

1 **DARLINGTON REFURBISHMENT PROGRAM**
2 **OVERVIEW**

3
4 **1.0 OVERVIEW**

5 The Darlington Refurbishment Program (“DRP”) is a multi-year, multi-phase mega-project that
6 will enable the Darlington Nuclear Generating Station (“Darlington”) to continue safe and
7 reliable operation until approximately 2055. The DRP includes the replacement of life-limiting
8 critical components, the completion of upgrades to meet applicable regulatory requirements,
9 and the rehabilitation of components at Darlington’s four units. The DRP is comprised of
10 individual projects of various scales and sizes that are being executed during multi-year
11 outages on each of the four units. The DRP began in 2007 and is being completed in three
12 phases: Initiation (2007-2009), Definition (2010-2015), and Execution (2016-2026). The first
13 three units to undergo refurbishment have been successfully returned to service.

14
15 OPG is now nearing the end of this mega project, with the last unit currently expected to return
16 to service during this proceeding, on time, on budget, safely and with quality. Post-
17 refurbishment, all units have performed well and are delivering to their planned production
18 targets with no major issues as a result of work completed in refurbishment.

19
20 OPG is currently forecasting the final cost of the DRP to be \$12.7B, which is approximately
21 (-\$100M) under the Release Quality Estimate (“RQE”) budget, the baseline against which the
22 cost of the program is measured. In addition to being on track to deliver the DRP’s scope within
23 the \$12.8B budget, OPG has successfully managed the program and pursued cost efficiencies
24 in the execution of the DRP, allowing it to offset the incremental costs associated with the black
25 swan¹ COVID-19 pandemic. As a result, the DRP has remained within budget, and the
26 Application is not seeking incremental recovery of costs due to the COVID-19 pandemic.

¹ A "black swan event" refers to a highly improbable, unpredictable, and impactful occurrence that comes as a surprise, often with significant negative consequences.

1 The settlement proposal approved by the OEB in the EB-2020-0290 Decision and Order states:

2
3 The Parties agree that forecasted nuclear capital expenditures
4 and financial commitments and in-service additions for the DRP
5 are reasonable and appropriate and form part of the settled
6 forecast rate base for the 2022-2026 period on the basis that
7 they remain within the total \$12.8B project budget first set out in
8 EB-2016-0152. The OEB will review the prudence of any
9 amounts sought by OPG in excess of the \$12.8B total, the
10 appropriateness of any future material changes to the scope of
11 the DRP and any corresponding changes in contracts, when
12 OPG seeks disposition of the actual DRP costs through the
13 Capacity Refurbishment Variance Account.²
14

15 OPG expects that the last unit, Unit 4, will be returned to service by April 2026, ahead of the
16 High Confidence Schedule approved in EB-2020-0290.³ There have been no material changes
17 to the scope of the DRP and, as noted, OPG expects the final costs of the DRP to be within
18 the approved \$12.8B budget. The total expenditures over the life of the DRP, including amounts
19 budgeted for 2025 and 2026, are summarized in Ex. D2-2-3, Table 1a.

20
21 Also, in EB-2020-0290, the OEB conducted a prudence review of the Heavy Water Storage
22 and Drum Handling Facility (“D2O Storage Project”) that formed part of the DRP. In its Decision
23 and Order, the OEB approved 2020-2026 in-service additions of \$381M,⁴ which factors in a
24 permanent rate base disallowance of \$113.7M to the total cost that OPG proposed to add to
25 rate base for the D2O Storage Project.⁵ OPG is not seeking cost recovery for any additional
26 amounts related to the D2O Storage Project in this application. The full \$509.3M cost of the
27 project continues to be considered in the assessment of OPG’s DRP performance against the
28 \$12.8B budget.

² OEB Decision and Order, EB-2020-0290, November 15, 2021, p. 86.

³ The High Confidence Schedule for the refurbishment outage of a Darlington unit refers to the schedule OPG utilizes as the basis of its public commitments to stakeholders, including the Government of Ontario, the Independent Electricity System Operator, the OEB and others. This schedule includes contingency amounts quantified based on a detailed analysis of risks. OPG also utilizes another shorter schedule, known as the Working Schedule, for day-to-day management of the refurbishment outages and for measuring performance on the outages, allowing for early escalation of issues.

⁴ In-service additions included in Ex. B3-3-1, Table 1, line 3.

⁵ OEB Decision and Order, EB-2020-0290, November 15, 2021, p. 2.

1 Over the life of the DRP, there have been variances in the amount and timing of capital and
2 non-capital expenditures and capital in-service amounts from those forecasts reflected in the
3 OEB-approved nuclear revenue requirements. The revenue requirement impacts of such
4 variances are recorded in the Capacity Refurbishment Variance Account (“CRVA”) pursuant to
5 Ontario Regulation 53/05. With the exception of certain amounts dispositioned in EB-2020-
6 0290 and EB-2023-0336, these impacts have been accumulating in the account since 2016.⁶
7 As DRP is now near completion, the Application seeks disposition of all such variances
8 recorded in the account as of December 31, 2024, for a net recoverable amount of \$170.2M.
9 In doing so, OPG commits, based on the current forecast, not to seek recovery in any future
10 application of any unlikely final costs of the DRP that exceed the \$12.8B budget. For details
11 on the DRP related balances recorded in the CRVA as of December 31, 2024, as well as a
12 forecast of such entries for 2025 and 2026, refer to Ex. H1-1-1, Section 5.6.2.1 and Ex. H1-1-
13 1, Tables 15 and 16.

14
15 This evidence at Ex. D2-2-1 to Ex. D2-2-3 provides a summary of the DRP, confirms that there
16 have been no material changes to the scope of the DRP, and provides the details to support
17 the forecasted final cost of the DRP at \$12.7B.

18 19 **2.0 PROGRAM SUMMARY**

20 In the EB-2016-0152 application, OPG provided evidence that it had completed the Definition
21 Phase of the DRP, all major contracts required to execute the scope of the DRP had been
22 awarded, and the detailed planning conducted by OPG and its contractors had enabled the
23 development of a four-unit budget and schedule for the successful execution of the DRP,
24 known as the RQE. The RQE was finalized in November 2015 and established a four-unit,
25 program-level control budget of \$12.8B that serves as the baseline against which the success

⁶ In EB-2020-0290, the OEB-approved settlement proposal provided for clearance of the impact of accelerated investment incentive property rules on DRP-related Capital Cost Allowance amounts, and the OEB’s Decision and Order regarding the D2O Storage Project resulted in an adjustment to amounts previously recorded in the account. In EB-2023-0336, the OEB-approved settlement proposal provided for clearance of the amounts recorded in the account for the D2O Storage Project as adjusted by the OEB’s Decision and Order in EB-2020-0290.

1 of the DRP is being measured.⁷ The RQE was the basis upon which OPG's Board of Directors
2 granted approval to proceed from the Definition Phase to the Execution Phase of the DRP in
3 November 2015, the basis of the Province's announced endorsement of the DRP on
4 January 11, 2016 and the basis of OPG's pre-filed evidence on the total expected cost of the
5 DRP in EB-2016-0152.⁸

6
7 Subsequent to the RQE, and prior to the start of the Unit 2 refurbishment outage, as planned,
8 OPG completed a more refined estimate of the cost and schedule for refurbishing Unit 2 and
9 a corresponding update to the DRP budget and schedule, known as the Unit 2 Execution
10 Estimate ("U2EE"), in August 2016. The U2EE was the basis upon which OPG's Board of
11 Directors granted approval to proceed with the execution of the Unit 2 refurbishment outage.
12 The U2EE maintained the four-unit, program-level control budget of \$12.8B.⁹ OPG did not
13 update its revenue requirement in EB-2016-0152 to reflect the U2EE on the basis that the
14 CRVA would capture any revenue requirement impacts of changes to in-service dates and in-
15 service amounts between such OEB-approved and actual impacts. The OEB agreed with this
16 approach.¹⁰ The U2EE is the baseline against which OPG measured its performance during
17 the execution of the Unit 2 refurbishment.

18
19 In the EB-2016-0152 application, OPG provided evidence that it had established the
20 appropriate organization, project controls, change management and oversight to manage,
21 control, report on, and take corrective actions, as required, to be able to complete the DRP
22 safely, on budget, on schedule and with the required quality. OPG sought and received
23 approval from the OEB for in-service additions of \$4,800.2M related to Unit 2 (including the
24 Definition Phase) in 2020 and 2021, as well as \$377.2M related to Unit Refurbishment Early

⁷ The impact of the COVID-19 pandemic in 2020 on the cost and schedule for the DRP could not have been foreseen at the time of the RQE. OPG deferred the start date of the Unit 3 refurbishment in 2020 in response to the pandemic and correspondingly revised the refurbishment start dates for Units 1 and 4. See EB-2020-0290, Ex. D2-2-3 for more details.

⁸ Province of Ontario, News Release: Ontario Moving Forward with Nuclear Refurbishment at Darlington and Pursuing Continued Operations at Pickering to 2024, January 11, 2016 <<https://news.ontario.ca/en/release/35478/ontario-moving-forward-with-nuclear-refurbishment-at-darlington-and-pursuing-continued-operations-at.html>>.

⁹ EB-2016-0152, Ex. L-4.3-1 Staff-055.

¹⁰ Decision and Order, EB-2016-0152, December 28, 2017, p. 39.

1 In-Service Projects, Facilities & Infrastructure Projects (“F&IP”) and Safety Improvement
2 Opportunities (“SIO”), for a total of \$5,177.4M.¹¹ The \$377.2M in-service additions for Early In-
3 Service Projects, SIO and F&IP were distributed over 2016 (the bridge year in the EB-2016-
4 0152 application) to 2021.

5

6 In its Decision and Order for EB-2016-0152, the OEB stated the following:

7

8 The OEB finds that the planning undertaken by OPG for the DRP
9 was reasonable. The OEB notes that both experts agreed that
10 the planning for the DRP had been conducted according to
11 industry standards. The OEB finds that OPG has developed
12 reasonable project control systems to manage the cost and
13 schedule of the DRP. OPG also performed adequate risk
14 assessment for the project and put in place processes to
15 address risks as they arise.

16

17 The OEB also finds that the oversight structure that OPG has
18 designed to monitor the DRP appears appropriate. As previously
19 discussed, there are multiple layers of oversight with respect to
20 DRP that should allow OPG to react appropriately to potential
21 issues. The oversight for the project includes both internal and
22 external expertise and resources.¹²

23

24 In the EB-2020-0290 application, OPG provided evidence that it started refurbishment of Unit 2
25 as planned on October 15, 2016, and returned Unit 2 to service on June 4, 2020, just over
26 three months later than its committed schedule. Of note, the final two-and-a-half months of the
27 Unit 2 refurbishment outage were completed under the state of emergency declared in Ontario
28 on March 17, 2020 as a result of the COVID-19 pandemic. Over the 2016-2024 period, there

¹¹ Early-In-Service projects are those that provide benefit to the station prior to the return-to-service date of the nuclear unit under refurbishment. Examples include in-plant modifications which are of immediate benefit to multiple or all units.

F&IP are projects that do not involve the refurbishment of units but which are necessary to enable execution of the unit refurbishments and are expected to be useful to OPG’s current and future nuclear operations independent of the DRP. A number of the F&IP involve upgrades to Darlington site infrastructure to ensure it can effectively support continued operations for 30 or more years. To meet required in-service dates, OPG commenced the F&IP work early in the Definition Phase of the DRP.

SIO are initiatives which OPG committed to in the Environmental Assessment (“EA”) for the DRP, primarily to address beyond-design-basis or four-unit events. The need for this work was established through the EA, which was filed with the Canadian Nuclear Safety Commission. To meet required in-service dates, OPG commenced execution of SIO work early in the Definition Phase of the DRP.

¹² OEB Decision and Order, EB-2016-0152, December 28, 2017, p. 36.

1 was a +2.4% variance (+\$126.0M) in DRP in-service amounts relative to the OEB-approved
2 amounts for the period in EB-2016-0152 (\$5,177.4M).¹³ This variance was not reflected in the
3 opening rate base for EB-2020-0290, as OPG proposed to defer the clearance of any such
4 amounts to a future application to allow an assessment of the recoverability of any DRP-related
5 variances in the context of the overall performance of the complete four-unit refurbishment.
6 This approach is consistent with the DRP being a single mega-project as opposed to a
7 collection of smaller projects, and with the OEB-approved Settlement Proposal in EB-2020-
8 0290 as noted above.

9
10 For the subsequent Units 3, 1, and 4 (together, the “Subsequent Units”), OPG provided
11 evidence in EB-2020-0290 that it had performed the detailed planning that was necessary,
12 including the incorporation of lessons learned¹⁴ from Unit 2 and the implementation of strategic
13 improvements, to establish the High Confidence Schedule and cost estimates for completing
14 the refurbishment of the Subsequent Units and the overall DRP in 2026, safely and with quality.
15 OPG also provided evidence that it had the appropriate organization, project controls, change
16 management and oversight in place to manage, control, report on, and take corrective actions,
17 as required, to be able to complete the DRP safely, on budget, on schedule and with the
18 required quality.

19
20 OPG’s EB-2020-0290 evidence presented the final Unit 3 Execution Estimate (“U3EE”) that
21 included the schedule impacts of the COVID-19 pandemic, and was the baseline against which
22 OPG and its Board of Directors measured the Company’s performance during the execution
23 of the Unit 3 refurbishment.¹⁵ The U3EE served as the underlying basis for the in-service
24 amounts requested and approved in the EB-2020-0290 application. It maintained the four-unit,
25 program-level control budget of \$12.8B, excluding any impact of the COVID-19 pandemic. In
26 addition, the DRP schedule was reassessed as a result of the COVID-19 pandemic. The U3EE

¹³ A \$132.7M forecast variance was noted in EB-2020-0290, Ex. D2-2-1, p. 3; the change in the variance was due to the actualization of costs.

¹⁴ “Lessons Learned” refers to specific and detailed knowledge and experience gained during a process, project, or activity which, when applied to the same or similar processes, projects or activities in the future, results in improved performance. “Strategic Improvements” are new approaches and/or innovative methods for planning and executing the Subsequent Units’ refurbishments that are implemented in addition to Lessons Learned.

¹⁵ EB-2020-0290, Ex. D2-2-7, Attachment 1.

1 maintained the High Confidence Schedule durations for the Unit 3, Unit 1, and Unit 4
2 refurbishment outage, although the start dates for each Unit were deferred relative to the RQE,
3 due to the pandemic. The deferral of the Unit 3 refurbishment had a cascading impact on the
4 Subsequent Units' refurbishment start dates as no additional overlap was introduced during
5 the schedule reassessment.

6
7 Consistent with the U3EE, in EB-2020-0290, OPG sought and received approvals in respect
8 of the refurbishment of the Subsequent Units, comprising \$6,442.6M for in-service additions
9 to rate base and \$110.5M for OM&A expenditures over the 2022-2026 period. The approved
10 in-service additions comprised: (1) \$1.4M in 2023 for an Early In-Service Project associated
11 with Unit 1, (2) \$2,505.5M in 2024 which included \$2,504.0M for completion of the Unit 3 and
12 \$1.6M for an Early In-Service Project associated with Unit 4; (3) \$1,907.3M in 2025 on
13 completion of Unit 1; and, (4) \$2,028.3M in 2026 on completion of Unit 4.¹⁶

14
15 OPG did not seek approval of any COVID-19 pandemic-related costs in the EB-2020-0290
16 application. OPG elected to continue to monitor, assess and explore potential efficiencies
17 during the execution of the Subsequent Units' refurbishments with a view to complete the DRP,
18 inclusive of the COVID-19 cost impacts, within the \$12.8B budget established at the time of
19 the RQE, if possible. OPG indicated that any ultimate variance to the \$12.8B caused by the
20 COVID-19 pandemic would be tracked separately and addressed through the CRVA in a future
21 proceeding.

22
23 Since EB-2020-0290, OPG completed the refurbishment of Unit 3 by successfully returning it
24 to service on July 18, 2023. Compared to the final U3EE that underpinned the revenue
25 requirements approved in EB-2020-0290, the refurbishment of Unit 3 was completed within
26 budget, 169 days ahead of the High Confidence Schedule, with an in-service addition of
27 \$2,295M.

¹⁶ Decision and Order, EB-2020-0290, November 15, 2021, p. 87.

1 Consistent with the planning approach to the Unit 2 and Unit 3 refurbishments, following EB-
2 2020-0290, OPG further updated the DRP budget and schedule as part of the Unit 1 Execution
3 Estimate (“U1EE”) in November 2021. The U1EE established the baseline against which OPG
4 and its Board of Directors measured the company’s performance during the execution of the
5 Unit 1 refurbishment. The High Confidence Schedule duration remained at 38 months as it was
6 at the time of the RQE and the U3EE. The U1EE maintained the four-unit, program-level
7 control budget of \$12.8B, excluding any ultimate impact of the COVID-19 pandemic.

8
9 The refurbishment outage for Unit 1 began February 15, 2022, and was completed when the
10 unit was successfully returned to service on November 27, 2024. The refurbishment of Unit 1
11 was completed within budget, 142 days ahead of the High Confidence Schedule, with an in-
12 service addition of \$1,732M.

13
14 As planned, OPG completed the Unit 4 Execution Estimate (“U4EE”) in March 2023 which
15 maintained the High Confidence Schedule duration at 37 months as it was at the time of the
16 RQE and the U3EE. The Unit 4 refurbishment outage began on July 19, 2023 with a return to
17 service planned for August 2026 at the time, per the High Confidence Schedule. The U4EE
18 maintained the four-unit, program-level control budget of \$12.8B, excluding any ultimate
19 impact of the COVID-19 pandemic. As set out in OPG’s 2025-2031 Business Plan, Unit 4 is
20 planned to be returned to service on April 15, 2026 three and half months ahead of the High
21 Confidence Schedule, with a planned in-service addition of \$2,292M, which continues to
22 remain within the \$12.8B budget.

23
24 OPG has made quarterly DRP performance update reports available to the public through its
25 website since the start of the Unit 2 refurbishment and will continue this practice until the
26 completion of the DRP. Each public report covers the four project pillars of safety, quality, cost,
27 and schedule. Additionally, in accordance with the OEB’s Decision and Order in EB-2016-
28 0152¹⁷ and EB-2020-0290,¹⁸ OPG has filed with the OEB detailed annual reports at the end of

¹⁷ OEB Decision and Order, EB-2016-0152, December 28, 2017, pp. 43-45.

¹⁸ OEB Decision and Order, EB-2020-0290, November 15, 2021, p. 117.

1 each year beginning in 2018 on the progress of the DRP. The annual reports are posted online
2 and include a range of measures of safety, quality, cost, and schedule performance. OPG will
3 continue to issue such annual reports until Unit 4 returns to service in 2026.¹⁹

4
5 In this Application, through Ex. D2-2-1 to Ex. D2-2-3, OPG provides an update on the progress
6 of the DRP and further evidence that it has effectively managed the DRP and expects to
7 complete it within the \$12.8B budget approved in EB-2020-0290. The evidence in this Ex. D2-
8 2-1 through Ex. D2-2-3 demonstrates that:

- 9 • OPG has successfully performed the Units 2, 3 and 1 refurbishments and returned the
10 units to service. OPG also successfully delivered on its commitment to pursue unit over
11 unit efficiencies, incorporating lessons learned from the preceding unit(s) and
12 implementing strategic improvements where possible.
- 13 • OPG is on track to deliver the last unit, Unit 4, on-time, safely and with quality, and within
14 the \$12.8B program budget approved in EB-2020-0290.
- 15 • The total forecast cost of \$12.7B for completing the DRP, including the impact of the
16 COVID-19 pandemic, remains within the baseline estimate of \$12.8B, as established in the
17 RQE. OPG has planned for these costs to be finalized in 2026 but expects that a minor
18 amount may fall into the first half of 2027 as part of project close out activities. These
19 amounts will be reconciled through the CRVA. An annual breakdown of the \$12.7B
20 forecasted total program expenditures is provided in Ex. D2-2-3, Table 1A.

21
22 Chart 1 provides a summary of the High Confidence Schedule durations for the refurbishment
23 outage of each of the four units compared to the actual or forecasted durations based on the
24 actual or forecasted start dates and end dates. As identified in EB-2020-0290 and noted
25 above,²⁰ the schedules reflect the impact of OPG's response to the COVID-19 pandemic that
26 resulted in a later start date for the refurbishment outage of Unit 3 in 2020 and correspondingly
27 later start dates for the Units 1 and 4 refurbishment outages in subsequent years. The Unit 3
28 and Unit 1 refurbishments incorporated lessons learned from the preceding unit(s) and the

¹⁹ Minor amount of project closeout costs may fall into the first half of 2027.

²⁰ Unit 2 high confidence duration of 40 months obtained from EB-2016-0152, Ex. D2-2-1, p. 2. Subsequent Unit durations of 40, 38 and 37 months obtained from EB-2020-0290, Ex. D2-2-5, p. 6.

1 implementation of strategic improvements, resulting in a ten-month improvement on the Unit 3
 2 refurbishment duration compared to Unit 2, and an additional one-month improvement on the
 3 duration of the Unit 1 refurbishment compared to Unit 3. Examples of lessons learned are
 4 provided in Ex. D2-2-2, Attachment 1.

5

6 **Chart 1 – High Confidence Schedule Duration as of RQE compared to Actual and**
 7 **Forecast Performance by Unit**

	High Confidence Duration (Months)	Start (Actual)	End (Actual/ Forecast)	Actual/Forecast Duration (Months)
Unit 2	40	15-Oct-2016	04-Jun-2020 (A)	44
Unit 3	40	03-Sep-2020	18-Jul-2023 (A)	34
Unit 1	38	15-Feb-2022	27-Nov-2024 (A)	33
Unit 4	37	19-Jul-2023	15-Apr-2026 (F)	33

8

9 Chart 2 provides a simplified breakdown of the \$12.8B program costs as of EB-2020-0290
 10 compared to the actual and forecast spend currently. The Unit 3 refurbishment capital cost
 11 was under budget at \$2,295M, while the Unit 1 refurbishment capital cost was under budget
 12 at \$1,732M.

**Chart 2 – Simplified Breakdown of Total Estimate to Complete
 Subsequent Units**

Program Component	DRP Program Cost as of EB- 2020-0290 (\$M)	Total Cost (Actual/Forecast) (\$M)
Capital		
Unit 2 (including definition)	4,762 ¹	4,766 (A)
Early In-Service (all units)	201 ²	193 (F)
Unit 3	2,504 ³	2,295 (A)
Unit 1	1,907 ⁴	1,732 (A)
Unit 4	2,028 ⁵	2,292 (F)
F&IP and SIO	628 ⁶	630 (A)
D2O Storage Project	509 ⁷	509 (A)
OM&A		
Project OM&A	261 ⁸	283 (F)
Total	12,800	12,700 (F)

Notes:

¹ EB-2020-0290, Ex. D2-2-9, Table 2: Total Project Cost (g) for Unit 2 (line 5)

² EB-2020-0290, Ex. D2-2-9, Table 2: Total Project Cost (g) (lines 7 to 9) + EB-2020-0290, Ex. D2-2-9, Table 3: Total Project Cost (h)(lines 4 to 8) + EB-2020-0290, Ex. D2-2-9, Table 4: Total Project Cost (b)(line 1)

³ EB-2020-0290, Ex. D2-2-9, Table 2: Total Project Cost (g) for Unit 3 (line 1)

⁴ EB-2020-0290, Ex. D2-2-9, Table 2: Total Project Cost (g) for Unit 1 (line 2)

⁵ EB-2020-0290, Ex. D2-2-9, Table 2: Total Project Cost (g) for Unit 4 (line 3)

⁶ EB-2020-0290, Ex. D2-2-9, Table 2: Total Project Cost (g)(lines 10 to 17) + EB-2020-0290, Ex. D2-2-9, Table 3: Total Project Cost (h) (lines 3, 9 to 11). Per EB-2020-0290, D2-2-9, Table 2: note 2, F&IP total project cost and release information reflect approved business case summaries and balancing adjustment

⁷ EB-2020-0290, Ex. D2-2-9, Table 2: Total Project Cost (g) for D2O Storage Project (line 6)

⁸ EB-2025-0297, Ex. D2-2-3, Table 1a: 2010 to 2019 actuals (a to j) (line 1) + EB-2020-0290, Ex. F2-7-1 Table 1: 2020 to 2026 budget (e to k) (line 4)

Some of the Unit 3 and Unit 1 cost savings resulting from strong performance and tightened risk profiles were partly carried over into the current U4EE forecast, helping to fund several aspects of the Unit 4 cost that were not present for the immediately preceding Unit 1, including a CanAtom execution phase incentive payable at the end of the program, demobilization costs assigned to Unit 4, and higher functional costs due to a shorter overlap period with another unit refurbishment. The currently planned Unit 4 capital cost is \$2,292M, which also includes

1 remaining program contingency to address any risks during the remainder of the DRP. Any
2 unutilized contingency upon completion of Unit 4 remaining amounts will be reconciled through
3 the CRVA.

