Program expenditures include Capital and Operations, Maintenance and Administration (OM&A) costs consistent with OEB-approved amounts.

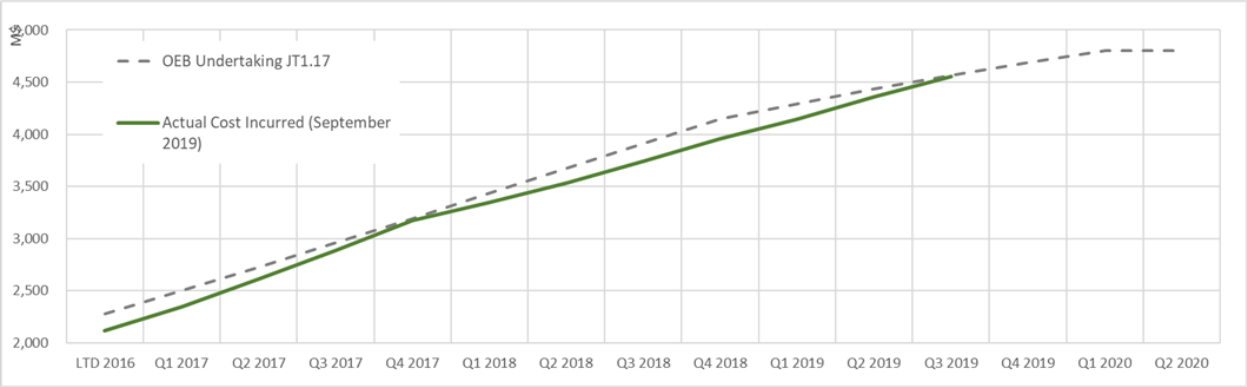
In its December 28th, 2017 Decision and Order in EB-2016-0152, the OEB included Actual Versus Forecast Cumulative Capital Costs as part of OPG's annual reporting requirements. This requirement was further defined in JT1.17C in the same proceeding as quarterly cost flows for the Unit 2 in-service amount of $4.8 billion approved by the OEB (excludes early in-service and pre-requisite projects that are included in **Table 5** above). **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[1]		
M$	**OEB Undertaking JT 1.17C (Forecast)**	**Actual Cost Incurred**
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	
Q1 2020	4,800	
Q2 2020	N/A	
Total	4,800	

Note
1 Capital costs include Unit 2, Unit 0 and Definition Phase.

Figure 1 – Actual vs. Cumulative Capital Cost Curve



ENGINEERING

Aggregate earned value for engineering is 99% complete for Unit 2. This figure includes both contractor and OPG engineering work that is being performed for the Program.

All planned engineering work is complete for Unit 2 and the majority of engineering requirements through execution are complete. Field engineering activities continue as planned to ensure issues are resolved as they emerge and designs are modified in field as required.

Design engineering for Unit 3 is 90% complete and is on track to be substantially complete by end of 2019. Lessons learned from Unit 2 are being incorporated into subsequent designs as appropriate.

Major engineering accomplishments in the period include:

- The "System Available for Service" process has been used to successfully return systems to service in Unit 2. As of November 5th, 2019, 40 systems have been returned to service. Training for staff involved in restart activities is continuing.
- The construction/field engineering group continues to successfully focus on improving processes and enabling the timely response to field initiated changes.
- The Re-tube & Feeder Replacement (RFR) Engineering OneTeam was formed between OPG and CanAtom and has led to improved collaboration and effectiveness between the engineering functions. Based on the RFR Engineering OneTeam success, this model is being extended to other significant project bundles such as TG for the remaining units.
- All safety analyses required to support unit restart and operation at high power have been submitted to the CNSC.
- Lessons learned from previous work continue to be captured and applied to future work. The Unit 3 Vault Vapour Recovery System modification was installed in Q2 2019 with significant savings compared to Unit 2, based on incorporation of lessons learned.

In addition, the following First-of-a-Kind projects are being monitored closely:

- Shutdown Cooling System enhancements involving the addition of two new auxiliary shutdown cooling pumps. The project has recently completed the field installation phase and is moving into the commissioning phase.
- Modifications to the Emergency Service Water system, which provides an emergency supply of water in a beyond design basis event of a main steam line break. The project is currently in the latter stages of the installation phase and is scheduled to be completed prior to the return-to-service of Unit 2.

PROCUREMENT

PROCUREMENT STATUS FOR UNIT 3

At the end of Q3 2019, 99% of Purchase Orders have been issued and 71% of all the requested materials for Unit 3 refurbishment were on site, with delivery of the remaining material items on track.

CONSTRUCTION

CONSTRUCTION PROGRESS SUMMARY

The execution of Unit 2 is currently 89% complete and non-critical path activities are 96% complete. The following major accomplishments occurred within the period:

- The RFR Installation series is complete following the installation of Fuel Channels and Feeders, and loading of the fuel. Challenges with welding, tooling and human performance at the beginning of the Feeder series had a cascading effect throughout the series and impacted the RTS Schedule. The issues were resolved and lessons learned are being applied to the planning of the remaining units. The final installation work required for the RFR series is Lower Body Tubing.
- The TG Overhaul project had challenges with the final coupling vacuum testing of the Generator resulting in the TG activities being placed on hold until repairs could be performed. Following the repairs and clean-up, the coupling vacuum test was completed successfully on April 9th, 2019.
- The Auxiliary Shutdown Cooling breaker construction was completed on July 29th, 2019.
- Fourteen obsolete computers were replaced to improve the performance of the Unit 2 shutdown system.
- The STOP project was completed on all four Units. This SIO initiative was the last of five SIOs intended to significantly improve the current plant mitigation capabilities to cope with the unlikely event of a multi-unit severe accident. The STOP project added an additional safety component to prevent over pressurization of the shield tanks.