4

5 **3.0 APPROVALS SOUGHT**

6 The Application proposes to clear all remaining DRP-related balances recorded in the CRVA
7 as of December 31, 2024 and commits not to seek recovery, in any future application, of any
8 unlikely final costs of the DRP that exceed the approved \$12.8B budget. Subject to this
9 commitment, OPG would record in the CRVA the revenue requirement of any differences
10 between the amount and timing of the remaining actual expenditures and in-service amounts
11 for the DRP and those forecasts reflected in the IR term revenue requirements approved in
12 this proceeding.

13

14 Given that actual costs for recovery would not exceed the \$12.8B budget, OPG seeks a final
15 determination of all DRP costs in this Application. OPG proposes that any DRP-related
16 amounts recorded in the CRVA subsequent to 2024 be allowed for recovery in a future
17 application on a mechanical basis, subject to the amounts being accurately recorded. The
18 DRP-related account entries would cease upon the effective date of a subsequent payment
19 amounts order that reflects the final actual in-service additions, not to exceed the \$12.8B
20 budget, in the payment amounts.

DARLINGTON REFURBISHMENT PROGRAM

PERFORMANCE

1.0 OVERVIEW

This exhibit provides an update on the refurbishment of the four units at Darlington (“DRP”), with a focus on OPG’s cost and schedule performance.

The DRP is nearly complete, with OPG having successfully returned Units 2, 3, and 1 to commercial in-service and Unit 4 expected to be returned to service by April 2026. Unit 2 was returned to service just over three months behind, while Units 3 and 1 were returned to service ahead of the High Confidence Schedule. Each successive unit has leveraged thousands of lessons learned¹ from the refurbishment of the preceding unit(s). Examples of lessons learned are provided in Attachment 1. These insights, along with several strategic improvements,² were integrated into the planning and execution of successive units, leading to demonstrated unit-over-unit improvements in cost and schedule performance. These unit-over-unit improvements have been integral to OPG being able to deliver the DRP within the \$12.8B budget and planned schedule.

OPG is currently forecasting the final cost of the DRP to be \$12.7B, which is \$100M under the Release Quality Estimate (“RQE”) budget. An annual breakdown of the \$12.7B forecasted program expenditures is included in D2-2-3, Table 1a. Notably, during the execution of Units 3 and 1, OPG experienced a black swan³ event with the COVID-19 pandemic that was not captured by the RQE. OPG maintained its focus on executing the project safely and with quality at all times, while managing the cost impact of this event. Strong execution performance,

¹ “Lessons Learned” refers to specific and detailed knowledge and experience gained during a process, project or activity which, when applied to the same or similar processes, projects or activities in the future, results in improved performance.

² “Strategic Improvements” are new approaches and/or innovative methods for planning and executing the Subsequent Units’ refurbishments that are being implemented in addition to lessons learned.

³ A “black swan event” refers to a highly improbable, unpredictable, and impactful occurrence that comes as a surprise, often with significant negative consequences.

1 attributable to efficiencies and performance improvement initiatives OPG pursued throughout
2 the program, ultimately allowed OPG to offset the \$127M impact of this black swan event.

3 4 **2.0 UNIT 2 AND COMMON COSTS PERFORMANCE**

5 In the EB-2016-0152 application, OPG sought approval for rate base additions of \$4,800.2M
6 (\$4,799.8M in 2020 and \$0.4M in 2021) for in-service amounts associated with the Unit 2
7 refurbishment (including contingency, interest and escalation), along with \$377.2M in in-
8 service amounts for other DRP-related facilities that would enter into service during the 2016-
9 2021 period. OPG submitted that the success of the Unit 2 refurbishment (including the
10 Definition Phase) should be measured on a total envelope basis, as it is a single integrated
11 mega-project rather than a collection of smaller projects. The OEB approved the additions to
12 rate base as proposed by OPG and agreed with the proposed budget envelope approach.^{4,5}

13 14 **2.1 Unit 2 Overview**

15 Unit 2 was the first of Darlington's four units to undergo refurbishment. This First-of-a-Kind
16 ("FOAK") program represented the first time that a CANDU nuclear reactor had been shut
17 down and refurbished from a "hot state" while the other immediate adjacent reactors continued
18 to operate. As a result, this program necessitated a number of FOAK aspects involving design,
19 equipment and execution methods. Challenges faced during the refurbishment of Unit 2
20 provided valuable lessons learned that enhanced the efficiency and effectiveness of
21 subsequent refurbishments of Units 3, 1, and 4 ("Subsequent Units").

22 23 **2.2 Unit 2 Scope**

24 Generally, the core scope of each unit's refurbishment is replicated unit-over-unit. However,
25 there have been two key areas of scope differences between Unit 2 and the Subsequent Unit
26 refurbishments, as follows.

⁴ OEB Decision and Order, EB-2016-0152, December 28, 2017, p. 26.

⁵ OEB Decision and Order, EB-2016-0152, December 28, 2017, p. 41.

1 First, there was certain scope for Unit 2 that did not need to be repeated in the Subsequent
2 Units. Darlington is an integrated four-unit station, where certain systems are common to all
3 units and the work on those systems only needed to be performed once. As the four units are
4 of the same design, there was also engineering work that did not have to be reperformed for
5 each Subsequent Unit.

6
7 Second, there was scope that, for strategic and/or timing reasons, was not executed for Unit 2,
8 but is included for the Subsequent Units. As contemplated in EB-2016-0152, the installation of
9 digital turbine controls and generator excitation controls was performed on Units 3, 1, and 4
10 during the refurbishment outages, but was excluded from the Unit 2 refurbishment scope at
11 the time of the RQE⁶ for two main reasons: (1) there was still useful life left in the existing
12 control systems on Unit 2; and (2) to mitigate risk, given that Unit 2 was the first unit to be
13 refurbished and this large FOAK modification would have introduced unnecessary additional
14 risk into the planning and execution of the Unit 2 refurbishment.

15
16 As OPG confirmed in EB-2020-0290, all of the scope included within the OEB's approval of
17 the \$4,800.2M in-service addition for the refurbishment of Unit 2 was completed.⁷

18 19 **2.3 Unit 2 Cost and Schedule Performance**

20 Cost estimating is a process that is repeated and refined at different stages of a program or
21 project, particularly as a project progresses through its project life cycle. With each iteration, a
22 cost estimate is expected to become more accurate. The OEB approved OPG's revenue
23 requirement in EB-2016-0152 based on the RQE for the DRP, which was approved by OPG's
24 Board of Directors in November 2015 and reflected in OPG's evidence submitted in that
25 application.⁸ Two months prior to the start of the refurbishment of Unit 2, as planned, OPG
26 completed a "check" to refine the forecast cost and schedule for the refurbishment of Unit 2,
27 which resulted in the Unit 2 Execution Estimate ("U2EE").⁹ The U2EE was approved by OPG's

⁶ EB-2016-0152, Ex. D2-2-5, p. 10.

⁷ EB-2020-0290, Ex. L-D2-02-Energy Probe-035, p. 1.

⁸ EB-2016-0152, Ex. D2-2-8, Section 1 and Attachment 1.

⁹ EB-2016-0152, L-04.3-1 Staff-055.

1 Board of Directors in August 2016 and established the Unit 2 project baselines for cost and
2 schedule monitoring.

3

4 As detailed in EB-2020-0290, OPG experienced challenges with the procurement and
5 installation of the Unit 2 feeder pipes.¹⁰ In particular:

- 6 • Delays were experienced in the receipt of the new feeders due to the required qualification
7 of fabrication welding specifications, inspection of fabrication, and welding, fabrication and
8 delivery issues;
- 9 • Higher than expected weld failure rates were experienced in field welds; and
- 10 • Congestion was experienced on the reactor face, particularly with regards to scaffolding.

11

12 Although these challenges were ultimately resolved, they affected the refurbishment schedule
13 and in August 2019, the High Confidence Schedule return-to-service date for Unit 2 was
14 reforecast from February 15, 2020, to June 25, 2020.

15

16 OPG commenced the Unit 2 refurbishment outage on October 15, 2016, and returned the unit
17 to commercial service on June 4, 2020, ahead of the reforecast High Confidence Schedule
18 and just three months behind the RQE and the U2EE High Confidence Schedule.

19

20 As noted, in EB-2016-0152, the OEB approved a total in-service amount of \$5,177.4M,
21 consisting of \$4,800.2M for the refurbishment of Unit 2 (including the Definition Phase) and
22 \$377.2M for Unit 2 Early In-Service Projects, Facilities & Infrastructure Projects (“F&IP”), and
23 Safety Improvement Opportunities (“SIO”) based on the RQE. Relative to the total approved
24 in-service amount of \$5,177.4M, there was a variance of (+\$126.0M) or (+2.4%) in DRP in-
25 service amounts over the 2016-2024 time period.¹¹

¹⁰ For further background on the feeder pipes and the challenges encountered, refer to EB-2020-0290, Ex. D2-2-2, Section 4.1.

¹¹ A \$132.7M forecast variance was noted in EB-2020-0290, Ex. D2-2-1, p. 3; the change in the variance was due to the actualization of costs.

1 Focusing on performance relative to the \$4,800.2M in-service amount for Unit 2 (including the
2 Definition Phase) approved by the OEB in EB-2016-0152, there was a net variance of
3 (-\$33.9M). This negative variance was due to placing (-\$70.3M) of projects early in-service
4 rather than as part of Unit 2 as they provided immediate benefit to Darlington operations. This
5 reduction to the Unit 2 in-service amount (including Definition Phase) was partly offset by an
6 increase of (+\$36.4M) to the Unit 2 in-service amount (including the Definition Phase).

7
8 For the Unit 2 Early In-Service Projects, F&IP and SIO excluding the Heavy Water Storage
9 and Drum Handling Facility, compared to the OEB-approved in-service amount in EB-2016-
10 0152 of \$377.2M over the 2017-2026 IR term, there was a total variance of (+\$159.9M). This
11 variance was the result of increased costs of (+\$89.6M) for these projects, and the earlier
12 declaration of in-service (+\$70.3M) for new Unit 2 Early In-Service Projects, as discussed
13 above. Further information on these in-service amounts was provided in EB-2020-0290, Ex.
14 D2-2-9.

15 16 **2.4 Unit 2 Quality Performance**

17 The refurbishment of a nuclear unit requires a constant focus on the quality of the construction
18 to meet or exceed all required specifications. The refurbishment of Unit 2 involved many
19 thousands of removal and installation activities, which required a high degree of precision.
20 Completion of work on Unit 2 required co-ordination and detailed scheduling of the activities
21 of multiple trades, e.g., boilermakers, welders, millwrights, pipefitters, carpenters, electricians,
22 painters, field engineers and radiation protection technologists in concert with the activities of
23 OPG operations and maintenance staff.

24
25 OPG's Quality Management program monitored quality issues and OPG worked
26 collaboratively with its contractors to resolve all Quality Events¹² and to ensure mitigation
27 measures were implemented to prevent recurrence. As a result, the quality of the work

¹² OPG defines a Quality Event as the number of Station Condition Records, Adverse Condition Event Reports, or Non-Conformance Reports related to issues that have a major impact on cost, quality, and schedule during the reporting period.

1 completed on Unit 2 was of a high standard, and OPG was able to carry forward lessons
2 learned to improve the approach throughout the remainder of the DRP.

3
4 Unit 2 has performed well post-refurbishment and is delivering to planned production targets,
5 with no major issues as a result of work completed in refurbishment.

6 7 **2.5 Lessons Learned and Strategic Improvements for Subsequent Units**

8 OPG captured thousands of lessons learned during the course of the Unit 2 refurbishment.
9 These lessons learned as well as a number of strategic improvements have been incorporated
10 into the planning and execution of the refurbishments of Units 3, 1, and 4, and resulted in unit-
11 over-unit cost and schedule duration improvements. For instance, lessons learned from Unit 2
12 led to improved performance in Subsequent Units' defueling and removal phases, including
13 the parallel removal of pressure tubes and calandria tubes, a FOAK evolution in the industry.
14 Applying these lessons learned resulted in Critical Path savings of 17 days on Unit 1's Middle
15 Feeder Initiative and advancements in Lower Body Support and Tubing windows.

16 17 **3.0 SUBSEQUENT UNITS PERFORMANCE**

18 **3.1 Subsequent Units Overview**

19 The refurbishment outages for Units 3, 1, and 4 were planned and carried out by applying
20 thousands of lessons learned from the Unit 2 refurbishment. By incorporating these insights
21 and a range of strategic improvements into the process for the Subsequent Units, OPG
22 achieved measurable reductions in cost and schedule duration for Unit 3 and Unit 1, with
23 further improvements being applied during the ongoing Unit 4 refurbishment execution.

24
25 Having returned Unit 2 to service on June 4, 2020 and commenced the refurbishment of Unit
26 3 on September 3, 2020, OPG's evidence in EB-2020-0290 presented its plans for the
27 remainder of the DRP, based on the final Unit 3 Execution Estimate ("U3EE").¹³ The U3EE

¹³ The original U3EE was approved by OPG's Board of Directors in March 2019. In August 2019, as a result of the revised Unit 2 schedule, OPG decided to defer the start of the Unit 3 refurbishment outage to May 2020 to minimize the overlap of the beginning of the Unit 3 and the end of the Unit 2 refurbishment outage. This had an impact on Units 1 and 4 also. In August 2020, as a response to the COVID-19 pandemic and the Government of Ontario's state of emergency declaration, OPG's Board of Directors approved a further revision to the U3EE to

1 reflected the schedule impacts of the COVID-19 pandemic and established the cost and
2 schedule baselines for cost and schedule monitoring for Unit 3. As the refurbishments of the
3 Subsequent Units were all to be executed with a degree of overlap, the planning process and
4 preparatory work for the three units was performed simultaneously, where it was more efficient
5 and cost-effective to do so. The U3EE maintained the same High Confidence Schedule
6 durations for the Subsequent Units as the RQE.

7
8 The OEB-approved settlement proposal in EB-2020-0290 included in-service additions to rate
9 base of a total of \$6,442.6M and OM&A expenditures totalling \$110.5M, which amounted to
10 the remainder of the \$12.8B program budget for the DRP. Currently, the DRP is tracking capital
11 costs at completion of Units 3, 1, and 4 to be (-\$119.7M) under budget at \$6,322.9M, resulting
12 in the total program cost of \$12.7B. The revenue requirement impact of the differences
13 between the OEB-approved amounts and actual in-service additions (and associated timing)
14 to rate base, as well as for the OM&A expenditures, is recorded in the Capacity Refurbishment
15 Variance Account (“CRVA”) pursuant to Ontario Regulation 53/05. The CRVA is discussed
16 further in Ex. H1-1-1, Section 5.6.

17
18 OPG successfully returned Unit 3 to service on July 18, 2023, 169 days ahead of the High
19 Confidence Schedule date. The refurbishment of Unit 1 was completed on November 27, 2024,
20 142 days ahead of the High Confidence Schedule date.

21
22 Based on IESO grid stability constraints, the start of Unit 4 was deferred by 17 days to July 19,
23 2023. As set out in OPG’s 2025-2031 Business Plan, Unit 4 is planned to be returned to service
24 on April 15, 2026, which would result in the unit being 109 days ahead of the High Confidence
25 Schedule date.

reflect a further deferral of the start of the Unit 3 refurbishment outage to early September 2020. Units 1 and 4 were correspondingly deferred to maintain the same degree of overlap in the schedule.

1 **3.2 Subsequent Units Scope**

2 In EB-2020-0290, OPG provided evidence that it had implemented a robust DRP scope
3 development process, and neither the scope of the DRP nor the process used to approve
4 scope changes had changed materially since the completion of the scope development
5 process at the time of the RQE.

6
7 As discussed above, one of the material scope differences between the Subsequent Units and
8 Unit 2 is the installation of digital turbine and generator excitation controls, which was executed
9 for the first time as part of the Unit 3 refurbishment. This scope was not on the critical path of
10 the Unit 3 refurbishment outage. OPG took measures to mitigate the risks associated with this
11 FOAK modification, including the installation of a full-scope simulator to allow testing and
12 training on the new digital controls before they were installed and commissioned on each of
13 Units 3, 1, and 4.

14
15 Recognizing the importance of this new scope, OPG closely monitored the performance and
16 outcomes of the above work during the Unit 3 implementation. Lessons learned from this initial
17 installation were systematically captured and used to inform improvements for the subsequent
18 units. As a result, each following unit benefited from enhanced planning, refined installation
19 procedures, and more effective training, leading to increased efficiency and reduced risk with
20 each successive upgrade. This continuous improvement ensured that OPG not only addressed
21 the challenges of the FOAK modification but also delivered measurable enhancements unit
22 over unit.

23
24 Details on the DRP scope development process and corresponding contractual changes were
25 provided in EB-2020-0290, Ex. D2-2-3 and Ex. D2-2-4. Since EB-2020-0290, there have been
26 no material changes to the DRP scope and corresponding changes to contracts.

27
28 **3.3 Subsequent Units Schedule Performance**

29 To plan for the refurbishment outages of the Subsequent Units, OPG implemented a similarly
30 detailed process as was used for Unit 2. The planning process was modified to account for

1 scope differences, risks associated with the overlapping of the Subsequent Units'
2 refurbishment outages, and to incorporate lessons learned and strategic improvements.

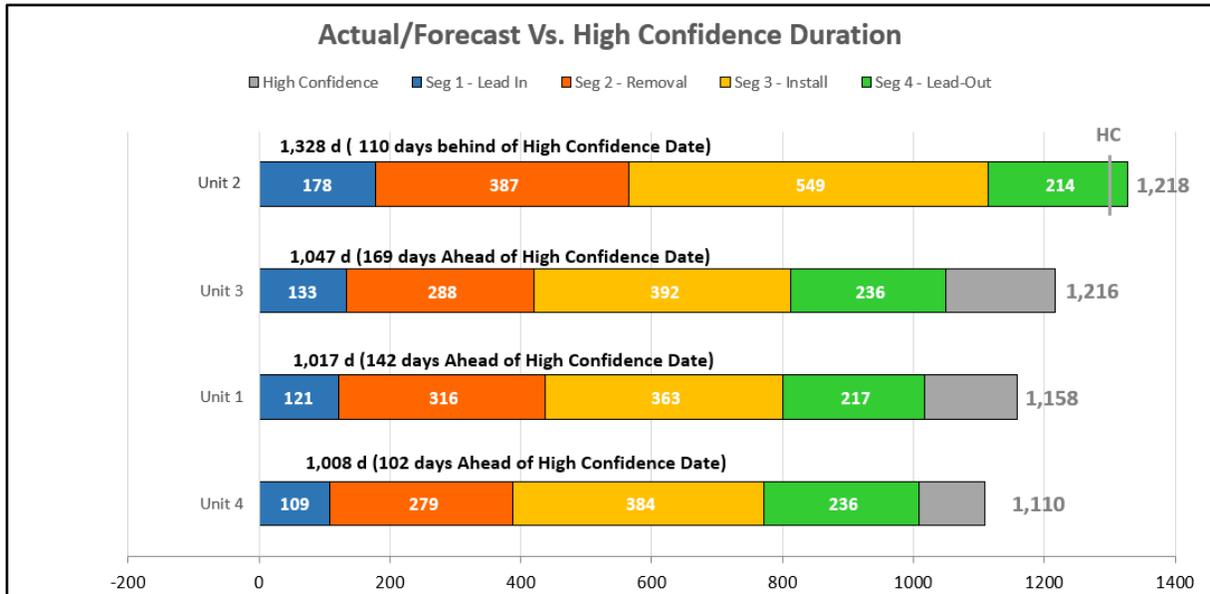
3
4 At the time of the RQE, OPG had developed both a Working Schedule and a High Confidence
5 Schedule for all four Units. Following the RQE, these schedules were refined as the execution
6 estimates were completed. OPG then used each unit's Working Schedule to drive the work on
7 these units to completion. OPG monitored progress against each unit's Working Schedule and
8 the High Confidence Schedule.

9
10 OPG began the refurbishment of Unit 3 as planned on September 3, 2020, and successfully
11 returned Unit 3 to service on July 18, 2023, 169 days ahead of the High Confidence Schedule
12 date and reflected a 281-day schedule duration improvement over Unit 2. The refurbishment
13 of Unit 1 started on February 15, 2022, as planned, and was completed on November 27,
14 2024, 142 days ahead of the High Confidence Schedule date, reflecting a 30-day schedule
15 duration improvement over Unit 3.

16
17 Overall, Units 3 and 1 were completed with marked performance improvements and
18 efficiencies relative to the previously completed Unit 2 and including a degree of overlap with
19 another unit. OPG forecasts that the execution of the Unit 4 refurbishment outage will be
20 completed ahead of the High Confidence Schedule duration of 37 months, resulting in all four
21 units returning to commercial operation in advance of the RQE timeline.

22
23 Figure 1 provides a comparison of refurbishment outage durations for the refurbishment of
24 Units 2, 3, 1, and 4 against the High Confidence Schedule (for Unit 2, as committed in the
25 RQE, and for Units 3, 1, and 4, as committed in each unit's Execution Estimate). The
26 performance demonstrates shorter durations delivered across key phases with each
27 successive refurbishment, highlighting the effectiveness of lessons learned and process
28 optimizations throughout the DRP.

Figure 1 - Comparison of the Refurbishment Outage Unit Performance Against the High Confidence Schedule



3.4 Subsequent Units Cost Performance

As with Unit 2, OPG completed an execution estimate prior to the execution of each Subsequent Unit, including the final U3EE in August 2020 which formed the basis of the EB-2020-0290 evidence. Since EB-2020-0290, OPG completed the Unit 1 Execution Estimate (“U1EE”) in November 2021 and the final Unit 4 Execution Estimate (“U4EE”) in March 2023. Each unit execution estimate provided an estimate to complete the overall DRP and confirmed that the overall program and associated contingencies were within the \$12.8B budget set in the RQE, exclusive of any COVID-19 pandemic impacts.

Consistent with the OEB’s approval in EB-2020-0290, OPG is measuring the success on the DRP at the total envelope level. By delivering the full program, inclusive of the Unit 2 and the Subsequent Units, within the \$12.8B approved budget, the DRP will have been completed within the OEB’s approval in EB-2020-0290. As discussed in Ex. D2-2-1, with the Unit 4 refurbishment approaching completion, OPG commits not to seek recovery, in any application, of any unlikely final costs of the DRP that exceed the \$12.8B budget.

1 Consistent with OPG's 2025-2031 Business Plan, OPG has planned DRP expenditures of
2 \$1,227.2M (capital) and \$12.3M (project OM&A costs) over 2025 and 2026, which would result
3 in the DRP being completed at a total cost of \$12.7B, approximately (-\$100M) under the
4 \$12.8B budget set at the RQE and approved by the OEB.

5
6 The Unit 3 and Unit 1 cost savings resulting from strong performance and tightened risk profiles
7 have enabled the DRP to offset the unexpected external cost impacts, such as those from the
8 COVID-19 pandemic experienced earlier in the program, with a portion carried over into the
9 current U4EE forecast to help fund several aspects of the Unit 4 cost that were not present for
10 the immediately preceding Unit 1. This includes a CanAtom Execution Phase incentive payable
11 at the end of the DRP, demobilization costs assigned to Unit 4, and higher functional costs due
12 to a shorter overlap period with another unit refurbishment

13
14 A detailed comparison of the actual/forecast DRP in-service amounts over the 2020-2026
15 period against those forecast in EB-2020-0290 is provided in Ex. D2-2-3.

16 17 **3.5 Subsequent Units Quality Performance**

18 As noted, the refurbishment of a nuclear unit requires a constant focus on the quality of the
19 construction to meet or exceed all required specifications. Similar to Unit 2, the refurbishment
20 of Units 3, 1, and 4 has involved many thousands of removal and installation activities, which
21 have required a high degree of precision. This has been further complicated by the risks
22 associated with the overlapping of these units, which required a planning and hybrid scheduling
23 process different than Unit 2. For example, work on Units 3 and 1 and ongoing work on Unit 4
24 have required co-ordination, and detailed scheduling of, the activities of multiple trades, e.g.,
25 boilermakers, welders, millwrights, pipefitters, carpenters, electricians, painters, field
26 engineers and radiation protection technologists in concert with the activities of OPG
27 operations and maintenance staff.

28
29 OPG's Quality Management program continued to monitor quality issues and OPG worked
30 collaboratively with its contractors to resolve all Quality Events and to ensure mitigation

1 measures were implemented to prevent recurrence. As a result, the quality of the work
2 completed on the Subsequent Units continued to improve.

3
4 Notably, the performance on the Lower Feeder Installation series for Unit 4 is currently
5 achieving an industry-leading weld failure rate of 1.23%, improving upon Unit 1's rate of 1.74%
6 and Unit 3's rate of 4.28%. This is setting a new benchmark for quality and performance in the
7 industry.

8
9 As with Unit 2, Units 3, and 1 have performed well post-refurbishment and are delivering to
10 planned production targets, with no major issues as a result of work completed in
11 refurbishment.

12 13 **4.0 REPORTING AND OVERSIGHT**

14 During the execution of the Units 3, 1, and 4 refurbishments, OPG implemented an assurance
15 plan compromised of several layers of oversight. This robust, tiered oversight structure was
16 effective in helping OPG and its contractors to meet safety, quality, cost and schedule
17 expectations by identifying issues and aiding in expeditious resolution. OPG's oversight
18 structure for the Subsequent Units was discussed in detail in EB-2020-0290, Ex. D2-2-8
19 Program Structure and Oversight.

20
21 The Refurbishment Review Board ("RRB")¹⁴ provided independent oversight to OPG's Board
22 of Directors on a quarterly basis over the course of the subsequent units' execution. RRB
23 members have experience in senior oversight and/or advisory capacities, including with project
24 management related to "mega-projects", experience with nuclear plant operations, and other
25 extensive nuclear power, regulatory, construction management, major contract management,
26 and project controls experience. The RRB is normally comprised of three to five external
27 members, typically with support from one internal OPG member. It meets approximately three
28 to four times per year, depending on Program status and schedule. The RRB provided overall

¹⁴ Formerly the Refurbishment Construction Review Board.

1 findings on the execution progress as well as more specific observations regarding the current
2 and upcoming scopes of work. The RRB issued its final report in May 2025.

3
4 In accordance with the OEB's Decision and Order in EB-2016-0152 and EB-2020-0290, OPG
5 has produced and filed with the OEB detailed annual reports on the DRP since 2018, which
6 summarize DRP performance, including the refurbishment of Subsequent Units. Copies of the
7 reports for 2020-2024 are provided in Attachments 2-6.¹⁵ The report for 2025 will be filed with
8 the OEB by December 2025, followed by what OPG expects to be the final report, for 2026, by
9 December 2026.

10 11 **5.0 PROJECT CLOSEOUT**

12 As OPG enters the final stages of the DRP, it will continue to thoroughly track and manage all
13 outstanding program activities, such as engineering and financial closeout. It will also track
14 and manage demobilization activities, which support the coordinated transition of DRP-related
15 operations and custody of assets to OPG's operating organizations upon project completion.

16
17 The costs associated with closeout are primarily related to OPG project management support
18 that will handle the standard components of project completion, including the closing and
19 documentation of purchase orders, engineering changes, project closure, and fixed-fee
20 payments. Demobilization costs will include project management and direct field labor support
21 for the removal of the temporary DRP-related support facilities and the demobilization of
22 remaining equipment and materials upon completion of the project.

23
24 OPG's current forecast indicates that closeout and demobilization activities, along with all
25 remaining obligations, will be managed within the current estimate of \$12.7B (and in any event
26 within the established budget of \$12.8B). OPG has planned to conduct these activities in 2026
27 but expects that a minor amount in the order of up to \$10M may fall into the first half of 2027
28 and would be reconciled through the CRVA.

¹⁵ DRP Annual Reports for 2018 and 2019 were provided in EB-2020-0290, Ex. D2-2-2, Attachments 1 and 2.

1 As noted, OPG has placed a strong emphasis on capturing and analyzing lessons learned
2 throughout the lifecycle of the program. These have been systematically collected and
3 documented, not only to inform each successive unit performance, but also to serve as a
4 valuable resource for future projects, such as the Pickering Refurbishment Program and the
5 Darlington New Nuclear Program.

LIST OF ATTACHMENTS

1

2

- 3 Attachment 1: Examples of Lessons Learned
- 4 Attachment 2: Darlington Refurbishment Program 2020 Annual Report
- 5 Attachment 3: Darlington Refurbishment Program 2021 Annual Report
- 6 Attachment 4: Darlington Refurbishment Program 2022 Annual Report
- 7 Attachment 5: Darlington Refurbishment Program 2023 Annual Report
- 8 Attachment 6: Darlington Refurbishment Program 2024 Annual Report

ATTACHMENT 1

Examples of DRP Lessons Learned from Units 2, 3, and 1

Unit 2

Unit 2 Examples	Recommendations/Actions
<p>Procedure and Documentation Issues</p> <ul style="list-style-type: none"> Last-minute changes to procedures, backlogs in procedure writing, and unclear documentation can cause delays and confusion during project execution. There was a need for better tracking of procedural changes and ensuring documentation was complete and timely. 	<ul style="list-style-type: none"> Planned for a “one time markup” approach and get procedures in early. Ensured procedure writing resources were available in advance. Tracked and verified key operational data (e.g., amounts transferred, levels recorded).
<p>Misalignment Between OPG and Contractors</p> <ul style="list-style-type: none"> Misalignment between OPG and contractors, especially regarding commissioning responsibilities, schedule expectations, and interpretation of requirements, can lead to confusion and project delays. 	<ul style="list-style-type: none"> Established clear checklists and conduct joint walkdowns in advance. Clearly defined decision-makers for open items. Reviewed and clarified commissioning workplans to assign responsibilities properly.
<p>Commissioning and Installation Challenges</p> <ul style="list-style-type: none"> Commissioning activities can be delayed or complicated by installation issues, lack of pre-commissioning checks, and insufficient consideration of commissioning requirements during design and construction phases. 	<ul style="list-style-type: none"> Issued outstanding commissioning workplans early for review. Ensured pre-commissioning checks were included in installation plans. Assigned and confirmed QA programs for each commissioning scope.
<p>Equipment and System Operability Problems</p> <ul style="list-style-type: none"> Problems with system integration (e.g., Heat Transport System Drain and Vac Dry), valve operability, and unmaintainable equipment can impact project timelines and require additional resources for troubleshooting. 	<ul style="list-style-type: none"> Set-up and staged critical equipment ahead of time. Included operability checks for key valves in pre-outage scopes. Provided appropriate tools and plans for dealing with stuck or hard-to-access equipment.
<p>Issues Tracking and Control</p> <ul style="list-style-type: none"> Weaknesses in tracking files and unclear control over issues and documentation make it difficult to monitor project progress and resolve problems promptly. 	<ul style="list-style-type: none"> Set-up agreed tracking files between OPG and contractors. Followed established processes and attended regular coordination meetings. Implemented improvement initiatives for document and issue control.

1 Unit 1

Unit 1 Examples	Recommendations/Actions
<p>Safety</p> <ul style="list-style-type: none"> Heat stress was a concern due to the temperature in the boilers. The team took constant temperature and humidity measurements, implemented air conditioning units and cooling tents and off-the-shelf fans. Spare mechanisms had tritiated oil still in them which required draining. This was a challenge for construction crews due to the additional safety practices required. 	<ul style="list-style-type: none"> The workplan was revised to perform as-found leak checks and document the appropriate tool and tool number to be used. OPG Safety and Emergency Response Team procured cooling vests and sought innovation to monitor boiler shell temperature. A sensor was installed on the shell of the boiler to remotely monitor temperature.
<p>Communication Protocols</p> <ul style="list-style-type: none"> The team found that it was beneficial to hold 15-minute calls prior to execution with updates from engineering, projects and BWXT including agendas and action tracking. A helium regulator was needed as part of the bench testing and station maintenance provided multiple options for use. Given the lack of tooling operating experience on the team, it was difficult to determine which one to proceed with since the Mechanical Maintenance Procedure only said to use a helium mass spectrometer. 	<ul style="list-style-type: none"> Team ensured projects scheduled pre-alignment meetings prior to Refurb Outage Control Centre and Planning and Control Centre update meetings and determined who will speak for each shift. The workplan was revised to perform as-found leak checks and document the appropriate tool and tool number to be used.
<p>Risk Management</p> <ul style="list-style-type: none"> Experienced multiple scenarios of Reactivity Mechanism Deck crane failure, leading to work stoppage; refurb maintenance set up emergent teams each time to get repairs done. Issues were raised regarding the quality and condition of loaned tools upon return. 	<ul style="list-style-type: none"> For future work, Reactivity Mechanism Deck crane planned maintenance completed prior to Start of Installation and expected to be available throughout the entire duration of the execution window. Centerline maintenance performed inventories for all Turbine Generator Replacement toolboxes and special tooling. They compiled this inventory in an electronic copy and a hard copy with images which was also distributed to GE to communicate the condition of the toolboxes.
<p>Resource allocations</p> <ul style="list-style-type: none"> During execution, the team did not have enough dunnage blocks once Unit 2 had overlap with Unit 3. 	<ul style="list-style-type: none"> For Units 1 and 4, the team procured a spare set of blocks.

1 **Unit 3**

Unit 3 Examples	Recommendations/Actions
<p>Communication and Coordination</p> <ul style="list-style-type: none"> The team found a process improvement opportunity to help drive a more focused Engineering Change (“EC”) framework and prevent configuration management issues. Upon achieving RCHP4, various lessons regarding the importance of improving communication were discussed and actions were assigned for the future. 	<ul style="list-style-type: none"> Ensured AS9 milestones were signed off prior to submission in EC packages involving On-line wiring. Ensured contactor documentation, including AutoCAD drawings, was submitted ahead of time to prevent delays. Improved the communication of the status of the work leading into the RCHP, including the size of outstanding activities and burndown rate of requirements. Held weekly meetings with the System Responsible Engineers, Operations Ops, Maintenance & Work Control Team Leaders to help ensure workgroups understood the outstanding scope. Communicated Return to Service Toolset rollout, including the Lookback, System Available for Service Open Item List, to stakeholder workgroups. Used the RCHP2 Lookback report to create a clearer picture of the remaining activities.
<p>Document Management</p> <ul style="list-style-type: none"> Document control team faced challenges reactivating documents since many were being held at “history” or “obsolete” causing potential issues to closeout. The team found that it would be beneficial to develop a means to track Return to Service document changes to ensure the Canadian Nuclear Safety Commission (“CNSC”) was notified of revisions. 	<ul style="list-style-type: none"> Ensured document status was identified prior to population of Affected Document List to allow for smooth workflow. A consolidated list of obsoleted documents was maintained by design EC and each design EC guide clearly outlined accountabilities with Design Safety Program. A list of documents of regulatory interest was created, and the file was linked to AS9. This was updated weekly by the Readiness for Service section and if any new revisions were issued, they were highlighted to send to CNSC.

FILED DECEMBER 31, 2020

Darlington Refurbishment Program Annual Report

2020 REPORT

AS PER DECISION AND ORDER IN EB-2016-0152

TABLE OF CONTENTS

INTRODUCTION	2
EXECUTIVE SUMMARY	2
DARLINGTON REFURBISHMENT PROGRAM STATUS	4
OVERVIEW.....	4
PROGRESS	4
SAFETY.....	5
Performance Metrics Summary.....	5
Campaigns, Programs And Initiatives.....	5
RADIOLOGICAL SAFETY	6
Performance Metrics Summary.....	6
QUALITY	7
SCHEDULE	7
Performance Metrics Summary.....	7
COST.....	9
ENGINEERING.....	11
PROCUREMENT	11
Procurement Status For Unit 3.....	11
Procurement Status For Unit 1.....	12
Procurement Status For Unit 4.....	12
CONSTRUCTION	12
Construction Progress Summary	12
Labour Relations Issues Summary.....	12
Environmental Issues Summary	12
TESTING, START-UP AND COMMISSIONING	13
Return-To-Service	13
PROGRAM RISKS AND RISK MANAGEMENT	13
STAFFING.....	14
Refurbishment Resources	14
Efforts To Fill Open Positions	14

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 Handling 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 Injury² 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 YTD²	OPG Target	Ontario Construction Industry³
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	Actual²	Target²
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 12 th , 2021	February 12 th , 2021
Segment 2 [Removal] Complete	January 11 th , 2022	January 11 th , 2022
Segment 3 [Install] Complete	April 7 th , 2023	April 7 th , 2023
Segment 4 [Lead Out / RTS] Complete	January 2 nd , 2024	January 2 nd , 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:

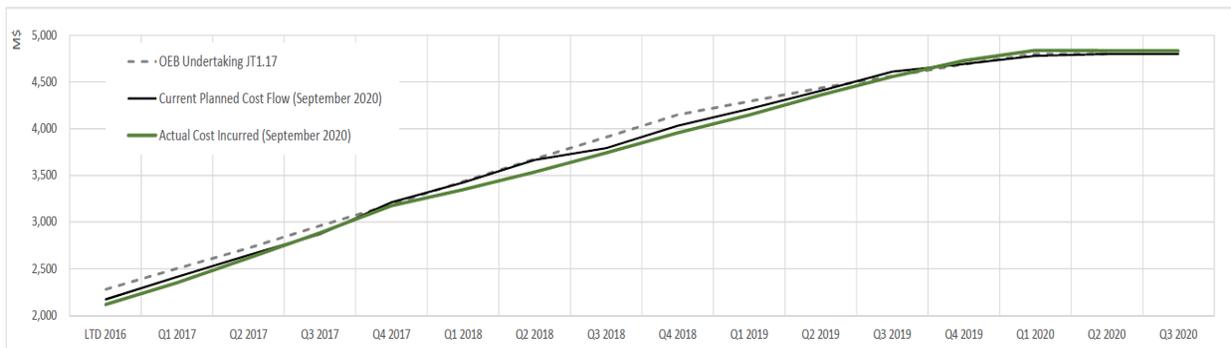
Table 6 provides a summary of the Actual vs. Forecast Cumulative Capital Costs.

Table 6 – Actual vs. Forecast Cumulative Capital Costs		
M\$	OEB Undertaking JT 1.17C (Forecast)	Actual Cost Incurred¹
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.

FILED DECEMBER 16, 2021

Darlington Refurbishment Program Annual Report

2021 REPORT

AS PER DECISION AND ORDER IN EB-2020-0290

TABLE OF CONTENTS

INTRODUCTION	2
EXECUTIVE SUMMARY	2
DARLINGTON REFURBISHMENT PROGRAM STATUS	4
OVERVIEW.....	4
PROGRESS	4
SAFETY.....	5
PERFORMANCE METRICS SUMMARY	5
CAMPAIGNS, PROGRAMS AND INITIATIVES	5
RADIOLOGICAL SAFETY	7
PERFORMANCE METRICS SUMMARY	7
QUALITY	7
SCHEDULE	8
PERFORMANCE METRICS SUMMARY	8
COST.....	9
ENGINEERING.....	11
PROCUREMENT	11
PROCUREMENT STATUS FOR UNIT 3	11
PROCUREMENT STATUS FOR UNIT 1	11
PROCUREMENT STATUS FOR UNIT 4	11
CONSTRUCTION	12
CONSTRUCTION PROGRESS SUMMARY.....	12
LABOUR RELATIONS ISSUES SUMMARY.....	12
ENVIRONMENTAL ISSUES SUMMARY	12
TESTING, START-UP AND COMMISSIONING	12
RETURN-TO-SERVICE.....	12
PROGRAM RISKS AND RISK MANAGEMENT	12
STAFFING.....	14
REFURBISHMENT RESOURCES	14
EFFORTS TO FILL OPEN POSITIONS	14



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FOR INFORMATION to the Ontario Energy Board

December 16, 2021

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, 2021.

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-2020-0290.¹

EXECUTIVE SUMMARY

The 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 and further refined its unit and Program estimates through the Unit 2 Execution Estimate (U2EE) in August 2016, final Unit 3 Execution Estimate (U3EE) in August 2020 and the Unit 1 Execution Estimate (U1EE) in November 2021, all of which maintain the Program estimate, exclusive of COVID-19 impacts, within the original \$12.8 Billion RQE budget and continue to forecast completion of the Unit 4 refurbishment in 2026. The U3EE formed the basis of OPG's December 2020 pre-filed evidence in EB-2020-0290. The execution estimate for Unit 4 is planned to be completed in 2023. OPG measures its performance over the refurbishment of each unit against each unit's execution estimate.

Unit 2 was successfully returned to service on June 4, 2020. Completion of the Unit 2 refurbishment on budget and with a small schedule variance of just over three months represented a significant achievement in mega-project execution for OPG. 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 ("COVID-19"). OPG remains focused on mitigating risks to its workers and operations, including the Program, posed by COVID-19. Based on COVID-19 impacts on the Program experienced to date, OPG forecasts incremental costs of approximately \$175 Million. Because of inherent uncertainties associated with COVID-19, 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 unit refurbishments in an effort to complete the Program inclusive of COVID-19 cost impacts within the \$12.8 Billion budget.

The final U3EE was completed in advance of the start of the refurbishment outage on Unit 3, and incorporated many lessons learned and strategic improvements based on the Unit 2 experience. The final U3EE was approved by OPG's Board of Directors in August 2020, and includes the deferred start to the refurbishment outages of the remaining units as a result of actions taken in response to COVID-19. Per the

¹ EB-2020-0290, Decision and Order, dated November 15, 2021, Schedule A (OEB Approved Settlement Proposal), Appendix A, p. 1.

final U3EE, the budget and High Confidence Schedule to complete Unit 3 are \$2,559 Million and 40 months, respectively.

On September 3, 2020, OPG commenced defueling of the Unit 3 reactor, marking the start of Unit 3 refurbishment execution. Performance on the Unit 3 refurbishment has been good. Unit 3 work is currently progressing ahead of schedule and on budget while meeting quality and safety metrics. Unit 3 is forecast to be completed on budget and on schedule by Q1 2024. As demonstrated by the good performance to date, lessons learned and strategic improvements have contributed to unit over unit efficiencies. For example, lessons learned have resulted in improved performance on Unit 3 throughout the defueling and removal phase, including the removal of pressure tubes and calandria tubes in parallel, which is a first of a kind (FOAK) evolution for the industry. In addition, the OneTeam approach between OPG and its major vendors has helped foster a more collaborative and effective working culture.

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.

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 33 Million hours worked with only one Lost Time Injury² since the start of the Program.
- **QUALITY:** The quality management program is used to identify issues during refurbishment execution by focused oversight of vendor-performed work. The quality of work on Unit 3 execution has been excellent to date with no Significant Quality Events. Since returning to service in June 2020, Unit 2 performance has been excellent and operating reliably without any major issues or unplanned outages related to Refurbishment work.
- **SCHEDULE:** Unit 3 refurbishment activities are currently progressing ahead of schedule, while incorporating continued COVID-19 protective measures. In August 2021, the project completed the removal of end fittings and immediately commenced the removal of pressure tubes and calandria tubes, which was completed on October 29, 2021 and marked the end of the Disassembly segment. The Unit 3 refurbishment project then entered the third major segment, the Reassembly segment, which involves installing and inspecting new reactor components, including new feeder tubes and fuel channel assemblies. During the third quarter of 2021, the project also commenced the Unit 3 upper and middle feeder installation series. This installation includes 960 new feeder tubes and will be completed in two segments, starting with the upper and middle feeders and followed by the lower feeders. Unit 3 is forecast to be returned to service on schedule by Q1 of 2024.
- **COST:** Total Program expenditures to date are \$8.1 Billion with the current estimate to complete the Program at \$4.7 Billion (excluding COVID-19 impacts). Unit 2 including Definition Phase and Campus Plan projects (excluding the D2O Storage Project) in-service amounts remain at an approximate \$133 Million variance to OEB-approved amounts in EB-2016-0152. Excluding COVID-19 impacts, life-to-date expenditures are \$1,412 Million for Unit 3, \$288 Million for Unit 1, and \$185 Million for Unit 4.

PROGRESS

The refurbishment of Unit 3 is 45% complete. Following is a status summary, as of September 30, 2021, of the major work completed since the 2020 DRP Annual Report filed December 31, 2020:

- Defueling of the Unit 3 reactor commenced on September 3, 2020 and was completed on November 28, 2020.
- The D2O Storage Project supported the refurbishment of Unit 3 beginning in Q4 2020 and will support the refurbishments of Units 1 and 4, including the overlapping refurbishment period.
- Installation of the Unit 3 Accessibility Platform Trolley and End Fitting Seal Caps began immediately after defuel and was completed on December 4, 2020.
- Installation of the Unit 3 Containment Bulkheads was completed on January 7, 2021.
- Removal of the Unit 3 Fuel Machine Bridge and Installation of the Refurbishment Tool Platform was completed on March 31, 2021.
- Removal of the Unit 3 Feeders was completed on May 15, 2021.
- End Fitting Removal completed on August 14, 2021.
- Calandria Tube Insert Removal was completed on September 15, 2021.

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.

- Three Integrated Implementation Plan (IIP) tasks for Unit 3 refurbishment are complete and the 25 remaining tasks for Unit 3 are tracking to the current plan approved by the Canadian Nuclear Safety Commission.

SAFETY

Safety is a priority for OPG. 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 2021, the Program reported a Total Recordable Injury Frequency (TRIF) of 0.33 against its internal target of 0.40 as a result of eight medically treated injuries from Q1 to Q3 2021. 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 33 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 2021.

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 reduce the likelihood of future incidents.