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 2019, the Program continues to have no reportable spills or infractions. Emissions are better than target and well below all regulatory limits.

TESTING, START-UP AND COMMISSIONING

RETURN-TO-SERVICE

Preparation activities for the restart of Unit 2 are continuing and, as of November 5th, 2019, 40 of 58 systems have been returned-to-service. Over the period, the following RTS focus areas were identified:

- completion of risk challenge process for all key evolutions and integrating the results into key evolution plans;
- returning systems to service to support the Restart Control Hold Points (RCHP);
- working with contract partners on documentation submissions required to support the start-up of Unit 2; and
- finalizing station integration plans to ensure resources, plans and procedures are in place to support the successful start of Unit 2.

The RTS process is highly complex and involves eight planned RCHPs, addressing regulatory and non-regulatory checks. The first RCHP was achieved with the moderator system being filled with heavy water. This milestone was achieved event free and with zero leaks. The second RCHP for New Fuel Load was achieved on November 3rd followed by the CNSC's approval to proceed with loading fuel into the reactor on November 5th, ahead of the need date. The next scheduled RCHP will be the Primary Heat Transport (PHT) System Fill. As Unit 2 refurbishment moves through the six remaining RCHP's, stringent measures are in place to ensure safety and quality are maintained at all times and each system is subjected to rigorous checks and testing prior to being returned-to-service.

The RTS program was extensively reviewed by both internal and external organizations in 2019 to assess and confirm the Program's readiness to return Unit 2 to service. OPG has incorporated opportunities for improvement identified by these assessments.

RTS RISKS FOR UNIT 2

The revised High Confidence schedule includes contingency days to address remaining risks and to ensure all work continues to be performed safely and with quality.

PROGRAM RISKS AND RISK MANAGEMENT

OPG uses a robust risk management process where risks are identified, classified, quantified and mitigated to the extent possible. In a project of this size and scope, global experience dictates that there will be uncertainties that cannot be entirely mitigated or avoided. 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 actively being managed by OPG:

1. **AVAILABILITY OF SKILLED CRAFT RESOURCES / SUPERVISION FOR THE REMAINING UNITS**

   Shortage of skilled trades is a risk for 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. In particular, OPG is continuing its collaboration with Bruce Power, relevant unions, educational institutions and other stakeholders to minimize potential cost and disruptions to the Program. This collaboration involves four streams to mitigate the risk of skilled trades' availability as outlined below:

   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 and training, as well as the development of a hybrid shift schedule designed to attract and retain the right resources and implement a sustainable schedule for the duration of the project;
   c) meetings held with OPG Indigenous Opportunities in Nuclear (ION) representatives and local indigenous employment offices focusing on ways to increase the level of interest of indigenous peoples in the trades; and
   d) establishing a boilermaker pre-apprentice program with Durham College.

2. TIMELY RENEWAL OF COLLECTIVE AGREEMENTS FOR UNIONIZED CONSTRUCTION TRADES

The collective agreements risk relates to the 19 Building Trade Unions. The Building Trade Union agreements are set to expire on April 30th, 2020 for all Collective Agreements both directly with OPG and through the Electrical Power Systems Construction Association. Early collective bargaining has commenced with one collective agreement having been reached with the Boilermakers thus far. The Nuclear Projects Agreements (NPA) expire December 31st, 2032 and helps mitigate Building Trade Union labour disruption risks throughout the life of the Program. The NPAs are an appendix to the current collective agreements and will be included in each renewal collective agreement occurring during the term of the NPA. Exceptions include the Operating Engineers, Canadian Union of Skilled Workers and the Labourers who either failed to agree to an NPA or maintain exit clauses.

Collective Agreements with the Power Workers Union (PWU) and the Society of United Professionals (Society) are typically effective for two to three years. The current Society collective agreement is set to expire on December 31st, 2019. A new collective agreement effective from January 1st, 2020 through December 31st, 2021 was awarded through interest arbitration on November 6th, 2019. The current PWU collective agreement was awarded through interest arbitration on April 3rd, 2019 and remains in effect from April 1st, 2018 until March 31st, 2021.

3. MANAGING THE COMMERCIAL IMPACT OF CONTRACTORS

OPG's Commercial Management is continually monitoring its contractors and their performance given the limited number of qualified vendors and substantial work in the industry. OPG is working collaboratively with Bruce Power to ensure adequate availability of reactor components for both the Program and Bruce Power's major component replacement project.

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[1]	779[2]	869[2]	853	N/A

Note

1 Actual FTEs for 2019 are as of September YTD.
2 2017 and 2018 FTE numbers are being restated as they were incorrectly reported in the 2018 report.

EFFORTS TO FILL OPEN POSITIONS

OPG has a number of programs in place to attract, retain and develop qualified personnel for the Program. Management continues to use corporate-wide succession planning and talent review processes to identify and prepare future leaders to assume key roles over the life of the Program.

OPG's Enterprise Projects 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. In addition, OPG's succession planning program and mentoring initiatives are designed to ensure that capability is sustained throughout the Program. The Program has been successful in filling positions.