PERFORMANCE METRICS SUMMARY

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

Table 1 – Safety Performance Metrics									
		Historical Actuals					2021		
Category	Measure	2016	2017	2018	2019	2020	Sep YTD²	OPG Target	Ontario Construction Industry 2020³
Safety	TRIF (per 200k hours) ¹	0.64	0.49	0.39	0.52	0.35	0.33	0.4	3.95
	Lost Time Injuries	0	0	0	1	0	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 2020 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 likelihood of serious events from occurring. The following are the key safety campaigns, programs, and initiatives that OPG and its vendor partners launched in 2021:

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 Program, posed by COVID-19. To date, OPG's emergency preparedness and implementation of enhanced safety measures have allowed essential workers and support staff to keep working safely. OPG has also been able to keep non-plant employees working from home, where possible. As of September 2021, employees previously working from home have been able to return to OPG worksites with COVID-19 safety protocols in place.

The protocols implemented by OPG include:

- Physical distancing through reduced/amended capacity in certain buildings, staggered schedules and staggered lunches and breaks.
- Use of face coverings.
- COVID-19 screening protocols, including an OPG QR code that require daily active screening for all staff.
- Abbott Panbio Rapid Antigen Testing at OPG sites including mandatory testing when onboarding.
- Increased number of hand sanitizing stations and portable hand washing units.
- Increased cleaning of major touch points.
- Comprehensive response procedures including screening/identification/isolation procedures for suspected cases along with deep clean protocols.
- Ongoing monitoring, review and preparation for any continued COVID-19 impacts, taking into account operating experience, lessons learned and public health guidelines.
- Encouragement and resources provided to advise staff of benefits of vaccinations.
- COVID-19 testing (including rapid screening tests for OPG and vendors) utilized for regular testing of unvaccinated employees/vendors.

- **A Fail-Safe Approach to Safety and Human Performance**

This initiative includes greater emphasis on safe work planning and event learning, recognition for safety-related improvements and the presence of defenses, and reviews to identify any areas of vulnerability if error occurs. Fail-Safe involves a strategy team consisting of OPG and vendors who are engaging workers in practices which utilize effective safety tools and defenses. Fail-Safe aligns with OPG's strategic direction to approach safety and human performance proactively. It identifies and strengthens the defenses in place to ensure events occur safely with no adverse consequences to the plant, people, or equipment if an event does occur. This initiative includes developing the Fail-Safe communication and implementation plan, providing training, and fostering worker engagement.

- **Staying on Top of Safety Initiative**

The objective of this initiative is to strategically dedicate time in the field to look out for one another by recognizing and reinforcing good safety behaviours. This program enhances working relationships and helps foster a culture of positive peer coaching. The focus is basic safety behaviours and observations are recorded in an OPG application allowing individuals to input and analyze observations and coaching reports for purposes of trending and lessons learned.

- **Unit 1 Proactive Human Performance and Safety Plan**

This initiative will build on the existing plan and will have 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 Units 2 and 3. This initiative includes mapping these events onto the Unit 1 schedule and developing actions to reduce the likelihood of recurrence of similar events on the remainder of Unit 3 and Unit 1.

- **Self-Assessments and Surveillances**

In addition to lessons learned, OPG's Health and Safety group conducts several 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 2021 include:

- Working at Heights Self-Assessment
- Equipment-Assisted Material Handling Self-Assessment
- Confined Space Self-Assessment
- Falling Objects Nuclear Refurbishment Self-Assessment
- Cost & Value Self-Assessment related to Gloves used Under Radiation Personal Protective Equipment in Containment
- Musculoskeletal Disorder Self-Assessment
- Falling Objects Self-Assessment related to Upper Feeder Installation Work
- Electrical Safety Self-Assessment

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 OPG’s “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’s radiological safety performance and includes both OPG and vendor employees.

Table 2 – Radiological Safety Performance Metrics						
	2019 Year End		2020 Year End		2021 End of Q3	
	Actual	Target	Actual	Target	Actual	Target
CRE (person-rem)¹	520	430	129	334	880	1104
Unplanned Exposures	0	0	0	0	0	0

Note:

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

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.

The quality management program is used to identify issues during refurbishment execution by focused oversight of vendor performed work. The quality of work on Unit 3 execution has been excellent to date with no Significant Quality Events. Incorporation of Unit 2 lessons learned, improved integrated training and collaboration between OPG and its vendor partners has resulted in strong quality performance on Unit 3.

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), and manage day-to-day activities, allowing for early escalation of issues.⁴ The use of a Working Schedule and High Confidence Schedule is an industry leading best practice for large and complex projects.

Based on the strong performance of Unit 3 to date, OPG has advanced its High Confidence Schedule for Units 3, 1 and 4 as part of the U1EE forecast. However, given significant ongoing schedule risks such as execution of the first units in an overlapped manner (Units 3 and 1) and COVID-19, from a program and system planning perspective, OPG continues to maintain its previous public commitment durations for each unit as it gains understanding of any impacts of these risks.

PERFORMANCE METRICS SUMMARY

As reflected in OPG's final U3EE dated August 2020, in response to COVID-19, OPG deferred the start of Unit 3 refurbishment 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 3 provides a summary of the Unit 3 schedule performance relative to the RQE/U3EE Working Schedule and High Confidence Schedule.

Table 3 – Unit 3 Schedule Performance Metrics			
Measure	2020 Year End Actual	2021 Q3 Actual	Working Schedule Target
Days Ahead of / Behind High Confidence Schedule LTD ¹	9 Days Ahead	75 Days Ahead	N/A
Critical Path Days Ahead of / Behind Working Schedule LTD ²	9 Days Ahead	48 Days Ahead	4-Sep-23
SPI ³	0.95	1.04	1
Forecast Working Schedule Completion Date ²	4-Sep-23	4-Sept-2023	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. 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.
3. SPI is calculated for construction, commissioning and inspection work packages only against the Working Schedule and SPI calculation includes both critical path and the non-critical path works.

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

Table 4 provides the planned key milestone completion dates for Unit 1 per the U1EE.

Table 4 – Key Unit 1 Milestone Status		
Key Milestone	High Confidence Schedule Planned Completion	Public Commitment Planned Completion
Segment 1 [Defuel / Lead In] Complete	July 9 th , 2022	N/A
Segment 2 [Removal] Complete	April 21 st , 2023	
Segment 3 [Install] Complete	June 7 th , 2024	
Segment 4 [Lead Out / RTS] Complete	January 3 rd , 2025	April 18 th , 2025

Note:

1. A risk based schedule assessment of the Public Commitment planned duration by segment has not been conducted. The Public Commitment planned duration is used to track the Unit 1 Segment 4 RTS (Return-to-Service) completion only.

COST

Total Program expenditures to date are \$8.1 Billion with the current estimate to complete the Program at \$4.7 Billion (excluding COVID-19 impacts). The total capital and OM&A cost through Unit 2, including all Early In-Service (EIS) and Campus Plan projects (but excluding the D2O Storage Project) was \$5.7 Billion.

After the approval of the RQE in 2015, OPG established the U2EE⁵ in August 2016, the final U3EE⁶ in August 2020, and the U1EE in November 2021. Detailed planning associated with the final U3EE and U1EE confirmed that the overall Program and associated contingencies were within the \$12.8 Billion set at RQE, exclusive of COVID-19 impacts.

Unit 2 (excluding Definition Phase) was returned to service on budget compared to the U2EE at a total cost of \$3,417 Million, \$11 Million over the RQE forecast of \$3,406 Million. Unit 2 including Definition Phase and Campus Plan projects (excluding the D2O Storage Project) in-service amounts remain at an approximate \$133 Million variance to OEB-approved amounts in EB-2016-0152.

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

Table 5 – Cost Performance Metrics Unit 3 ¹				
Unit	CPI (Q3 2021)	LTD Q3 2021 Actual Cost	Current Estimate to Complete	Current Estimate at Completion
Unit 3	0.99	\$1.4 Billion	\$1.1 Billion	\$2.5 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 Ex. 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.

⁵ A copy of U2EE is provide in EB-2016-0152 (Ex. L-4.3-1, Staff-055)

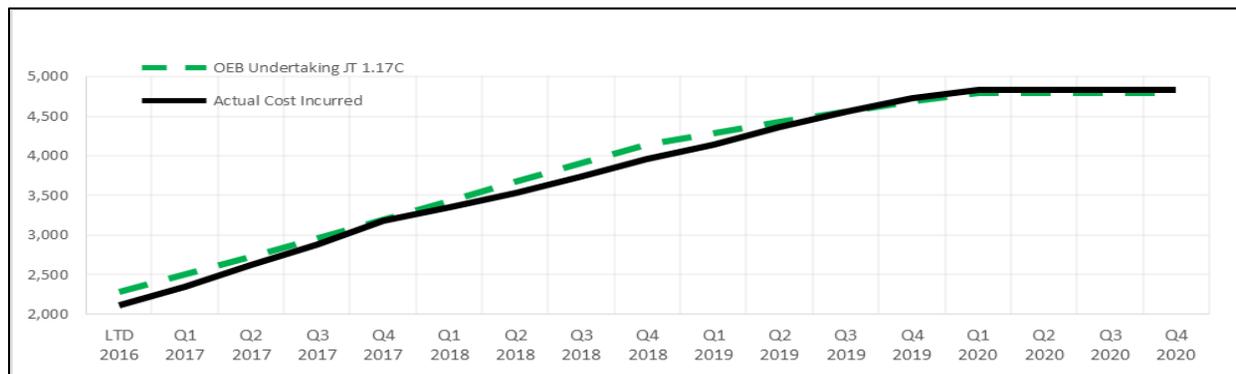
⁶ A copy of U3EE is provide in EB-2020-0290 (Ex. D2-2-7, Attachment 1)

Table 6 – Actual vs. Forecast Cumulative Capital Costs		
M\$	OEB Undertaking JT1.17C (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
Q4 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 U1EE, the refurbishment of Unit 3 is forecast to be completed within the budget of \$2,559 Million set per the final U3EE, and the estimated costs to complete the refurbishments of Unit 1 and Unit 4 are \$1,984 Million and \$2,086 Million, respectively, excluding any COVID-19 impacts.

Life-to-date expenditures are \$1,412 Million for Unit 3, \$288 Million for Unit 1, and \$185 Million for Unit 4. Per the U1EE, the overall Program estimate remains within the \$12.8 Billion RQE budget, excluding COVID-19 impacts.

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

The strategy for Design Engineering is to replicate the Engineering Changes (ECs) from Unit 2 and Unit 3 and modify the ECs for use on Units 1 and 4, as required, based on lessons learned. Unit 1 design ECs are progressing on plan and are 98% complete.

Unit 4 design ECs are also progressing on plan and are 67% complete. The remaining Unit 4 ECs are mainly associated with incorporating lessons learned from Units 2 and 3 for the emergency heat sink, auxiliary shutdown cooling, and fire protection modifications. All engineering packages are expected to be completed ahead of the segment-related design milestones.

Major engineering accomplishments in the period include:

- Leveraging the fact that the scopes of work required to refurbish each of the four Darlington units are largely similar, an in-house design model was used for Unit 3/1/4 Balance of Plant modifications where OPG Design Engineering managed the design replication efforts. This approach has resulted in good performance.
- Modifications to the Unit 3 Turbine Generator have been completed and static commissioning is expected to commence in Q4 2021.

Lessons learned and strategic improvements from Unit 2 and Unit 3 (collected to date) are incorporated into subsequent unit designs. Some of these improvements are highlighted below:

- For the remaining units, the pressure tubes and calandria tubes will be removed simultaneously using new tooling. This tooling is in use for Unit 3 and is resulting in efficiencies compared to Unit 2.
- For the Unit 2 auxiliary shutdown cooling modifications, there were a large number of field initiated changes due to interferences with other systems and structures. For Unit 3, laser scanning in the plant was used to create a 3D model. The model was used to create the design drawings related to the interferences, which significantly reduced the number of Unit 3 field initiated changes.

PROCUREMENT

PROCUREMENT STATUS FOR UNIT 3

At the end of Q3 2021, 98% of purchase orders were issued and 96% of the requested materials for the 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 2021, 92% of purchase orders were issued and 86% of all the requested materials for the 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 the Unit 4 refurbishment is in progress and on track to meet the planned need dates.

CONSTRUCTION

CONSTRUCTION PROGRESS SUMMARY

As of September 30, 2021, the execution of Unit 3 is 45% complete and non-critical path activities are 51% complete. The following major accomplishments occurred within the period:

- Installation of the Unit 3 Containment Bulkheads was completed on January 7, 2021.
- Removal of the Unit 3 Fuel Machine Bridge and installation of the Refurbishment Tool Platform was completed on March 31, 2021.
- Removal of the Unit 3 Feeders was completed on May 15, 2021.
- Turbine Generator centerline and generator rewind work was completed on August 8, 2021.
- Calandria Tube Insert Removal was completed on September 15, 2021.
- Critical path work is progressing through the FOAK concurrent removal of calandria and pressure tubes which started on September 15, 2021.
- Installation of the Unit 3 Auxiliary Shutdown Cooling and Emergency Heat Sink Modifications are in progress.

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

As of September 30, 2021, the Program continues to have excellent environmental performance with no reportable spills or infractions. Emissions are 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. Unit 3 return-to-service is forecasting on schedule.

PROGRAM RISKS AND RISK MANAGEMENT

OPG uses a robust risk management process where risks are identified, classified, quantified and mitigated, to the extent possible. Industry 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.

Major risks to the Program have not changed since OPG's 2020 DRP Annual Report. 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, vendors 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.
 - Implementing a hybrid shift schedule to attract and retain the right resources and apply a sustainable schedule for the duration of the Program.
 - (c) Building up new sources of supply through:
 - Partnership with the OPG Indigenous Opportunities Network representatives and Durham College to create Millwrights Training program to train Indigenous candidates to become Millwright apprentices at OPG.
 - Pilot program (Skilled Trades Expanding Opportunities Network) with Durham College, the Millwrights Local 2309, CanAtom and Black & McDonald to accelerate the hiring of women into the Millwrights. Several female candidates have already been hired from the Durham College program directly into Millwrights to start apprenticeships at OPG.
 - Completion of the Boilermaker Helper program and Boilermaker helpers hired for the Unit 3 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. Mitigation actions for this risk are on-going for Units 3, 1 & 4.
3. **Disruption of Refurbishment Program due to COVID-19:** To help manage the COVID-19 risk, a number of mitigating actions are in place, including:
- (a) Business Continuity Plan and Crisis Management Communication Centre remain activated including detailed readiness plans in place for any potential disruption due to subsequent waves of COVID-19.
 - (b) Active COVID-19 daily screenings.
 - (c) COVID-19 testing (including rapid screening tests for OPG and vendors) continues to be in place and will be utilized for regular testing of unvaccinated employees/vendors.
 - (d) Critical OPG and vendor project staff remain working full time in the workplace while still maintaining a reduced building capacity. Support staff began the transition back to the workplace in September 2021.

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	2021
Planned at RQE	740	752	758	747	N/A
Planned at U3EE	N/A				880
Actual ²	797	867	850	722	724 ¹

Notes:

1. Actual FTEs for 2021 are as of September YTD.
2. 2017-2019 actuals restated based on minor retroactive organizational changes.

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 continues to leverage industry best practices and utilize enterprise-wide talent and succession planning processes. This helps to ensure 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 implemented a training program specifically designed to advance project management capability across the organization.

FILED DECEMBER 16, 2022

Darlington Refurbishment Program Annual Report

2022 REPORT

AS PER DECISION AND ORDER IN EB-2020-0290

TABLE OF CONTENTS

INTRODUCTION	2
EXECUTIVE SUMMARY	2
DARLINGTON REFURBISHMENT PROGRAM STATUS	4
OVERVIEW	4
PROGRESS	4
SAFETY	5
PERFORMANCE METRICS SUMMARY	5
Campaigns, Programs, And Initiatives	5
RADIOLOGICAL SAFETY	7
Performance Metrics Summary	7
QUALITY	7
SCHEDULE	7
Performance Metrics Summary	8
COST	9
ENGINEERING	11
PROCUREMENT	12
Procurement Status For Unit 3	12
Procurement Status For Unit 1	12
Procurement Status For Unit 4	12
CONSTRUCTION	12
Construction Progress Summary	12
Labour Relations Issues Summary	12
Environmental Issues Summary	13
TESTING, START-UP, AND COMMISSIONING	13
Return-To-Service	13
PROGRAM RISKS AND RISK MANAGEMENT	13
STAFFING	13
Refurbishment Resources	13
Efforts To Fill Open Positions	14



FOR INFORMATION to the Ontario Energy Board

December 16, 2022

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, 2022.

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-2020-0290.¹

EXECUTIVE SUMMARY

The Program is a multi-year, multi-phase, mega-project that will enable the Darlington Generating Station (Darlington) to continue safe and reliable operation until 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 and further refined its unit and Program estimates through the Unit 2 Execution Estimate (U2EE) in August 2016, Unit 3 Execution Estimate (U3EE) in August 2020 and Unit 1 Execution Estimate (U1EE) in November 2021. All of these maintained the Program estimate, exclusive of COVID-19 impacts, within the original \$12.8 Billion RQE budget and continue to forecast completion of the Unit 4 refurbishment in 2026. The U3EE formed the basis of OPG’s December 2020 pre-filed evidence in EB-2020-0290¹. OPG measures its performance over the refurbishment of each unit against each unit’s execution estimate.

The Program continues to track to the \$12.8 billion budget, excluding the impacts of “black swan” events such as the COVID-19 pandemic. Based on COVID-19 impacts experienced to date, OPG forecasts costs of approximately \$175 Million. OPG continues to assess and seek ways to manage the impact of the COVID-19 pandemic on the project’s total cost. In addition, OPG is continuing to assess and monitor potential impacts associated with the current extraordinary inflationary environment on the project.

Unit 2 was successfully returned to service on June 4, 2020. Completion of the Unit 2 refurbishment on budget and with a small schedule variance of just over three months represented a significant achievement in mega-project execution for OPG.

Unit 3 refurbishment is currently in its third major segment, Reassembly, which involves the installation and reassembly of reactor components, including new feeder tubes and Fuel Channel Assemblies. Following the successful completion of the fuel channel installation in July 2022, Lower Feeder Installation series commenced and is targeted for completion in the fourth quarter of 2022. Unit 3 is currently expected to be returned to service by late 2023, ahead of the committed return to service date of the first quarter of 2024.

¹ EB-2020-0290, Decision and Order, dated November 15, 2021, Schedule A (OEB Approved Settlement Proposal), Appendix A, p. 1.

The final U1EE was approved by OPG's Board of Directors in November 2021 in advance of the start of the refurbishment outage on Unit 1 and incorporated additional lessons learned, and strategic improvements based on the Unit 3 refurbishments. Per the final U1EE, the budget and High Confidence Schedule to complete Unit 1 are \$1,984 Million and 38 months, respectively.

On February 15th, 2022, OPG commenced defueling of the Unit 1 reactor, marking the start of Unit 1 refurbishment execution. Unit 1 refurbishment is currently in its second major segment, Disassembly, with activities progressing on schedule, following the completion of the Feeder Cabinet Removal in September 2022. The removal of fuel channel assemblies is expected to commence in the fourth quarter of 2022 with the removal of end fittings. As demonstrated by the performance to date, lessons learned, and strategic improvements have contributed to unit over unit efficiencies. Unit 1 is scheduled to be returned to service in the second quarter of 2025.

Preparation for the refurbishment of Unit 4 is progressing on plan. The execution estimate for Unit 4 is planned to be completed March 2023. Field execution work plans and material procurement continues to progress well and remain on schedule.

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 39 million hours worked with only one Lost Time Injury² since the start of the Program, which occurred in May 2019.
- **QUALITY:** The quality management program is used to identify issues during refurbishment execution by focused surveillance of vendor-performed work. There have been no Significant Quality Events (SQEs) recorded on Unit 3 or Unit 1 to date. Relative to Unit 2, there has been significant improvement in Unit 3 Feeder program welding activities.
- **SCHEDULE:** Unit 3 refurbishment activities are currently progressing ahead of schedule. On July 18, 2022, the project completed the Fuel Channel Installation Series, and successfully transitioned into the Lower Feeder Installation Series, and is progressing on track. Unit 3 is expected to be returned to service ahead of the committed return to service date of the first quarter of 2024. Unit 1 refurbishment activities are progressing on plan and on September 8, 2022, the project completed the Retube Tooling Platform series and transitioned into Feeder Cabinet Removal window, which was successfully completed September 20, 2022. Unit 1 Critical Path is now progressing through the Feeder Removal series. Unit 1 is forecast to be returned to service on schedule by Q2 2025.
- **COST:** Total Program expenditures to date are \$9.0 Billion with the current remaining estimate to complete the Program at \$3.8 Billion (excluding COVID-19). Excluding COVID-19 impacts, life-to-date expenditures are \$1,937 Million for Unit 3, \$643 Million for Unit 1, and \$232 Million for Unit 4.

PROGRESS

The refurbishment of Unit 3 is 84% complete. Following is a status summary, as of September 30, 2022, of the major work completed since the 2021 DRP Annual Report filed December 31, 2021:

- Calandria Tube (CT) Installation series completed March 14, 2022.
- Upper and Middle Feeder Installation completed April 12, 2022.
- Fuel Channel Installation completed July 18, 2022.
- Successful completion of the first Unit 3 Restart Control Hold Point 1 (RCHP 1) on July 28, 2022.
- Turbine Generator (TG) Static Commissioning completed September 23, 2022.
- Seven Integrated Implementation Plan (IIP) tasks for Unit 3 refurbishment have been completed with 22 remaining. Remaining IIP tasks are tracking to the current plan approved by the Canadian Nuclear Safety Commission (CNSC). The Safety Improvement Opportunity update is now included as a Unit 3 IIP task.

The refurbishment of Unit 1 is 25% complete. Following is a status summary, as of September 30, 2022, of the major work completed since the 2021 DRP Annual Report filed December 31, 2021:

- Defueling completed April 23, 2022.
- Installation of Accessibility Platform Trolley and End Fitting Seal Caps completed on May 4, 2022.
- Installation of Containment Bulkheads completed June 9, 2022.
- Containment pressure test and final vault commissioning completed June 22, 2022.

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.

- Bulk Interference Removal series completed July 13, 2022.
- Removal of 1 Fuel Machine Bridge and Installation of the Refurbishment Tool Platform completed September 8, 2022.
- Feeder Cabinet Removal completed September 20, 2022.
- Nine IIP tasks for Unit 1 refurbishment have been completed with 25 remaining. Remaining IIP tasks are tracking to the current plan approved by the CNSC.

SAFETY

Safety is a top priority for OPG. 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. At the end of Q3 2022, the Program reported a Total Recordable Injury Frequency (TRIF) of 0.26 against its internal target of 0.40, reflecting seven medically treated injuries from Q1 to Q3 2022. 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 over 39 million hours worked with only one Lost Time Injury, which occurred in May 2019 with no Lost Time Injuries since then.

OPG employs a variety of leading indicators to ensure that issues are addressed before incidents occur. OPG's practice of proactively tracking events/safety incidents 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 reduce the likelihood of future incidents.

PERFORMANCE METRICS SUMMARY

Table 1 provides a summary of the Program's Safety Performance and includes OPG and Vendor workers.

Safety Performance Metrics										
			Historical Actuals						Actual	IHSA
Category	Measure	OPG Target	2016	2017	2018	2019	2020	2021	2022 (Q3) YTD	Ontario Construction Industry 2021
Safety	TRIF (Total Recordable Injury Frequency)	0.40	0.64	0.49	0.39	0.52	0.35	0.25	0.26	4.58
	Lost Time Injuries	0	0	0	0	1	0	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. IHSA rating is the most current safety rating for the Ontario Construction Industry (current as of 2021 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 likelihood of serious events from occurring. The following are the key safety campaigns, programs, and initiatives that OPG and its vendor partners launched in 2022:

- **A Fail-Safe Approach to Safety and Human Performance**

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

This initiative builds on the existing plan which includes greater emphasis on safe work planning, event learning, recognition for safety-related improvements and the presence of defenses. Fail-Safe involves a strategy team consisting of OPG and vendors who are engaging workers in practices which utilize safety tools and defenses. Fail-Safe aligns with OPG's strategic direction to proactively approach safety and human performance. It identifies defenses in place to ensure events occur safely with no adverse consequences to people, the plant or equipment. This initiative involves developing the Fail-Safe communication and implementation plan, training and fostering worker engagement. Recent accomplishments include engaging vendors to support Fail-Safe workshops for work planning by implementing strong defenses prior to execution of work, and creation of a fleet Fail-Safe guide & plan to track accomplishments and set goals.

- **Remote Monitoring**

OPG and CanAtom worked to develop a solution to mitigate the risk of heat stress for workers. Monitoring conditions for heat stress and calculating work rest regimens had been done with the Wet Bulb Global Temperature device in the field, which required the personnel performing the testing to be exposed to the conditions. OPG is implementing the new X-Labs WIFI Gateway wireless transceiver to transmit sensor data to the cloud for remote monitoring. This enables immediate access to current conditions and reduces wait time by providing real time metrics.

- **Implementation of Worklete**

OPG is piloting the Worklete project to address body mechanic hazards. Worklete uses a micro-learning approach to teach employees safe body mechanic principles. It helps build muscle memory and safe habits that can be applied to any task, whether at or outside of work.

- **My reasons for working safely lanyard card initiative**

OPG has implemented a personalized initiative for working safely. All employees, including vendors, identify their personal reason for working safely (e.g., for family, pet, themselves, etc.) using a photo attached to their lanyard. This reminds employees why they need to work safely on an individual and co-worker level.

- **Confined Space App Implementation**

OPG developed and implemented the Confined Space App to reduce errors in confined space documentation, provide interlocks, and to ensure unqualified workers are not assigned to confined space work. The App has been found effective in reducing documentation errors and non-compliances.

- **Response to COVID-19**

OPG has remained vigilant with its safety protocols and protective measures to mitigate COVID-19 transmissions in accordance with Provincial guidelines.

- **Units 314 Proactive Human Performance and Safety Plan**

This initiative builds on the existing plan and will have 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 Units 2, 3 & 1. This initiative includes mapping these events and developing actions to reduce the likelihood of similar events on Unit 4 and the work remaining on Unit 3 and Unit 1.

- **Self-Assessments and Surveillances**

In addition to lessons learned, OPG's Health and Safety group conducts several self-assessments and surveillance on higher risk areas to ensure improvements are incorporated into planning to reduce the risk of injury. Examples of self-assessments and surveillance performed in 2022 include:

- Working at Heights and Falling Objects Self-Assessment
- Material Handling and Safe Driving Practices Self-Assessment
- Confined Space Self-Assessment and Follow up Confined Space Self-Assessment
- Industrial Hygiene Self-Assessment

RADIOLOGICAL SAFETY

OPG’s Radiological Protection (RP) program continues to meet regulatory requirements and industry standards. No worker has received a dose above regulatory limits or OPG’s more stringent internal targets. This performance is a result of OPG’s robust nuclear safety culture and OPG’s “As Low as Reasonably Achievable” (ALARA) radiological safety principles. Lessons learned on Unit 2 have been incorporated into training and enhanced radiological safety measures on Unit 3 and Unit 1. 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’s radiological safety performance and includes both OPG and vendor employees.

Table 2 – Radiological Safety Performance Metrics						
	2020 Year End		2021 Year End		2022 End of Q3	
	Actual	Target	Actual	Target	Actual	Target
Unit 3 CRE (person-rem)¹	129	334	1028	1379	294	543
Unit 1 CRE (person-rem)¹	N/A	N/A	N/A	N/A	379	560
Unplanned Exposures	0	0	0	0	0	0

Note:

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

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 highly technical welding operations that are critical. A certain amount of rework is to be expected on a program of this nature.

The quality management program is used to identify issues during refurbishment execution by focused surveillance of vendor performed work. The quality of work on Unit 3 and 1 has been good to date. Relative to Unit 2, there has been significant improvement in the quality of welding activities on the U3 Feeder program.

Incorporation of Unit 2 and 3 lessons learned, and Kaizen/Six Sigma lean practices have improved industrial and radiological safety, tooling, critical task training, organizational alignment, and One Team culture. Critical path savings have resulted from two trolley defuel, Pressure Tube/Calandria Tube removal tool redesign, bulkhead shielding removal, and general overall proficiency due to training improvements.

SCHEDULE

OPG measures Program progress against two schedules:

1. A longer High Confidence Schedule
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), and manage day-to-day activities, allowing for early escalation of issues.⁴ The use of both a Working Schedule and High Confidence Schedule is an industry leading best practice for large and complex projects.

Based on the strong performance of Unit 3 to date, OPG has advanced its High Confidence Schedule for Units 3, 1 and 4 as part of the U1EE forecast. Given inherent schedule risks remain from factors such as the ongoing execution of the units in an overlapped manner (Units 3 and 1), OPG continues to maintain its previous public commitment durations for each unit.

PERFORMANCE METRICS SUMMARY

Table 3A provides a summary of the Unit 3 schedule performance relative to the U3EE Working Schedule and High Confidence Schedule.

Table 3A - Unit 3 Schedule Performance Metrics				
Measure	2020 Year End Actual	2021 Year End Actual	2022 Q3 Actual	Working Schedule Target
Days Ahead of / Behind High Confidence Schedule LTD ¹	9 Days Ahead	76 Days Ahead	107 Days Ahead	N/A
Critical Path Days Ahead of / Behind Working Schedule LTD ²	9 Days Ahead	44 Days Ahead	60 Days Ahead	4 - Sept - 2023
SPI ³ (Schedule Performance Index)	0.95	1.00	1.01	1.00
Forecast Working Schedule Completion Date ²	4 - Sept - 2023	4 - Sept - 2023	4 - Sept - 2023	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. Critical Path Days Ahead/Behind and Forecast Working Schedule Completion Date are calculated as progress for all work currently completed relative to the Working Schedule and do not consider projected gains or losses for future work.
3. SPI is calculated for construction, commissioning, and inspection work packages only against the Working Schedule and SPI calculation includes both critical path and the non-critical path works.

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

Table 3B provides a summary of the Unit 1 schedule performance relative to the U1EE Working Schedule and High Confidence Schedule.

Table 3B - Unit 1 Schedule Performance Metrics		
Measure	2022 Q3 Actual	Working Schedule Target
Days Ahead of / Behind High Confidence Schedule LTD ¹	24 Days Ahead	N/A
Critical Path Days Ahead of / Behind Working Schedule LTD ²	1 Day Ahead	14 - Oct - 2024
SPI ³ (Schedule Performance Index)	0.87	1.00
Forecast Working Schedule Completion Date ²	14 - Oct - 2024	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. Critical Path Days Ahead/Behind and Forecast Working Schedule Completion Date are calculated as progress for all work currently completed relative to the Working Schedule and do not consider projected gains or losses for future work.
3. SPI is calculated for construction, commissioning and inspection work packages only against the Working Schedule and SPI calculation includes both critical path and the non-critical path works.

COST

Total Program expenditures to date are \$9.0 Billion with the current remaining estimate to complete the Program at \$3.8 Billion (excluding COVID-19 impacts).

After the approval of the RQE in 2015, OPG established the U2EE⁵ in August 2016, the final U3EE⁶ in August 2020, and the U1EE in November 2021. Detailed planning associated with the final U3EE and U1EE confirmed that the overall Program and associated contingencies were within the \$12.8 Billion set at RQE, exclusive of COVID-19. OPG is currently completing the U4EE, which is on track for March 2023. Planning and pre-requisite activities for the refurbishment of Unit 4 are progressing as planned. The planning, pre-requisite and execution work for Unit 1 and Unit 4 refurbishments has and will incorporate the benefits of experience with the first two units, Unit 2 and Unit 3, and additional strategic improvements. The refurbishment of Unit 4 is scheduled to be completed by the end of 2026.

⁵ A copy of U2EE is provided in EB-2016-0152 (Ex. L-4.3-1, Staff-055)

⁶ A copy of U3EE is provided in EB-2020-0290 (Ex. D2-2-7, Attachment 1)

Table 4 provides a summary of the cost performance metrics for Unit 3 and Unit 1.

Table 4 – Cost Performance Metrics Unit 3 & Unit 1¹ (Millions)				
Unit	CPI (Q3 2022)	LTD Q3 2022 Actual Cost	Current Estimate to Complete	Current Estimate at Completion
Unit 3	0.98	\$1,937	\$595	\$2,532
Unit 1	0.96	\$643	\$1,341	\$1,984

Note:

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

Table 5 provides a summary of the Total Program Actual Cost Incurred vs. Forecast Cumulative Costs for all Units (excluding the impacts of COVID-19):

Table 5 – Total Program Actual vs. Forecast Cumulative Costs EB-2020-0290 (Millions)		
	Forecast Cumulative Costs¹	Actual Cost Incurred²
Q1 2021	7,746	7,637
Q2 2021	8,048	7,861
Q3 2021	8,324	8,076
Q4 2021	8,575	8,289
Q1 2022	8,849	8,518
Q2 2022	9,153	8,758
Q3 2022	9,438	9,003
Q4 2022	9,735	
Q1 2023	10,050	
Q2 2023	10,327	
Q3 2023	10,576	
Q4 2023	10,836	
Q1 2024	11,101	
Q2 2024	11,380	
Q3 2024	11,617	
Q4 2024	11,829	
Q1 2025	11,982	
Q2 2025	12,126	
Q3 2025	12,283	
Q4 2025	12,439	
Q1 2026	12,577	
Q2 2026	12,662	
Q3 2026	12,723	

Q4 2026	12,800	
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Notes:

1. Total Program forecast cumulative costs (inclusive of capital and OM&A costs) are per EB-2020-0290, Ex. L-D2-02-Environmental Defence-005, Chart 1 and exclude COVID-19 impacts. The expenditures are based on the U3EE, which did not separate between capital and OM&A costs. As stated in the interrogatory response, as OPG continues to execute Units 3 and 1, and implements further Lessons Learned and Strategic Initiatives to the planning and execution of Unit 4, the forecast quarterly expenditure profile may change. OPG will continue to report on this basis for ease of comparability.
2. Actuals are based on life-to-date total Program spend, inclusive of both capital and OM&A costs, and exclude COVID-19 impacts.

Per the U1EE, the refurbishment of Unit 3 estimated total cost to complete is \$2,532 Million, within the budget of \$2,559 Million set per the final U3EE, and the estimated total costs to complete the refurbishments of Unit 1 and Unit 4 are \$1,984 Million and \$2,086 Million, respectively, excluding any COVID-19 impacts.

Life-to-date capital and OM&A expenditures, excluding COVID-19, as of Q3 2022 are \$1,937 Million for Unit 3, \$643 Million for Unit 1, and \$232 million for Unit 4.

OPG will continue to monitor, track, and explore potential efficiencies during the execution of the refurbishment of remaining units in an effort to complete the Program within the \$12.8 Billion budget inclusive of COVID-19 cost impacts. OPG is also continuing to assess and monitor potential impacts on the project associated with the current extraordinary inflationary environment as part of development of the U4EE.

ENGINEERING

The strategy for Design Engineering is to replicate the Engineering Changes (ECs) from Unit 2 and Unit 3 and modify the ECs for use on Units 1 and 4, as required, based on lessons learned.

Currently, engineering is 99% complete, and the remaining ECs are mainly associated with incorporating lessons learned from Unit 3 for the turbine generator (TG) and fire protection software modifications.

Major engineering accomplishments in the period include:

- First of a kind turbine generator (TG) static commissioning has been completed for Unit 3 including integrated system testing of all TG trip tests.
- Unit 1 engineering design changes are 100% complete for all refurbishment programs.

Lessons learned and strategic improvements from Unit 2 and Unit 3 (collected to date) have been incorporated into subsequent unit designs. Some of these improvements are highlighted below:

- Robust Construction Complete Declaration (CCD) and System Available for Service (SAFS) process that has been proven on Unit 2. Lessons learned have been incorporated to help with timing and integration of the CCD and SAFS processes into the schedule and CNSC hold point reviews.
- Foreign Material Exclusion (FME) Program – Building on Unit 2, the team developed improved FME, and FME inspection strategies for DNRU3 which resulted in a significant reduction in FME findings in Primary Heat Transport header and upper and middle feeders. This has reduced inspection time on critical path and helped to protect the integrity of the fuel, which will aid the team to reach the corporate goal of zero fuel defects.
- Engineering staff are highly integrated with CanAtom under One Team model for RFR.

PROCUREMENT

PROCUREMENT STATUS FOR UNIT 3

98% of materials for Unit 3 have been delivered to site as planned, with remaining material tracking to the planned need date.

PROCUREMENT STATUS FOR UNIT 1

91% of purchase orders were issued and 88% of materials for Unit 1 have been delivered to site, with remaining materials tracking to the planned need date.

PROCUREMENT STATUS FOR UNIT 4

71% of purchase orders were issued and 65% of materials for Unit 4 have been delivered to site, with remaining materials tracking to the planned need date.

CONSTRUCTION

CONSTRUCTION PROGRESS SUMMARY

As of September 30, 2022, the execution of Unit 3 is 84% complete and non-critical path activities are 91% complete. The following major accomplishments occurred within the period:

- Calandria Tube Installation series completed March 14, 2022.
- Upper and Middle Feeder Installation completed April 12, 2022.
- The Upper and Middle Feeder post-installation and demobilization completed May 20, 2022.
- Fuel Channel Installation completed July 18, 2022.
- Successful completion of RCHP 1 on July 28, 2022.
- Turbine Generator Static Commissioning completed September 23, 2022.
- Turbine Generator panning for Dynamic Commissioning is currently underway.

As of September 30, 2022, the execution of Unit 1 is 25% complete and non-critical path activities are 38% complete. The following major accomplishments occurred within the period:

- Unit 1 Defueling completed April 23, 2022.
- Installation of Accessibility Platform Trolley and End Fitting Seal Caps completed May 4, 2022.
- Installation of Containment Bulkheads completed June 9, 2022.
- Containment pressure test and final vault commissioning completed June 22, 2022.
- Bulk Interference Removal series successfully completed July 13, 2022.
- Removal of Fuel Machine Bridge and Installation of the Refurbishment Tool Platform completed September 8, 2022.
- Feeder Cabinet Removal completed September 20, 2022.
- Unit 1 is progressing through the Feeder Removal series.

LABOUR RELATIONS ISSUES SUMMARY

In May 2022, the Society of Professional Engineering and Associates engaged in a labour stoppage, which concluded in July 2022 with the ratification of a Collective Agreement. The effects of the strike were well managed and resulted in minimal impact to Program cost and schedule.

In July 2022, Technical Standards and Safety Authority staff engaged in a labour stoppage, which concluded in October 2022 with the ratification of a Collective Agreement. The effects of the strike were well managed resulting in no impacts to Program cost and schedule.

OPG is proactively taking steps to mitigate any risks of future labour relations issues.

ENVIRONMENTAL ISSUES SUMMARY

As of September 30, 2022, the Program continues to have excellent environmental performance with no reportable spills or infractions. Emissions are well below regulatory limits.

TESTING, START-UP, AND COMMISSIONING

RETURN-TO-SERVICE

OPG forecasts Unit 3 return-to-service to occur ahead of schedule, in late 2023.

PROGRAM RISKS AND RISK MANAGEMENT

OPG uses a robust risk management process where risks are identified, classified, quantified, and mitigated. Industry experience dictates that there will be uncertainties that cannot be 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 major risks are being managed by OPG:

1. **Vendor Performance:** Ensuring contractors provide increased capability and a mature succession plan to complete the work successfully, safely and with quality. Additionally, vendors could become stretched as they respond to an increase in construction work. The Quality Management team is standardizing quality measures across the enterprise and creating the infrastructure to support tiered quality metrics and mitigations.
2. **Availability of Skilled Resources / Supervision of Future Units:** The Program has been challenged with skilled craft resource availability. OPG is continuing to monitor, optimize, increase, and develop a better supply of trades for projects. This includes continuing collaboration with key partners such as Bruce Power, Electric Power Systems Construction Association, Boilermakers, Sarnia Construction Association, OPG Indigenous Opportunities Network and Durham College to maximize the supply pool, align project resource demand and training programs.
3. **Inflation:** OPG is managing its response to extraordinary inflationary impacts at a corporate level where DRP exposure is continuing to be assessed and monitored. Mitigation actions have been implemented through supply chain and OPG continues to monitor inflation trends for further mitigation actions as required.

STAFFING

REFURBISHMENT RESOURCES

Table 6 provides a summary of the OPG Resources on the Program:

Table 6 – Full Time Equivalent (FTE) Resources by Year (plan vs. actual)					
Measure	2018	2019	2020	2021	2022
Planned at RQE	752	758	747	N/A	N/A
Planned at U3EE	N/A			880	944
Actual	867	850	722	690	712 ¹

Notes:

1. Actual FTEs for 2022 are as of September YTD.

EFFORTS TO FILL OPEN POSITIONS

Talent acquisition initiatives are in place to fill open positions, primarily in Operations & Maintenance and Execution organizations, as required.

OPG has several Talent Management programs in place to attract, retain, and develop qualified personnel across the company, including for the duration of the Program. Management continues to leverage industry best practices and utilize enterprise-wide talent and succession planning processes. This helps to ensure 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 implemented a training program specifically designed to advance project management capability across the organization.

In 2022, to compliment this training program, a Project Management Community of Practice has been established where selected experienced project management coaches assist junior employees with implementing OPG's enterprise project management processes. To further support employee development and succession planning programs, Career Path documents have been developed for several Enterprise Projects roles for project professionals and business units where their transferrable skillsets can be utilized.

FILED DECEMBER 15, 2023

Darlington Refurbishment Program Annual Report

2023 REPORT

AS PER DECISION AND ORDER IN EB-2020-0290

TABLE OF CONTENTS

INTRODUCTION	2
EXECUTIVE SUMMARY	2
DARLINGTON REFURBISHMENT PROGRAM STATUS	4
OVERVIEW	4
PROGRESS	4
ANNUAL INTEGRATED IMPLEMENTATION PLAN (IIP) COMMITMENT	5
SAFETY	5
Performance Metrics Summary	6
Campaigns, Programs, And Initiatives	6
RADIOLOGICAL SAFETY	7
Performance Metrics Summary	8
QUALITY	8
SCHEDULE	8
Performance Metrics Summary	9
COST	10
ENGINEERING	12
PROCUREMENT	12
Procurement Status For Unit 1	12
Procurement Status For Unit 4	12
CONSTRUCTION	12
Construction Progress Summary	12
Labour Relations Issues Summary	13
Environmental Issues Summary	13
TESTING, START-UP, AND COMMISSIONING	13
Unit 3 Return-To-Service	13
PROGRAM RISKS AND RISK MANAGEMENT	14
STAFFING	14
Refurbishment Resources	14
Efforts To Fill Open Positions	15

December 15, 2023

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, 2023.

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-2020-0290.¹

EXECUTIVE SUMMARY

The Program is a multi-year, multi-phase, mega-project that will enable the Darlington Nuclear Generating Station (Darlington) to continue safe and reliable operation until 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 and further refined its unit and Program estimates through the Unit 2 Execution Estimate (U2EE) in August 2016, Unit 3 Execution Estimate (U3EE) in August 2020, the Unit 1 Execution Estimate (U1EE) in November 2021 and the Unit 4 Execution Estimate (U4EE) in March 2023. All of which maintain the Program estimate, exclusive of external events such as COVID-19, within the original \$12.8 Billion RQE budget and continue to forecast completion of the Unit 4 refurbishment in 2026. The U3EE formed the basis of OPG’s December 2020 pre-filed evidence in EB-2020-0290.¹ OPG measures its performance over the refurbishment of each unit against each unit’s execution estimate.

The cost forecast for the overall Darlington Refurbishment Program remains on plan at \$12.8 Billion, excluding the impact of COVID-19. Based on the COVID-19 impacts to date, OPG is forecasting costs of \$130 Million. In addition, OPG is continuing to assess and monitor potential impacts associated with the current extraordinary inflationary environment on the project.

Unit 2 was successfully returned to service on June 4, 2020. Completion of the Unit 2 refurbishment on budget and with a small schedule variance of just over three months, represented a significant achievement in mega-project execution for OPG.

Unit 3 was successfully reconnected to the grid on July 17, 2023, with good quality and safety, within the approved budget, and 169 days ahead of public commitment schedule. Overall, the return to service of Unit 3 represents another significant milestone for the Program with performance improvements exceeding the planned unit over unit efficiencies. Unit 2 and Unit 3 are operating at 100 percent full power.

The U1EE was approved by OPG’s Board of Directors in November 2021 in advance of the start of the refurbishment outage on Unit 1, and incorporated additional lessons learned, and strategic improvements based on the Unit 2 and Unit 3 refurbishments. Per the final U1EE, the budget and High Confidence Schedule to complete Unit 1 are \$1,984 Million and 38 months, respectively.

¹ EB-2020-0290, Decision and Order, dated November 15, 2021, Schedule A (OEB Approved Settlement Proposal), Appendix A, p. 1.

Unit 1 refurbishment activities are progressing on schedule and are currently in the third major segment, Reassembly, which involves the installation and reassembly of reactor components, including new feeder tubes and fuel channel assemblies. The third segment is progressing as planned, with the Fuel Channel Installation series targeting completion in the fourth quarter of 2023. Unit 1 is on track to be returned to service in the second quarter of 2025.

Unit 4 is the last of four units at the Darlington Nuclear Generating Station undergoing refurbishment. The final U4EE was approved by OPG's Board of Directors in March 2023. Per the final U4EE, the budget and High Confidence Schedule to complete Unit 4 is \$2,128 Million and 37 months, respectively.

Unit 4 execution commenced on July 19, 2023, shortly after the return to service of Unit 3. Based on Independent Electricity System Operator (IESO) grid stability constraints, the approval for the outage was delayed 17 days. Unit 4 safely and successfully completed the defueling of the reactor in September 2023. The unit is progressing through Disassembly segment, forecasting completion in the third quarter of 2024, and is on track to be returned to service in the third quarter of 2026.

DARLINGTON REFURBISHMENT PROGRAM STATUS

OVERVIEW

Key Program highlights include:

- **SAFETY:** Safety performance continues to be better than the average construction industry performance in Ontario. The Program is approaching 50 million hours worked with only one Lost Time Injury² (in May 2019) since the start of the Program.
- **QUALITY:** The quality management program is used to identify issues during refurbishment execution by focused surveillance of vendor-performed work. Quality of work to date has surpassed nuclear standards, and in most cases is industry leading. There have been no Significant Quality Events (SQEs) recorded on Unit 4, Unit 3, and Unit 1 to date.
- **SCHEDULE:** Unit 3 refurbishment completed, 169 days ahead of public commitment schedule and was reconnected to the grid on July 17, 2023. Unit 3 continues to progress through the close out phase which is to be completed by the third quarter of 2024. Unit 1 refurbishment activities are progressing on plan, and Critical Path is progressing through the Fuel Channel Installation Series. Unit 1 is expected to return to service (RTS) by the second quarter of 2025. Unit 4 execution began on July 19, 2023, and is progressing on plan through disassembly segment. Unit 4 is expected to return to service by the third quarter of 2026.
- **COST:** OPG is continuing to track to the \$12.8 Billion budget excluding impact of COVID-19. Total Program expenditures to date are \$10 Billion. Excluding COVID-19 impacts, life-to-date expenditures as of September 30, 2023 are \$2,228 Million for Unit 3, \$1,242 Million for Unit 1, and \$351 Million for Unit 4.

PROGRESS

The refurbishment of Unit 3 is 100% complete. Following is a status summary, as of September 30, 2023, some key milestones are as follows:

- U3 Bulkhead Removal completed April 15, 2023.
- First criticality achieved on May 22, 2023.
- Low Power testing completed June 19, 2023.
- U3 Turbine Generator Dynamic Commissioning completed on July 3, 2023.
- First Synchronization and Run-up completed July 10, 2023.
- Reconnection to the electrical grid completed on July 17, 2023.
- Return to service completed on July 18, 2023.

The refurbishment of Unit 1 is 70% complete. Following is a status summary, as of September 30, 2023, some key milestones are as follows:

- Unit 1 Feeder Removal completed on November 2, 2022.
- Pressure Tube (PT) Sever and Sever Bellows was completed on December 17, 2022.
- End Fitting Removal completed on January 26, 2023.
- Removal of the Calandria Tube (CT) was completed on April 27, 2023.
- Tube Sheet Bore Cleaning completed on May 23, 2023.
- Bellows Inspection completed on June 3, 2023.

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.

- Calandria Tube Install Series completed on August 12, 2023.

The refurbishment of Unit 4 is 11% complete. Following is a status summary, as of September 30, 2023, some key milestones are as follows:

- Unit 4 Shutdown began on July 19, 2023.
- Unit 4 Defueling completed on September 4, 2023.
- Crane Maintenance completed on September 7, 2023.
- End Fitting Cap Installation completed on September 15, 2023.

ANNUAL INTEGRATED IMPLEMENTATION PLAN (IIP) COMMITMENT

- All DNRU3 IIPs are complete and closed.
- Overall, 79% (492 of 622) of IIP commitments have been completed to date. There are 61 overall tasks due in 2023 with 21 IIP items remaining and 40 IIP items are closed/complete. The IIP commitments for 2023 are on track to be achieved.

SAFETY

Safety is a top priority for OPG. OPG has one of the lowest injury rates in the Canadian electricity sector³. In order to maintain this safety performance, OPG continues to set challenging targets for its day-to-day operations. At the end of the third quarter of 2023, the Program reported a Total Recordable Injury Frequency (TRIF) of 0.22 against its internal target of 0.40, reflecting six medically treated injuries from Q1 to Q3 2023. 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 over 50 million hours worked with one Lost Time Injury, which occurred in May 2019 with no Lost Time Injuries since then.

OPG employs a variety of leading indicators to ensure that issues are addressed before incidents occur. OPG's practice of proactively tracking events/safety incidents 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 reduce the likelihood of future incidents. In addition, the Safe Work Planning Assessment (SWPA) is being piloted to assess the quality of direct controls implemented to address high-energy hazards within safe work plans. The implementation of the SWPA is expected by the first quarter of 2024.

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

PERFORMANCE METRICS SUMMARY

Table 1 provides a summary of the Program’s Safety Performance and includes OPG and Vendor workers.

Safety Performance Metrics											
			Historical Actuals							Actual	IHSA ³
Category	Measure	OPG Target	2016	2017	2018	2019	2020	2021	2022	2023 (Q3) YTD ²	Ontario Construction Industry 2022
Safety	TRIF (Total Recordable Injury Frequency) ¹	0.40	0.64	0.49	0.39	0.52	0.35	0.25	0.26	0.22	4.24
	Lost Time Injuries	0	0	0	0	1	0	0	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. IHSA rating is the most current safety rating for the Ontario Construction Industry (current as of 2022 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 likelihood of serious events occurring. The following are the key safety campaigns, programs, and initiatives that OPG and its vendor partners advanced in 2023:

- **A Fail-Safe Approach to Safety and Human Performance**

This initiative is currently ongoing, it includes a greater emphasis on safe work planning, event learning, recognition for safety-related improvements and the presence of defenses. Fail-Safe involves a strategy team consisting of OPG and vendors who are engaging workers in practices which utilize safety tools and defenses. Fail-Safe aligns with OPG’s strategic direction to proactively approach safety and human performance. It identifies defenses in place to ensure events occur safely with no adverse consequences to people, the plant or equipment. For 2023, there is a re-focus on incorporating Fail Safe concepts in Safe Work Plans (SWP) and Pre-Job Briefs (PJB) with the use of multiple strong defenses/direct controls, and hazard recognition to build capacity. The generation of progressive metrics to capture the presence of Fail-Safe defenses is ongoing.

- **Remote Monitoring**

OPG (including X-Labs) and CanAtom worked to develop a solution to mitigate the risk of heat stress for workers. Monitoring conditions for heat stress and calculating work rest regimens had been done with the Wet Bulb Global Temperature device in the field, which required the personnel performing the testing to be exposed to the conditions. In the Unit 1 vault, OPG has implemented the X-Labs WIFI Gateway wireless transceiver to transmit sensor data to the cloud for remote monitoring. This enables immediate access to current conditions and reduces wait time by providing real time metrics.

- **DataCube – Construction Observations Report**

As of the second quarter of 2023, the DataCube was implemented as a digital tool to capture observations, coaching and actions across all field staff in the Enterprise, including Darlington Refurbishment. The report transforms the way we do work by centralizing information on safety related metrics from the field, identifying trends in real time and making informed decisions to act

on the trends in timely manner. The DataCube has been effective in connecting users by notifying relevant groups on the occurrence of key events and streamlining collaboration between OPG and vendor partners.

- **Power Solutions – Safety Culture**

In addition to our existing safety programs, Power Solutions was officially launched across the Enterprise, including Darlington Refurbishment, to empower field staff with the ability to report issues or provide feedback on conditions anonymously to reconcile the concerns. Power Solutions is frequently used by vendor partners and staff to address issues in an expeditious manner and provide feedback to the leadership team on the culture in the field. Since its inception in the second quarter of 2023, the team has addressed over 90% of the issues that have been reported, further driving open communication and OneTeam collaboration with our vendor partners on our safety value practices.

- **Confined Space App Implementation**

OPG developed and implemented the Confined Space App fleetwide to reduce errors in confined space documentation, provide interlocks, and to ensure unqualified workers are not assigned to confined space work. The App has been found effective in reducing documentation errors and non-compliance instances. The Confined Space App has won one internal and two external awards. It represents industry leading safety technology. Work groups using the App have provided positive feedback by noting the App has made the confined space work process more efficient.

- **Units 314 Proactive Human Performance and Safety Plan**

This initiative builds on the existing plan and has 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 and Unit 3. This initiative includes mapping these events and developing actions to reduce the likelihood of similar events occurring during the work remaining on Unit 1 and Unit 4.

- **Self-Assessments and Surveillances**

In addition to lessons learned, OPG's Health and Safety group conducts several self-assessments and surveillance on higher risk areas to ensure improvements are incorporated into planning to reduce the risk of injury. Examples of self-assessments and surveillance performed in 2023 include:

- Working at Heights and Falling Objects Self-Assessment.
- Material Handling Self-Assessment.
- Confined Space Self-Assessment on Implementation of Confined Space App.
- Electrical Safety Self-Assessment.
- Worker Protection Program Self-Assessment.
- Foreign Material Exclusion Program.

RADIOLOGICAL SAFETY

OPG's Radiological Protection (RP) program continues to meet regulatory requirements and industry standards. All workers are in compliance within regulatory dose limits. This performance is a result of OPG's robust nuclear safety culture and OPG's "As Low as Reasonably Achievable" (ALARA) radiological safety principles. Lessons learned on Unit 2 and Unit 3 have been incorporated into training and enhanced radiological safety measures on Unit 1 and Unit 4. 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’s radiological safety performance and includes both OPG and vendor employees.

Table 2 - Radiological Safety Performance Metrics						
	2021 Year End		2022 Year End		2023 End of Q3	
	Actual	Target	Actual	Target	Actual	Target
Unit 3 CRE (person-rem)¹	1,028	1,379	337	633	55	95
Unit 1 CRE (person-rem)¹	N/A	N/A	722	984	416	435
Unit 4 CRE (person-rem)²	N/A	N/A	N/A	N/A	114	120
Unplanned Exposures	0	0	0	0	0	0

Note:

1. A lower number represents a lower amount of radiological exposure.
2. Based on ALARA evaluation of increased CRE to date and comparison with DNRU1, DNRU4 CRE is trending above target. Based on preliminary projections above, the total CRE for DNRU4 will increase from 1,635 person-rem to 2,110 person-rem due to elevated dose rates from the feeders. This is a preliminary estimate.

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 highly technical welding operations that are critical. A certain amount of rework is to be expected on a program of this nature.

The quality management program is used to identify issues during refurbishment execution by focused surveillance of vendor performed work. There has been no Significant Quality Events declared for Unit 3 or Unit 1 to date. There has been significant improvement in the quality of welding activities on the Unit 3 Feeder program as compared to Unit 2 and the same good performance is being continued in Unit 1.

Incorporation of lessons learned, and Kaizen/Six Sigma lean practices have improved industrial and radiological safety, tooling, schedule management, organizational alignment, and enhanced safety and Foreign Material Exclusion (FME) planning and oversight. Critical path, and cost-savings have resulted from initiatives such as two trolley defuel, breathing air tie ins, combined Pressure Tube/Calandria Tube removal strategy, Gantry Crane System, System Scaffolding, and many other initiatives. A culture of continuous improvement has resulted in the collection and implementation of lessons learned and continues to drive performance in Unit 1 and 4 Return to Service, with a robust performance with Unit 3 Return to Service. The most significant improvement elements from Unit 3 include Operational Transfer Plans, and Refurb Outage Control Centre Change Management.

SCHEDULE

OPG measures Program progress against two schedules:

1. A longer High Confidence Schedule
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), and manage day-to-day activities, allowing for early escalation of issues⁴. The use of both a Working Schedule and High Confidence Schedule is an industry leading best practice for large and complex projects.

Based on the strong performance and completion of Unit 3 to date, OPG has advanced its High Confidence Schedule for Units 1 and 4 as part of the U1EE and U4EE forecast. Given inherent schedule risks that remain from factors such as the ongoing execution of the units in an overlapped manner (Units 1 and 4), OPG continues to maintain its previous public commitment durations for each unit.

PERFORMANCE METRICS SUMMARY

Table 3A provides a summary of the Unit 1 schedule performance relative to the U1EE Working Schedule and High Confidence Schedule.

Table 3A - Unit 1 Schedule Performance Metric			
Measure	2022 Year End Actual	2023 Q3 Actual	Working Schedule Target
Days Ahead of / Behind High Confidence Schedule LTD ¹	12 Days Ahead	30 days Ahead	N/A
Critical Path Days Ahead of / Behind Working Schedule LTD ²	17 Days Behind at Completion of Sever Bellows (W113)	16 Days Behind at Completion of CT Install (W118)	14-Oct-2024
SPI ³ (Schedule Performance Index)	0.93	0.99	1.00
Forecast Working Schedule Completion Date ²	14-Oct-2024	12-Oct-2024	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. Critical Path Days Ahead/Behind and Forecast Working Schedule Completion Date are calculated as progress for all work currently completed relative to the Working Schedule and do not consider projected gains or losses for future work.
3. SPI is calculated for construction, commissioning, and inspection work packages only against the Working Schedule and SPI calculation includes both critical path and the non-critical path works.

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

Table 3B provides a summary of the Unit 4 schedule performance relative to the U4EE Working Schedule and High Confidence Schedule.

Table 3B – Unit 4 Schedule Performance Metrics		
Measure	2023 Q3 Actual	Working Schedule Target
Days Ahead of / Behind High Confidence Schedule LTD ¹	11 Days Ahead	N/A
Critical Path Days Ahead of / Behind Working Schedule LTD ²	5 Days Ahead (At Completion of End Fitting Install W017)	15 - Feb - 2026
SPI ³ (Schedule Performance Index)	1.00	1.00
Forecast Working Schedule Completion Date ²	13- Jan - 2026	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. Critical Path Days Ahead/Behind and Forecast Working Schedule Completion Date are calculated as progress for all work currently completed relative to the Working Schedule and do not consider projected gains or losses for future work.
3. SPI is calculated for construction, commissioning, and inspection work packages only against the Working Schedule and SPI calculation includes both critical path and the non-critical path works.

COST

Total Program expenditures to date are \$10 Billion with the current remaining estimate to complete the Program at \$2.8 Billion. The overall program estimate at completion remains at \$12.8 Billion (excluding COVID-19 impacts).

After the approval of the RQE in 2015, OPG established the U2EE⁵ in August 2016, the final U3EE⁶ in August 2020, the U1EE in November 2021, and the U4EE in March 2023. Detailed planning associated with the final U1EE and U4EE confirmed that the overall Program and associated contingencies were within the \$12.8 Billion set at RQE, exclusive of COVID-19 impact. The COVID-19 impact is forecasted to be \$130 Million.

The planning, pre-requisite and execution work for Unit 1 and Unit 4 refurbishments has and will incorporate the benefits of experience with the first two units, Unit 2 and Unit 3, and additional strategic improvements. The refurbishment of Unit 4 is scheduled to be completed by the third quarter 2026.

OPG continues to assess and seek ways to manage the impact of the COVID-19 pandemic on the project's total cost, which is otherwise continuing to track to the \$12.8 Billion budget.

⁵ A copy of U2EE is provide in EB-2016-0152 (Ex. L-4.3-1, Staff-055).

⁶ A copy of U3EE is provided in EB-2020-0290 (Ex. D2-2-7, Attachment 1).

Table 4 provides a summary of the cost performance metrics for Unit 3, Unit 1, and Unit 4.

Table 4 – Cost Performance Metrics Unit 3, Unit 1 & Unit 4¹ (Millions)				
Unit	CPI (Q3 2023)	LTD Q3 2023 Actual Cost	Current Estimate to Complete	Current Estimate at Completion
Unit 3	1.03	\$2,228	\$263	\$2,491
Unit 1	0.97	\$1,242	\$742	\$1,984
Unit 4	1.02	\$351	\$1,777	\$2,128

Notes:

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

Table 5 provides a summary of the Total Program Actual Cost Incurred vs. Forecast Cumulative Capital Costs for all Units (excluding the impacts of COVID-19).

Table 5 – Total Program Actual vs. Forecast Cumulative Costs EB-2020-0290 (Millions)		
	Forecast Cumulative Costs¹	Actual Cost Incurred
Q1 2021	7,746	7,637
Q2 2021	8,048	7,861
Q3 2021	8,324	8,076
Q4 2021	8,575	8,289
Q1 2022	8,849	8,518
Q2 2022	9,153	8,758
Q3 2022	9,438	9,003
Q4 2022	9,735	9,268
Q1 2023	10,050	9,510
Q2 2023	10,327	9,784
Q3 2023	10,576	10,014
Q4 2023	10,836	
Q1 2024	11,101	
Q2 2024	11,380	
Q3 2024	11,617	
Q4 2024	11,829	
Q1 2025	11,982	
Q2 2025	12,126	
Q3 2025	12,283	
Q4 2025	12,439	
Q1 2026	12,577	
Q2 2026	12,662	

Q3 2026	12,723	
Q4 2026	12,800	

Notes:

1. Total Program forecast cumulative costs (inclusive of capital and OM&A costs) are per the EB-2020-0290, Ex. L-D2-02-Environmental Defence-005, Chart 1 and exclude COVID-19 impacts. The expenditures are based on the U3EE, which did not separate between capital and OM&A costs. As stated in the interrogatory response, as OPG continues to execute Units 4 and 1, and implements further Lessons Learned and Strategic Initiatives to both units, the forecast quarterly expenditure profile may change. OPG will continue to report on this basis for ease of comparability.
2. Actuals are based on life-to-date total Program spend, inclusive of both capital and OM&A costs, and exclude COVID-19 impacts.

ENGINEERING

The strategy for Design Engineering is to replicate the Engineering Changes (ECs) from Unit 2 and Unit 3 for Units 1 and 4 and modify them based on lessons learned. Unit 1 EC replication has been completed.

Major engineering accomplishments for the period include:

- Completion of Turbine Generator (TG) dynamic commissioning and EC Available for Services (AFS) on Unit 3.
- Completion of TG modification related pre-energization Construction Completion Declarations on Unit 1.
- Feeders ensure clean campaign boroscope inspections on Unit 1 were completed, part of our FME program. This helps to protect the integrity of the fuel and aid the team in reaching the corporate goal of zero fuel defects.

PROCUREMENT

PROCUREMENT STATUS FOR UNIT 1

98% of purchase orders were issued and 96% of materials for Unit 1 have been delivered to site, with remaining materials on track for the planned need date.

PROCUREMENT STATUS FOR UNIT 4

88% of purchase orders were issued and 76% of materials for Unit 4 have been delivered to site, with remaining materials on track for the planned need date.

CONSTRUCTION

CONSTRUCTION PROGRESS SUMMARY

As of September 30, 2023, Unit 3 construction activities were 100% completed.

As of September 30, 2023, the execution of Unit 1 is 70% complete overall and non-critical path, or bulkwork, activities are 81% complete. The following major accomplishments occurred within the period:

- Unit 1 Feeder Removal was completed on November 2, 2022.
- PT Sever and Sever Bellows was completed on December 17, 2022.

- End Fitting Removal was completed on January 26, 2023.
- Calandria Tube Removal was completed on April 27, 2023.
- Tube sheet Bore Cleaning was completed on May 23, 2023.
- Bellows Inspection was completed on June 3, 2023.
- Calandria Tube Install Series was completed on August 12, 2023.
- Fuel Channel Install Series is currently in progress.

As of September 30, 2023, the refurbishment of Unit 4 is 11% complete overall and non-critical path, or bulkwork, activities are 12% complete. The following major accomplishments occurred within the period:

- Unit 4 Shutdown began on July 19, 2023.
- Unit 4 Defueling was completed on September 4, 2023.
- Crane Maintenance was completed on September 7, 2023.
- End Fitting Cap Installation was completed on September 15, 2023.

LABOUR RELATIONS ISSUES SUMMARY

Members of the Society of Energy Professionals at the Electrical Safety Authority (ESA) commenced strike action on September 20, 2023. There are a small number of ESA employees that perform limited inspections at OPG facilities.

There is minimal risk of this labour disruption impacting OPG operations. OPG is currently in collective bargaining with the Canadian Union of Skilled Workers and negotiations are ongoing. There is no immediate risk of labour disruption. Risk assessments are underway to determine any potential impact from labour disruption to the DRP.

The OPG Labour Contingency Planning Team has been activated, is monitoring both situations and is prepared to respond if required.

ENVIRONMENTAL ISSUES SUMMARY

There was one infraction on Refurbishment Unit 3 in June 2023 due to an Environmental Compliance Approval (ECA), It was Non-Compliance for Boiler Morpholine exceeding the ECA Limits. There were two contributing causes identified:

- 1) Insufficient resource priority for boiler sampling and analysis after chemical addition, thus an opportunity to terminate morpholine addition earlier was missed.
- 2) The morpholine pump stroke rate (and thus dosing rate) was found greater than expected.

Reoccurrence control has been addressed via a Station Condition Record corrective action evaluation.

As well, there was one reportable spill on Refurbishment Unit 3 on October 2022 due to a refrigerant leak from an HVAC system due to a valve and O-ring fitting failure. The equipment was isolated and repaired.

The remaining refrigerant was recovered and degraded components were replaced. Radiological and conventional emissions remain well below regulatory limits.

TESTING, START-UP, AND COMMISSIONING

UNIT 3 RETURN-TO-SERVICE

On July 17, 2023, Darlington Nuclear Generating Station's Unit 3 reconnected to the electricity grid following refurbishment.

PROGRAM RISKS AND RISK MANAGEMENT

OPG uses a robust risk management process that identifies, classifies, quantifies, and mitigates risks. Industry experience dictates that there will be uncertainties that cannot be avoided on a Program 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 cost estimation. These contingency amounts are expected to be used over the course of the Program.

The following major risks are being managed by OPG:

1. **Availability of Skilled Resources / Supervision of Future Units:** The Program has experienced resource challenges with skilled trades resource availability. OPG monitors market demand conditions and has skilled trade forecasts to predict risks and develop mitigation plans for future resource challenges (resource optimization, industry sharing, and resource recruiting. Collaboration with industry partners continues with Bruce Power, Electrical Power Systems Construction Association, Construction Labour Relations Association of Ontario, and Provincial Building and Construction Trades Council of Ontario ensuring a fulsome understanding of resource demand profiles across Ontario. A strong relationship continues with all Building Trade Unions, Durham College, Durham District School Board, Kawartha Pine Ridge District School Board (KPRDSB) and the Indigenous Opportunities Network to maximize recruiting efforts for future projects.
2. **Inflation:** OPG is managing its response to extraordinary inflationary impacts at a corporate level where DRP exposure is continuing to be assessed and monitored. Mitigation actions have been implemented through supply chain and OPG continues to monitor inflation trends for further mitigation actions as required.

STAFFING

REFURBISHMENT RESOURCES

Table 6 provides a summary of the OPG Resources on the Program.

Table 6 – Full Time Equivalent (FTE) Resources by Year (Plan vs. Actual)					
Measure	2019	2020	2021	2022	2023
Planned at RQE	758	747	N/A		
Planned at U3EE	N/A		880	944	N/A
Planned at U4EE	N/A				1026 ¹
Actual	850	722	690	718	765 ²

Notes:

1. The variance of OPG resources against plan is primarily driven by the contracting strategy for certain maintenance activities.
2. Actual FTEs for 2023 are as of September Year to Date.

EFFORTS TO FILL OPEN POSITIONS

Talent acquisition initiatives are in place to fill open positions.

OPG has several Talent Management programs and initiatives in place to attract, retain, and develop qualified personnel across the company, including for the duration of the Program. Management continues to leverage industry best practices and utilize enterprise-wide talent and succession planning processes. This helps to ensure 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 implemented a training program specifically designed to advance project management capability across the organization.

To further support employee development and succession planning programs, Career Path documents have been developed for several Enterprise Projects roles for project professionals and business units where their transferrable skillsets can be utilized.

FILED DECEMBER 18, 2024

Darlington Refurbishment Program Annual Report

2024 REPORT

AS PER DECISION AND ORDER IN EB-2020-0290

TABLE OF CONTENTS

INTRODUCTION	2
EXECUTIVE SUMMARY	2
DARLINGTON REFURBISHMENT PROGRAM STATUS	4
OVERVIEW	4
PROGRESS	4
SAFETY	5
Performance Metrics Summary	5
Campaigns, Programs, And Initiatives	6
RADIOLOGICAL SAFETY	7
Performance Metrics Summary	7
QUALITY	8
SCHEDULE	8
Performance Metrics Summary	9
COST	10
ENGINEERING	12
PROCUREMENT	12
Procurement Status For Unit 1	12
Procurement Status For Unit 4	12
CONSTRUCTION	13
Construction Progress Summary	13
LABOUR RELATIONS ISSUES SUMMARY	13
ENVIRONMENTAL ISSUES SUMMARY	13
TESTING, START-UP, AND COMMISSIONING	14
Unit 1 Return-To-Service	14
Unit 4 Return-To-Service	14
PROGRAM RISKS AND RISK MANAGEMENT	14
STAFFING	15
Refurbishment Resources	15
Efforts To Fill Open Positions	15



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FOR INFORMATION to the Ontario Energy Board

December 18, 2024

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, 2024.

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-2020-0290.¹

EXECUTIVE SUMMARY

The Program is a multi-year, multi-phase, mega-project that will enable the Darlington Nuclear Generating Station (Darlington) to continue safe and reliable operation until 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 and further refined its Unit and Program estimates through the Unit 2 Execution Estimate (U2EE) in August 2016, Unit 3 Execution Estimate (U3EE) in August 2020, Unit 1 Execution Estimate (U1EE) in November 2021 and Unit 4 Execution Estimate (U4EE) in March 2023. All of these maintain the Program estimate, exclusive of external events such as COVID-19, within the original \$12.8 Billion RQE budget and continue to forecast completion of the four-unit refurbishment in 2026. The U3EE formed the basis of OPG's December 2020 pre-filed evidence in EB-2020-0290.¹ OPG measures its performance over the refurbishment of each Unit against each Unit's execution estimate.

The cost forecast for the overall Darlington Refurbishment Program remains on plan at \$12.8 Billion, excluding the impact of COVID-19. Based on the COVID-19 impacts to date, OPG is forecasting costs of \$127 Million. OPG is continuing to assess and monitor further potential impacts associated with the current extraordinary inflationary environment on the project.

Unit 2 was successfully returned to service on June 4, 2020. Completion of the Unit 2 refurbishment on budget and with a small schedule variance of just over three months, represented a significant achievement in mega-project execution for OPG. Unit 3 was successfully reconnected to the grid on July 17, 2023, which represented another significant milestone for the Program. Both Unit 2 and Unit 3 are operating at 100 percent full power.

¹ EB-2020-0290, Decision and Order, dated November 15, 2021, Schedule A (OEB Approved Settlement Proposal), Appendix A, p. 1.

The U1EE was approved by OPG's Board of Directors in November 2021 in advance of the start of the refurbishment outage on Unit 1, and incorporated additional lessons learned, and strategic improvements based on the Unit 2 and Unit 3 refurbishments. Per the final U1EE, the budget and High Confidence Schedule to complete Unit 1 are \$1,984 Million and 38 months, respectively.

As of September 30, 2024, Unit 1 refurbishment activities were progressing on schedule and in the fourth and final major segment, Power Up & Lead-Out, which involves restoration of the Vault, receiving approval from the CNSC to proceed with increasing reactor power above 35% of full power and returning the unit to commercial service. Unit 1 was successfully reconnected to the grid on November 27, 2024, with good quality and safety, within the approved budget, and 142 days ahead of public commitment schedule. Overall, the return to service of Unit 1 represents another significant milestone for the Program with performance improvements exceeding the planned unit over unit efficiencies. Unit 1 is operating at 100 percent full power.

Unit 4 is the last of four units undergoing refurbishment. The final U4EE was approved by OPG's Board of Directors in March 2023. Per the final U4EE, the budget and High Confidence Schedule to complete Unit 4 are \$2,128 Million and 37 months, respectively.

Unit 4 execution commenced on July 19, 2023, shortly after the return to service of Unit 3. Based on Independent Electricity System Operator (IESO) grid stability constraints, the approval for the outage was delayed 17 days. The Unit is currently progressing through the Reassembly and Installation Segment, which involves the installation and reassembly of reactor components, including calandria tubes, fuel channels, and new feeder tubes. Unit 4 is on track to be returned to service by the third quarter of 2026.

DARLINGTON REFURBISHMENT PROGRAM STATUS

OVERVIEW

Key Program highlights include:

- **SAFETY:** Safety performance continues to be better than the average construction industry performance in Ontario. The Program is approaching 56 million hours worked with only one Lost Time Injury² (in May 2019) since the start of the Program. Programmatically, OPG has implemented the Fail-Safe methodology that attempts to build capacity by adding defenses in a layered approach with the mindset to reduce risk and chance of injury to the worker.
- **QUALITY:** The quality management program is used to identify issues during refurbishment execution by focused surveillance of vendor-performed work. Quality of work to date has surpassed nuclear standards, and in most cases is industry leading. There was one Significant Quality Event (SQE) for Unit 1 in September 2024 and none for Unit 4 to date.
- **SCHEDULE:** Unit 1 was returned to service on November 27, 2024. As of September 30, 2024, Unit 1 refurbishment activities were progressing on plan, and Critical Path was progressing through Low Power Testing, Heat-up & Fuel Bundle Analysis. Unit 4 execution began on July 19, 2023, and was progressing on plan through Tube Sheet bore Cleaning as of September 30th, 2024. Unit 4 is expected to return to service by the third quarter of 2026.
- **COST:** OPG is continuing to track to the \$12.8 Billion budget excluding impact of COVID-19. Total Program expenditures to date are \$11.1 Billion. Excluding COVID-19 impacts, life-to-date expenditures as of September 30, 2024 are \$1,711 Million for Unit 1 and \$941 Million for Unit 4.

PROGRESS

Unit 1 was successfully reconnected to the grid on November 27, 2024. As of September 30, 2024, the refurbishment of Unit 1 was 99% complete. Some of the major accomplishments are as follows:

- RCHP 1 Moderator Fill on December 23, 2023.
- RCHP 2 Fuel Load on April 28, 2024.
- RCHP 4 Primary Heat Transport System Fill on May 31, 2024.
- RCHP 3 Bulkhead Removal on August 10, 2024.
- RCHP 5 GSS Removal on September 13, 2024.

As of September 30, 2024, the refurbishment of Unit 4 is 51% complete; some of the major accomplishments are as follows:

- Segment 1 Lead In on October 21, 2023.
- Segment 2 Removal with completion of Pressure Tube and Calandria Tube removal on September 4, 2024.

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.

ANNUAL INTEGRATED IMPLEMENTATION PLAN (IIP) COMMITMENT

- All Unit 1 IIPs are complete and closed.
- Overall, 91% (566 of 622) of IIP commitments have been completed to date. There are 71 overall tasks due in 2024 with 3 IIP tasks remaining and 68 IIP tasks are closed/complete. The IIP commitments for 2024 are on track to be achieved.

SAFETY

Safety is a top priority for OPG. OPG has one of the lowest injury rates in the Canadian electricity sector³. In order to maintain this safety performance, OPG continues to set challenging targets for its day-to-day operations. At the end of the third quarter of 2024, the Program reported a Total Recordable Injury Frequency (TRIF) of 0.19 against its internal target of 0.40, reflecting six medically treated injuries from Q1 to Q3 2024. 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 over 56 million hours worked with one Lost Time Injury, which occurred in May 2019. There have been no Lost Time Injuries since then.

OPG employs a variety of leading indicators to ensure that issues are addressed before incidents occur. OPG proactively tracks all events/issues and has adopted the Safety Classification and Learning (SCL) model. The SCL model is focused on learning from events to prevent recurrence and keep workers safe, which aligns with OPG's Fail-Safe strategy. OPG carefully logs and reviews each of these incidents and implements corrective actions to reduce the likelihood of future incidents. In addition, the Safe Work Planning Assessment (SWPA) has been implemented to assess the quality of direct controls implemented to address high-energy hazards within safe work plans.

PERFORMANCE METRICS SUMMARY

Table 1 provides a summary of the Program's Safety Performance and includes OPG and Vendor workers.

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

Table 1 - Safety Performance Metrics												
			Historical Actuals								Actual	IHSA ³
Category	Measure	OPG Target	2016	2017	2018	2019	2020	2021	2022	2023	2024 (Q3) YTD ²	Ontario Construction Industry 2023 ³
Safety	TRIF (Total Recordable Injury Frequency) ¹	0.40	0.64	0.49	0.39	0.52	0.35	0.25	0.26	0.19	0.19	3.91
	Lost Time Injuries	0	0	0	0	1	0	0	0	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. 2023 IHSA rating is the most current safety rating for the Ontario Construction Industry (as of March 2024).

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 likelihood of serious events occurring. The following are the key safety campaigns, programs, and initiatives that OPG and its vendor partners advanced in 2024:

- **A Fail-Safe Approach to Safety and Human Performance**

This ongoing initiative emphasizes safe work planning, event learning, recognition for safety-related improvements and the presence of defenses. Fail-Safe involves a strategy team consisting of OPG and vendors who are engaging workers in practices which utilize safety tools and defenses. Fail-Safe aligns with OPG's strategic direction to proactively approach safety and human performance. For 2024, the focus has continued to have Fail-Safe concepts in Safe Work Plans (SWP) and Pre-Job Briefs (PJB) with the use of defenses/direct controls, and hazard recognition to build capacity. The generation of progressive metrics to capture the presence of Fail-Safe defenses is ongoing. Introduction of SCL model metrics is targeted to be implemented in Q1 2025.

- **DataCube – Construction Observations Report**

DataCube was implemented in the second quarter of 2023 as a digital tool to capture observations, coaching and actions across all field staff in the Enterprise, including the Program, and continues to be utilized. The report transforms the way OPG does work by centralizing information on safety related metrics from the field, identifying trends in real time and making informed decisions to act on the trends in timely manner. The DataCube has been effective in connecting users by notifying relevant groups on the occurrence of key events and streamlining collaboration between OPG and vendor partners.

- **Power Solutions – Safety Culture**

Power Solutions continues to support the Program, by empowering field staff with the ability to report issues or provide feedback on conditions anonymously to reconcile the concerns. Power Solutions is frequently used by vendor partners and staff to address issues in an expeditious manner and provide feedback to the leadership team on the culture in the field.

- **Confined Space App**

The Program continues to use the Confined Space application to reduce errors in confined space documentation, provide interlocks, and ensure unqualified workers are not assigned to confined space work. Work groups using the App have provided positive feedback by noting the App has made the confined space work process more efficient.

- **Units 314 Proactive Human Performance and Safety Plan**

The refurbishment group continues to use this road map to drive aligned communications throughout the Refurbishment project in collaboration with the vendor partners.

- **Surveillances and Benchmarking**

OPG's Health and Safety group conducts ongoing surveillances with vendor partner work groups on higher risk areas to ensure hazards are identified and actions are incorporated into planning to reduce the risk of injury.

A self-assessment to review the effectiveness of corrective actions for consequential events is in progress. The goal of the self-assessment is to confirm effectiveness and transfer knowledge into the planned Pickering Refurbishment.

Benchmarking with other work programs within OPG and with Bruce Power was also performed to implement best practices for current Program work activities. Best practices from Edison Electric Institute (EEI) are also being introduced into the work program, through SCL and Fail-Safe initiatives.

- **Trending, Prevention and Intervention (TPI) Program**

The Program has adopted the TPI program to identify, detect and correct issues pertaining to the Industrial Safety functional area. TPI enables the site to take action by reviewing trends and putting in place the necessary actions.

RADIOLOGICAL SAFETY

OPG's Radiological Protection (RP) program continues to meet regulatory requirements and industry standards. All workers are in compliance within regulatory dose limits. This performance is a result of OPG's robust nuclear safety culture and OPG's "As Low as Reasonably Achievable" (ALARA) radiological safety principles. Lessons learned on Unit 2 and Unit 3 have been incorporated into training and enhanced radiological safety measures on Unit 1 and Unit 4. The Program's ALARA committee continues to monitor and challenge RP performance to ensure ALARA principles result in lower doses to workers.

There has been one (1) unplanned radiological exposure YTD which occurred in September 2024 related to an acute tritium uptake during a valve setup in Unit 1, the first to date within the Program. OPG's Radiation Protection team and the Responsible Health Physicist Assessment determined that the worker dose uptake meets the threshold to be reportable to the regulator but did not exceed OPG Exposure Control Limits or Regulatory Dose Limits for the year.

PERFORMANCE METRICS SUMMARY

Table 2 provides a summary of the Program's radiological safety performance and includes both OPG and vendor employees.

Table 2 - Radiological Safety Performance Metrics						
	2022 Year End		2023 Year End		2024 End of Q3	
	Actual	Target	Actual	Target	Actual	Target
Unit 1 CRE (person-rem)¹	722	984	416	435	128	221
Unit 4 CRE (person-rem)¹	N/A	N/A	114	120	833	1085
Unplanned Exposures	0	0	0	0	1	0

Note:

1. Collective Radiation Exposure (CRE). A lower number represents a lower amount of radiological exposure.

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 highly technical welding operations that are critical. A certain amount of rework is to be expected on a program of this nature.

The quality management program is used to identify issues during refurbishment execution by focused oversight on vendor performed work. As of September 30, 2024, there has been one SQE declared for Unit 1 related to a measurement discrepancy on installed Fuel Channel End Fittings, and none for Unit 4.

Incorporation of lessons learned, and Kaizen/Six Sigma lean practices have improved industrial and radiological safety, tooling, schedule management, organizational alignment, Foreign Material Exclusion (FME) planning and oversight. The culture of continuous improvement for the Program has yielded significant benefits, as lessons learned have been effectively collected and integrated, thereby driving improved performance across Unit 1 and Unit 4. The success of OPG’s Culture of Continuous Improvement can be attributed, in large part, to the Window Specific Lessons Learned Workshops. These have been instrumental in capturing and disseminating valuable insights and best practices.

SCHEDULE

OPG measures Program progress against two schedules:

1. A longer High Confidence Schedule
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), and manage day-to-day activities, allowing

for early escalation of issues⁴. The use of both a Working Schedule and High Confidence Schedule is an industry leading best practice for large and complex projects.

Based on the strong performance and completion of Unit 3 to date, OPG has advanced its High Confidence Schedule for Units 1 and 4 as part of the U1EE and U4EE forecasts. Given inherent schedule risks that remained from factors such as the ongoing execution of the units in an overlapped manner (Units 1 and 4), OPG has continued to maintain its previous public commitment durations for each unit.

PERFORMANCE METRICS SUMMARY

Table 3A provides a summary of the Unit 1 schedule performance relative to the U1EE Working Schedule and High Confidence Schedule.

Table 3A - Unit 1 Schedule Performance Metric			
Measure	2023 Year End Actual	2024 Q3 Actual	Working Schedule Target
Days Ahead of / Behind High Confidence Schedule LTD ¹	23 Days Ahead	44 days Ahead	N/A
Critical Path Days Ahead of / Behind Working Schedule LTD ²	29 Days Behind at Completion of Fuel Channel Install (W119)	30 Days Behind At Completion of ATC (Approach To Critical) (W092)	14-Oct-2024
SPI ³ (Schedule Performance Index)	1.00	1.00	1.00
Forecast Working Schedule Completion Date ²	22-Oct-2024	25-Oct-2024	N/A

Notes:

1. Days Ahead/Behind is calculated as progress for all work currently completed relative to the Life to Date (LTD) allotment of Contingency Days available in the High Confidence Schedule.
2. Critical Path Days Ahead/Behind and Forecast Working Schedule Completion Date are calculated as progress for all work currently completed relative to the Working Schedule and do not consider projected gains or losses for future work.
3. SPI is calculated for construction, commissioning, and inspection work packages only against the Working Schedule and SPI calculation includes both critical path and the non-critical path works.

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

Table 3B provides a summary of the Unit 4 schedule performance relative to the U4EE Working Schedule and High Confidence Schedule.

Table 3B – Unit 4 Schedule Performance Metrics			
Measure	2023 Year End Actual	2024 Q3 Actual	Working Schedule Target
Days Ahead of / Behind High Confidence Schedule LTD ¹	30 Days Ahead	16 Days Behind	N/A
Critical Path Days Ahead of / Behind Working Schedule LTD ²	16 Days Ahead (At Completion of Remove Fueling Machine Bridges & Install Radioactive Particle Trackers W101)	44 Days Behind At Completion of Calandria Tube Removal (W117)	15-Feb-2026
SPI ³ (Schedule Performance Index)	1.03	0.98	1.00
Forecast Working Schedule Completion Date ²	28-Dec-2025	07-Feb-2026	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. Critical Path Days Ahead/Behind and Forecast Working Schedule Completion Date are calculated as progress for all work currently completed relative to the Working Schedule and do not consider projected gains or losses for future work.
3. SPI is calculated for construction, commissioning, and inspection work packages only against the Working Schedule and SPI calculation includes both critical path and the non-critical path works.

COST

Total Program expenditures to date are \$11.1 Billion, with the current remaining estimate to complete the Program at \$1.7 Billion. The overall program estimate at completion remains at \$12.8 Billion (excluding COVID-19 impacts).

After the approval of the RQE in 2015, OPG established the U2EE⁵ in August 2016, the final U3EE⁶ in August 2020, the U1EE in November 2021, and the U4EE in March 2023. Detailed planning associated with the final U1EE and U4EE confirmed that the overall Program and associated contingencies were within the \$12.8 Billion set at RQE, exclusive of COVID-19 impact. The COVID-19 impact is forecasted to be \$127 Million.

⁵ A copy of U2EE is provide in EB-2016-0152 (Ex. L-4.3-1, Staff-055).

⁶ A copy of U3EE is provided in EB-2020-0290 (Ex. D2-2-7, Attachment 1).

The planning, pre-requisite and execution work for Unit 1 and Unit 4 refurbishments has and will incorporate the benefits of experience with the first two units, Unit 2 and Unit 3, and additional strategic improvements. OPG continues to assess and seek ways to manage the impact of the COVID-19 pandemic on the project's total cost, which is otherwise continuing to track to the \$12.8 Billion budget.

OPG has been managing its response to extraordinary inflationary impacts at a corporate level where DRP exposure is continuing to be assessed and monitored. Mitigation actions continue to be implemented through supply chain and OPG continues to monitor inflation trends for further mitigation actions as required.

Table 4 provides a summary of the cost performance metrics for Unit 1 and Unit 4.

Table 4 – Cost Performance Metrics Unit 1 & Unit 4¹ (Millions)				
Unit	CPI (Q3 2024)	LTD Q3 2024 Actual Cost	Current Estimate to Complete	Current Estimate at Completion
Unit 1	1.00	\$1,711	\$273	\$1,984
Unit 4	0.98	\$941	\$1,436	\$2,377 ²

Notes:

1. Program expenditures include capital and OM&A costs consistent with OEB-approved amounts.
2. Includes program contingency of \$249 Million following the close out of Unit 3.

Table 5 provides a summary of the Total Program Actual Cost Incurred vs. Forecast Cumulative Capital Costs for all Units (excluding the impacts of COVID-19).

Table 5 – Total Program Actual vs. Forecast Cumulative Costs EB-2020-0290 (Millions)		
	Forecast Cumulative Costs¹	Actual Cost Incurred
Q1 2021	7,746	7,637
Q2 2021	8,048	7,861
Q3 2021	8,324	8,076
Q4 2021	8,575	8,289
Q1 2022	8,849	8,518
Q2 2022	9,153	8,758
Q3 2022	9,438	9,003
Q4 2022	9,735	9,268
Q1 2023	10,050	9,510
Q2 2023	10,327	9,784
Q3 2023	10,576	10,014
Q4 2023	10,836	10,273
Q1 2024	11,101	10,523
Q2 2024	11,380	10,800
Q3 2024	11,617	11,083

Q4 2024	11,829	
Q1 2025	11,982	
Q2 2025	12,126	
Q3 2025	12,283	
Q4 2025	12,439	
Q1 2026	12,577	
Q2 2026	12,662	
Q3 2026	12,723	
Q4 2026	12,800	

Notes:

1. Total Program forecast cumulative costs (inclusive of capital and OM&A costs) are per the EB-2020-0290, Ex. L-D2-02-Environmental Defence-005, Chart 1 and exclude COVID-19 impacts. The expenditures are based on the U3EE, which did not separate between capital and OM&A costs. As stated in the interrogatory response, as OPG continues to execute Units 4 and 1, and implements further Lessons Learned and Strategic Initiatives to both units, the forecast quarterly expenditure profile may change. OPG will continue to report on this basis for ease of comparability.
2. Actuals are based on life-to-date total Program spend, inclusive of both capital and OM&A costs, and exclude COVID-19 impacts.

ENGINEERING

The strategy for Design Engineering was to replicate the Engineering Changes (ECs) from Unit 2 and Unit 3 for Units 1 and 4 and modify them based on lessons learned. Unit 1 and Unit 4 EC replication has been completed.

Major engineering accomplishments for the period include:

- Completed Unit 3 EC closeout.
- Completed Unit 1 Return to Service activities such as Moderator Fill, Fuel Load, Primary Heat Transport Fill and Containment Restoration.
- Completed Unit 1 Turbine Generator (TG) static commissioning and EC Available for Services (AFS) for major modifications such as Fuel Channels, Feeders, Feeder Instrumentation, Auxiliary Shutdown Cooling, Emergency Heat Sink and Liquid Relief Valve Replacements.
- Completed work to support the removal of the Unit 1 Guaranteed Shutdown State, and first criticality. Completed the Calandria Tube and Pressure Tube removal series which completed the major removal scope on Unit 4.

PROCUREMENT

PROCUREMENT STATUS FOR UNIT 1

All materials necessary for Unit 1 Return to Service have been procured. As of September 30, 2024, 100% of purchase orders were issued and 98% of materials for Unit 1 have been delivered to site, with remaining materials on track for the planned need date.

PROCUREMENT STATUS FOR UNIT 4

As of September 30, 2024, 98% of purchase orders were issued and 90% of materials for Unit 4 have been delivered to site, with remaining materials on track for the planned need date.

CONSTRUCTION

CONSTRUCTION PROGRESS SUMMARY

As of September 30, 2024, the execution of Unit 1 is 99% complete overall and non-critical path, or bulk work, activities are 95% complete. Unit 1 Construction activities were completed on August 30, 2024, and the Unit is in the final commissioning and start-up windows as of September 30, 2024. The following major accomplishments occurred within the period:

- Unit 1 Moderator Refill was completed on January 11, 2024.
- Unit 1 Fuel Load was completed on May 18, 2024.
- Primary Heat Transport Refill was completed on May 31, 2024.
- Unit 1 Vault Turnover back to Station was completed August 10, 2024.
- Unit 1 Bulkhead Removal was completed August 26, 2024.
- First criticality achieved on September 15, 2024.

As of September 30, 2024, the refurbishment of Unit 4 is 51% complete overall and non-critical path, or bulk work, activities are 59% complete. The following major accomplishments occurred within the period:

- Bulkhead Installation was completed on October 9, 2023, successfully isolating Unit 4 from the operating units.
- Removal of Fueling Machine Bridges and Installation of Re-Tube Tooling Platforms was completed on December 27, 2023.
- Removal of Bulk Interferences, Feeder Cabinets, Feeder Tubes, End Fittings, and Severing of Bellows and Pressure Tubes was completed on April 24, 2024.
- Successful completion of the Pressure Tube and Calandria Tube Removal window on September 4, 2024, which marked the completion of the removal phase for Unit 4.

LABOUR RELATIONS ISSUES SUMMARY

The Society of Energy Professionals and OPG entered into a new two-year collective agreement (January 1, 2024 – December 31, 2025).

The Power Workers' Union (PWU) and OPG entered into three-year agreement from April 1, 2024, to March 31, 2027.

Construction work in Ontario is performed through craft unions with established bargaining rights at OPG facilities. These bargaining rights are established either through the Electrical Power Systems Construction Association (EPSCA) or directly with OPG. The associated collective agreements are negotiated either directly between the parties or through the EPSCA, as applicable. All of these construction collective agreements expire on April 30, 2025. EPSCA is currently negotiating renewal agreements with the construction trade unions. On January 30, 2024, OPG and CUSW successfully reached agreement on the renewal of the collective agreement for the time period covering May 1, 2023, to April 30, 2025.

ENVIRONMENTAL ISSUES SUMMARY

From September 30, 2023, to September 30, 2024, there was one reportable spill, which occurred in April 2024. This spill occurred on Refurbishment Unit 4 and was due to a refrigerant leak caused by a degraded o-ring. The o-ring was promptly replaced before resuming working on the unit. Regulatory reporting was promptly completed for this spill.

There were no infractions in the Program during this period. Radiological and conventional emissions remain well below regulatory limits.

TESTING, START-UP, AND COMMISSIONING

Unit 1 Return-To-Service

Unit 1 began the return-to-service window on August 10, 2024. As of September 30, 2024, 92% of systems put into a modified or lay-up state were fully returned to service, and two of the four start-up Regulatory Hold Points were cleared.

Unit 4 Return-To-Service

Unit 4 is forecasted to begin return-to-service by the second quarter of 2026 and complete return-to-service by the third quarter of 2026.

PROGRAM RISKS AND RISK MANAGEMENT

OPG uses a robust risk management process that identifies, classifies, quantifies, and mitigates risks. Industry experience dictates that there will be uncertainties that cannot be avoided on a Program 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 cost estimation. These contingency amounts are expected to be used over the course of the Program.

The program risks are being managed by OPG include:

1. Any Turbine Generator issues during dynamic testing may delay Unit 1 and Unit 4 Return to Service.
2. Discovery work: Additional leak checks may be required during restoration activities, across multiple bundles, with a potential impact to Unit 1 and Unit 4 Return to Service.
3. Availability of Skilled Resources: The Program has experienced resource challenges with skilled trades resource availability. OPG monitors market demand conditions and has skilled trade forecasts to predict risks and develop mitigation plans for future resource challenges across the organization (resource optimization, industry sharing, and resource recruiting).

STAFFING

REFURBISHMENT RESOURCES

Table 6 provides a summary of the OPG Resources on the Program.

Table 6 – Full Time Equivalent (FTE) Resources by Year (Plan vs. Actual)						
Measure	2019	2020	2021	2022	2023	2024
Planned at RQE	758	747	N/A			
Planned at U3EE	N/A		880	944	N/A	
Planned at U4EE	N/A				1026 ¹	948
Actual	850	722	690	718	837	790 ²

Notes:

1. The variance of OPG resources against plan is primarily driven by the contracting strategy for certain maintenance activities.
2. Actual FTEs for 2024 are as of September Year to Date.

EFFORTS TO FILL OPEN POSITIONS

Talent acquisition initiatives are in place to fill open positions.

OPG has several Talent Management programs and initiatives in place to attract, retain, and develop qualified personnel across the company, including for the duration of the Program. Management continues to leverage industry best practices and utilize enterprise-wide talent and succession planning processes. This helps to ensure 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 implemented a training program specifically designed to advance project management capability across the organization.

To further support employee development and succession planning programs, Career Path documents have been developed for several Enterprise Projects roles for project professionals and business units where their transferrable skillsets can be utilized.

1 **DARLINGTON REFURBISHMENT PROGRAM**
2 **IN-SERVICE AMOUNTS**

3
4 **1.0 OVERVIEW**

5 This evidence presents the capital expenditures for the Darlington Refurbishment Program
6 (“DRP”) for the years 2020-2026 in Ex. D2-2-3, Table 1b and the capital in-service amounts
7 for the DRP for the same years in Ex. D2-2-3, Tables 2-5. The in-service amounts are
8 presented by the same categories as in EB-2020-0290.

9
10 In EB-2016-0152, the OEB approved DRP in-service additions of \$4,809.6M over the 2020-
11 2021 period, which reflected in-service additions of \$4,800.2M for the Unit Refurbishment –
12 Unit 2 and \$9.4M in Facilities and Infrastructure Projects.

13
14 In EB-2020-0290, the OEB-approved DRP in-service additions of \$6,442.6M over the 2022-
15 2026 period, which reflected in-service additions of \$1.4M for an Early In-service project
16 associated with Unit 1, \$2,504.0M for the Unit Refurbishment – Unit 3, \$1.6M for an Early In-
17 service Project associated with Unit 4, \$1,907.3M for the Unit Refurbishment – Unit 1 and
18 \$2,028.3M for the Unit Refurbishment – Unit 4.

19
20 This exhibit provides a variance analysis for the DRP in-service amounts relative to the OEB-
21 approved amounts, excluding the Heavy Water Storage and Drum Handling Facility.¹

22
23 OPG has not conducted a term-over-term variance analysis as the Application is not seeking
24 any incremental approvals for the DRP over the IR term.

¹ The OEB conducted a prudence review of the Heavy Water Storage and Drum Handling Facility in EB-2020-0290, the results of which are reflected in OPG's rate base. OPG is not seeking cost recovery for any additional amounts related to this project. See Ex. D2-2-1, Section 1.0 for further details.

1 **2.0 COMPARISON OF IN-SERVICE AMOUNTS FOR UNIT REFURBISHMENTS**

2 The following provides a comparison between and actual or forecast and OEB-approved Unit
3 Refurbishment in-service amounts for each of the four units comprising the DRP scope. All of
4 these amounts fall into the 2020-2026 period.

5
6 Unit Refurbishment – Unit 2

7 The Unit Refurbishment – Unit 2 in-service amount comprises costs incurred to complete the
8 refurbishment scope and return Unit 2 to service. In EB-2016-0152, the OEB approved a Unit
9 Refurbishment – Unit 2 in-service amount of \$4,799.8M on February 20, 2020 and close out
10 costs of \$0.4M in 2021. Unit 2 was returned to service on June 4, 2020. The actual Unit 2 in-
11 service amounts were \$4,765.0M for 2020, \$6.2M for 2021, (-\$2.5M) for 2022, and
12 (-\$2.4M) for 2023.² The variance (-\$33.9M) was due to placing (-\$70.3M) of projects early in-
13 service rather than as part of Unit 2 as they provided immediate benefit to Darlington, partially
14 offset by an increase of (+\$36.4M) in the Unit 2 in-service amount (including the Definition
15 Phase) due to higher spend. These key Early In-service Projects are further discussed in
16 Section 3.0 below.

17
18 Unit Refurbishment – Unit 3

19 The Unit Refurbishment – Unit 3 in-service amount comprises costs incurred to complete the
20 refurbishment scope and return Unit 3 to service. In EB-2020-0290, the OEB approved a Unit
21 Refurbishment – Unit 3 in-service amount of \$2,504.0M on January 2, 2024. Unit 3 was
22 returned to service returned to service on July 18, 2023. The actual Unit 3 in-service amounts
23 were \$2,242.4M for 2023 and closeout costs of \$49.7M in 2024 and \$3.0M in 2025. The
24 variance (-\$208.9M) primarily resulted from savings due to unutilized contingency on Unit 3.

25
26 Unit Refurbishment – Unit 1

27 The Unit Refurbishment – Unit 1 in-service amount comprises costs incurred to complete the
28 refurbishment scope and return Unit 1 to service. In EB-2020-0290, the OEB approved a Unit
29 Refurbishment – Unit 1 in-service amount of \$1,907.3M on April 18, 2025. Unit 1 was returned

² The negative amounts are due to unit closeout adjustments.

1 to service on November 13, 2024. The actual Unit 1 in-service amounts were \$1,689.9M for
2 2024, plus forecast closeout costs of \$35.7M 2025, and \$6.2M in 2026. The variance
3 (-\$175.6M) primarily resulted from savings due to unutilized contingency on Unit 1.

4 5 Unit Refurbishment – Unit 4

6 The Unit Refurbishment – Unit 4 in-service amount comprises costs incurred to complete the
7 refurbishment scope and return Unit 4 to service. In EB-2020-0290, the OEB approved a Unit
8 Refurbishment – Unit 4 in-service amount of \$2,028.3M on October 16, 2026. Unit 4 is planned
9 to be returned to service on April 15, 2026. The planned Unit 4 in-service amount is \$2,291.5M.
10 The resulting variance (+\$263.2M) is primarily driven by a CanAtom Execution Phase incentive
11 payable at the end of the program and demobilization costs assigned against Unit 4. In EB-
12 2020-0290, the costs for both of these elements were not separately assigned and, as
13 required, were expected to be drawn from the overall program contingency. Any unutilized
14 contingency upon completion of Unit 4 will be reconciled through the Capacity Refurbishment
15 Variance Account.

16 17 **3.0 PERIOD-OVER-PERIOD CHANGES – BRIDGE YEARS**

18 The following provides a period-over-period comparison between the forecast and OEB-
19 approved annual in-service amounts for the DRP for the bridge years.

20 21 **2026 Budget versus 2026 OEB-Approved**

22 The forecasted 2026 in-service amounts of \$2,299.4M are (+\$271.1M) higher than the OEB-
23 approved amount of \$2,028.3M, primarily due to a CanAtom Execution Phase incentive
24 payable at the end of the program and demobilization costs assigned against Unit 4.

25 26 **2025 Budget versus 2025 OEB-Approved**

27 The forecasted 2025 in-service amounts of \$38.6M are (-\$1,868.7M) lower than the OEB-
28 approved amount of \$1,907.3M due to the earlier in-service of Unit 1 in 2024 relative to the
29 plan of 2025.

1 **4.0 PERIOD-OVER-PERIOD CHANGES – HISTORICAL YEARS**

2 The following provides a period-over-period comparison between the actual and OEB-
3 approved annual in-service amounts for the DRP for the historical years.

4
5 **2024 Actual versus 2024 OEB-Approved**

6 The actual 2024 in-service amounts of \$1,741.9M are (-\$763.7M) lower than the OEB-
7 approved amount of \$2,505.5M, due to the earlier in-service of Unit 3 in 2023 relative to the
8 plan of 2024, partly offset by the earlier in-service of Unit 1 in 2024 relative to the plan of 2025.

9
10 **2023 Actual versus 2023 OEB-Approved**

11 The actual 2023 in-service amounts of \$2,240.1M are (+\$2,238.6M) higher than the OEB-
12 approved amount of \$1.4M, primarily due to earlier in-service of Unit 3, relative to the plan of
13 2024.

14
15 **2022 Actual versus 2022 OEB-Approved**

16 There are no project significant actual or OEB-approved in-service amounts for 2022.

17
18 **2021 Actual versus 2021 OEB-Approved**

19 There are no project significant actual or OEB-approved in-service amounts for 2021.

20
21 **2020 Actual versus 2020 OEB-Approved**

22 Excluding the D2O Storage Project, the actual 2020 in-service amounts of \$4,774.1M are
23 (-\$35.1M) lower than the OEB-approved amount of \$4,809.2M, primarily due to placing
24 (-\$70.3M) of projects early in-service rather than as part of Unit 2, partially offset by an increase
25 of (+\$36.4M) in the Unit 2 in-service amount (including the Definition Phase) due to higher
26 spend. These new Early In-service Projects provided immediate benefit to Darlington, as
27 detailed in EB-2020-0290, Ex. D2-2-9. The three main projects are summarized below:

- 28 • Breathing Air Capacity Enhancement – installed additional air compressors to provide
29 breathing air to suited personnel working in the vault, immediately benefiting the station
30 due to enhanced reliability and performance of the station’s breathing air system.

- 1 • Fuel Handling Power Track Refurbishment – refurbished major components of the three
2 existing power tracks integral to the operation of the fuel handling system, immediately
3 benefitting the station due to support for the fueling of the operating units.
- 4 • Service Air Capacity – installed new service air compressors and air receivers to increase
5 the capacity of the station service air system, immediately benefitting the station due to
6 enhanced reliability and performance of the station’s service air system.

Numbers may not add due to rounding.

Filed: 2025-12-12
 EB-2025-0297
 Exhibit D2
 Tab 2
 Schedule 3
 Table 1a

Table 1a
Program Expenditures Summary - Darlington Refurbishment Program (\$M)

Line No.	Description	2010 Actual	2011 Actual	2012 Actual	2013 ⁺ Actual	2014 Actual	2015 Actual	2016 Actual	2017 Actual	2018 Actual	2019 Actual	2020 Actual	2021 Actual
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
1	OM&A	3.2	2.6	2.8	6.3	6.3	1.6	3.1	36.1	31.3	1.7	19.0	35.6
2	Capital Expenditures	32.6	91.0	232.5	409.3	694.3	705.8	1,019.2	1,249.3	1,079.2	1,150.5	781.5	813.0
3	Total Darlington Refurbishment Program	35.8	93.6	235.3	415.6	700.5	707.4	1,022.3	1,285.4	1,110.5	1,152.2	800.5	848.5

Line No.	Description	2022 Actual	2023 Actual	2024 Actual	2025 Budget	2026 Budget	2010-2026 Total
		(a)	(b)	(c)	(d)	(e)	(f)
4	OM&A	22.3	39.0	59.7	10.5	1.8	282.8
5	Capital Expenditures	970.3	973.2	988.2	835.2	392.0	12,417.0
6	Total Darlington Refurbishment Program	992.6	1,012.2	1,047.9	845.7	393.8	12,699.8

Notes:

- 1 Line 1 cols. (a) through (c) per EB-2013-0321, Ex. F2-7-1, Table 1, line 3, cols. (a) through (c) and Line 2 cols. (a) through (c) per EB-2013-0321, Ex. D2-1-2, Table 1, line 2, cols. (a) through (c).
- 2 Line 1 cols. (d) through (f) per EB-2016-0152 Ex. F2-7-1, Table 1, line 1, cols. (a) through (c) and Line 2 cols. (d) through (f) per EB-2016-0152 Ex. D2-1-2, Table 1, line 2, cols. (a) through (c).
- 3 Line 1 cols. (g) through (j) per EB-2020-0290 Ex. F2-7-1, Table 1, line 4, cols. (a) through (d) and Line 2 cols. (g) through (j) per EB-2020-0290 Ex. D2-1-2, Table 1, line 2, cols. (a) through (d).
- 4 Line 1, cols. (k) through (l) and Line 4, cols. (a) through (e) per Ex. F2-7-1, Table 1, line 4, cols. (a) through (g) and Line 5 per Ex. D2-1-2, Table 1, line 2, cols. (a) through (g).
- 5 * Line 1, col. (d) has been revised from amounts shown in EB-2016-0152 Ex. D2-1-2, Table 1, line 2, col. (a) as projects 73706, 25619 and 34000 were reclassified as noted in EB-2016-0152 Ex. D-2-10 pp. 10 and pp. 11.

Numbers may not add due to rounding.

Filed: 2025-12-12
 EB-2025-0297
 Exhibit D2
 Tab 2
 Schedule 3
 Table 1b

Table 1b
 Capital Expenditures Summary - Darlington Refurbishment Program (\$M)

Line No.	Description	2020 Actual	2021 Actual	2022 Actual	2023 Actual	2024 Actual	2025 Budget	2026 Budget	2027 Plan	2028 Plan	2029 Plan	2030 Plan	2031 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
1	Darlington Refurbishment Program - Unit Refurbishment¹	771.4	813.9	970.2	971.4	987.9	835.2	392.0	0.0	0.0	0.0	0.0	0.0
2	Facilities and Infrastructure Projects	0.4	(1.4)	(0.9)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Heavy Water Storage Facility (D2O Storage) Project²	7.0	(0.3)	0.0	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	Safety Improvement Opportunities	2.7	0.8	0.9	1.8	(0.1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	Total Darlington Refurbishment	781.5	813.0	970.3	973.2	988.2	835.2	392.0	0.0	0.0	0.0	0.0	0.0

Notes:

- 1 The DRP Unit Refurbishment includes the Unit 2, Unit 3, Unit 1, Unit 4, and Early In-Service projects.
- 2 Heavy Water Storage Facility (D2O Storage) project costs in rate base are limited to amounts approved by the OEB in EB-2020-0290.

Numbers may not add due to rounding.

Filed: 2025-12-12
 EB-2025-0297
 Exhibit D2
 Tab 2
 Schedule 3
 Table 2

Table 2
 Capital Project Listing - Darlington Refurbishment Program
 Projects ≥ \$30M Total Project Cost¹

Line No.	Facility	Project Name	Project Number	Category	Start Date	Final In-Service Date	Total Project Cost (\$M)	Total In-Service (\$M)	In-Service 2025 (\$M)	In-Service 2026 (\$M)	In-Service 2027 (\$M)	In-Service 2028 (\$M)	In-Service 2029 (\$M)	In-Service 2030 (\$M)	In-Service 2031 (\$M)
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
		ONGOING PROJECTS FROM EB-2020-0290													
1	DN	Darlington Refurbishment - Unit Refurbishment - Unit 3	Various	Unit Refurb -Unit 3	Sep-20	Jul-23	2,295.1	2,295.1	3.0	0.0	0.0	0.0	0.0	0.0	0.0
2	DN	Darlington Refurbishment - Unit Refurbishment - Unit 1	Various	Unit Refurb -Unit 1	Feb-22	Nov-24	1,731.7	1,731.7	35.7	6.2	0.0	0.0	0.0	0.0	0.0
3	DN	Darlington Refurbishment - Unit Refurbishment - Unit 4	Various	Unit Refurb -Unit 4	Jul-23	Apr-26	2,291.5	2,291.5	0.0	2,291.5	0.0	0.0	0.0	0.0	0.0
4		Subtotal					6,318.3	6,318.3	38.6	2,297.7	0.0	0.0	0.0	0.0	0.0
5		Total - Projects ≥ \$30M Total Project Cost					6,318.3	6,318.3	38.6	2,297.7	0.0	0.0	0.0	0.0	0.0

Notes:

¹ Projects with expenditures during forecast period OR In-Service Amounts in Bridge or forecast period AND Completed/Deferred Projects at the time of preparing the 2025-2031 Business Plan.

Numbers may not add due to rounding.

Filed: 2025-12-12
 EB-2025-0297
 Exhibit D2
 Tab 2
 Schedule 3
 Table 4

Table 4
 Capital Project Listing - Darlington Refurbishment Program
 Projects <\$10M Total Project Cost¹

Line No.	Project Name	Number of Projects	Total Project Cost (\$M)	Average Cost Of All Projects (\$M)	In-Service IR Term (\$M)	In-Service 2025 (\$M)	In-Service 2026 (\$M)	In-Service 2027 (\$M)	In-Service 2028 (\$M)	In-Service 2029 (\$M)	In-Service 2030 (\$M)	In-Service 2031 (\$M)
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
1	Unit Refurbishment - Early In-service	3	7.4	2.5	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0
2	Facilities & Infrastructure Projects	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Safety Improvement Opportunities	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	Total - Projects <\$10M Total Project Cost	3	7.4	2.5	0.0	0.0	1.7	0.0	0.0	0.0	0.0	0.0

Notes:

- 1 Projects with expenditures during forecast period OR In-Service Amounts in Bridge or forecast period AND Completed/Deferred Projects at the time of preparing the 2025-2031 Business Plan.

Numbers may not add due to rounding.

Filed: 2025-12-12
 EB-2025-0297
 Exhibit D2
 Tab 2
 Schedule 3
 Table 5a

Table 5a
 Comparison of In-Service Capital Additions - Darlington Refurbishment Program (\$M) 2020-2028

Line No.	Business Unit	2020 OEB Approved	(c)-(a) Change	2020 Actual	2021 OEB Approved	(f)-(d) Change	2021 Actual	2022 OEB Approved	(i)-(g) Change	2022 Actual	2023 OEB Approved	(l)-(j) Change	2023 Actual
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
1	Darlington Refurbishment - Unit Refurbishment - Unit 2	4,799.8	(34.8)	4,765.0	0.4	5.8	6.2	0.0	(2.5)	(2.5)	0.0	(2.4)	(2.4)
2	Darlington Refurbishment - Unit 2 Refurbishment - Early I/S	0.0	2.2	2.2	0.0	1.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0
3	Subtotal	4,799.8	(32.6)	4,767.2	0.4	7.3	7.7	0.0	(2.5)	(2.5)	0.0	(2.4)	(2.4)
4	Facilities & Infrastructure Projects	9.4	0.6	10.0	0.0	(1.4)	(1.4)	0.0	(0.9)	(0.9)	0.0	0.0	0.0
5	D20 Storage Project ¹	0.0	381.0	381.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	Safety Improvement Opportunities	0.0	(3.0)	(3.0)	0.0	1.5	1.5	0.0	4.2	4.2	0.0	0.0	0.0
7	Darlington Refurbishment - Unit Refurbishment - Unit 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,242.4	2,242.4
8	Darlington Refurbishment - Unit 3 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	2.9	0.0	0.0	0.0
9	Darlington Refurbishment - Unit Refurbishment - Unit 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	Darlington Refurbishment - Unit 1 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	(1.4)	0.0
11	Darlington Refurbishment - Unit Refurbishment - Unit 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Darlington Refurbishment - Unit 4 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	Total In-Service Capital Additions	4,809.2	345.9	5,155.1	0.4	7.4	7.8	0.0	3.7	3.7	1.4	2,238.6	2,240.1

Line No.	Business Unit	2024 OEB Approved	(c)-(a) Change	2024 Actual	2025 OEB Approved	(f)-(d) Change	2025 Budget	2026 OEB Approved	(i)-(g) Change	2026 Budget	2027 Plan	(l)-(j) Change	2028 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
14	Darlington Refurbishment - Unit Refurbishment - Unit 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	Darlington Refurbishment - Unit 2 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	Subtotal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Facilities & Infrastructure Projects	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	D20 Storage Project ¹	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Safety Improvement Opportunities	0.0	2.3	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	Darlington Refurbishment - Unit Refurbishment - Unit 3	2,504.0	(2,454.3)	49.7	0.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0
21	Darlington Refurbishment - Unit 3 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	Darlington Refurbishment - Unit Refurbishment - Unit 1	0.0	1,689.9	1,689.9	1,907.3	(1,871.7)	35.7	0.0	6.2	6.2	0.0	0.0	0.0
23	Darlington Refurbishment - Unit 1 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	Darlington Refurbishment - Unit Refurbishment - Unit 4	0.0	0.0	0.0	0.0	0.0	0.0	2,028.3	263.2	2,291.5	0.0	0.0	0.0
25	Darlington Refurbishment - Unit 4 Refurbishment - Early I/S	1.6	(1.6)	0.0	0.0	0.0	0.0	0.0	1.7	1.7	0.0	0.0	0.0
26	Total In-Service Capital Additions	2,505.5	(763.7)	1,741.9	1,907.3	(1,868.7)	38.6	2,028.3	271.1	2,299.4	0.0	0.0	0.0

Notes:

¹ In its EB-2020-0290 Decision and Order, the OEB approved in-service additions of \$381M, which factors in a permanent rate base disallowance of \$113.7M to the total cost that OPG proposed to add to rate base for the D20 Storage Project.

Numbers may not add due to rounding.

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 Exhibit D2
 Tab 2
 Schedule 3
 Table 5b

Table 5b
 Comparison of In-Service Capital Additions - Darlington Refurbishment Program (\$M) 2028-2031

Line No.	Business Unit	2028 Plan	(c)-(a) Change	2029 Plan	(e)-(c) Change	2030 Plan	(g)-(e) Change	2031 Plan	2022-2026 Actual & Budget	(j)-(h) Change	2027-2031 Plan
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
1	Darlington Refurbishment - Unit Refurbishment - Unit 2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(4.9)	4.9	0.0
2	Darlington Refurbishment - Unit 2 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	Subtotal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(4.9)	4.9	0.0
5	Facilities & Infrastructure Projects	0.0	0.0	0.0	0.0	0.0	0.0	0.0	(0.9)	0.9	0.0
6	D2O Storage Project	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	Safety Improvement Opportunities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	(6.5)	0.0
8	Darlington Refurbishment - Unit Refurbishment - Unit 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,295.1	(2,295.1)	0.0
9	Darlington Refurbishment - Unit 3 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	(2.9)	0.0
10	Darlington Refurbishment - Unit Refurbishment - Unit 1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,731.7	(1,731.7)	0.0
11	Darlington Refurbishment - Unit 1 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	Darlington Refurbishment - Unit Refurbishment - Unit 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,291.5	(2,291.5)	0.0
13	Darlington Refurbishment - Unit 4 Refurbishment - Early I/S	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	(1.7)	0.0
14	Total In-Service Capital Additions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6,323.6	(6,323.6)	0.0