

DARLINGTON REFURBISHMENT PROGRAM

OVERVIEW

1.0 PROGRAM SUMMARY

The Darlington Refurbishment Program (the “Program” or “DRP”) 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 Program is comprised of individual projects of various scales and sizes that will be executed during multi-year outages on each of the four units.

The Program began in 2007 and is being completed in three Phases, Initiation (2007-2009), Definition (2010-2015), and Execution (2016-2026). In its previous rate application (EB-2016-0152), OPG provided evidence that it had completed the Definition Phase of the Program, that all major contracts required to execute the scope of the Program had been awarded, and that the detailed planning conducted by OPG and its contractors had enabled the development of a four-unit budget and schedule for the successful execution of the Program, known as the Release Quality Estimate (“RQE”). The RQE was finalized in November 2015 and established a four-unit, program-level control budget of \$12.8B that serves as the baseline against which the success of the Program is being measured.¹ The RQE was the basis upon which OPG’s Board of Directors granted approval to proceed from the Definition Phase to the Execution Phase of the Program in November 2015, the basis of the Province’s announced endorsement of the Program on January 11, 2016, and the basis of OPG’s pre-filed evidence in EB-2016-0152.²

¹ The impact of the COVID-19 pandemic in 2020 on the cost and schedule for the Program 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 start dates for Units 1 and 4, and is tracking the incremental costs associated with the pandemic separately. See additional discussion of the COVID-19 impacts on pages five through eight of this exhibit as well as in Exhibits D2-2-5, D2-2-6, and D2-2-7.

² <https://news.ontario.ca/en/release/35478/ontario-moving-forward-with-nuclear-refurbishment-at-darlington-and-pursuing-continued-operations-at.html>

1 Subsequent to the RQE, and prior to the start of the Unit 2 refurbishment outage, as planned,
2 OPG completed a more refined estimate of the cost and schedule for refurbishing Unit 2 and
3 a corresponding update to the Program budget and schedule, known as the Unit 2 Execution
4 Estimate ("U2EE"), in August 2016. The U2EE was the basis upon which OPG's Board of
5 Directors granted approval to proceed with the execution of the Unit 2 refurbishment outage.
6 The U2EE maintained the four-unit, program-level control budget of \$12.8B. The U2EE was
7 provided to the OEB in EB-2016-0152, in response to a Board Staff interrogatory (EB-2016-
8 0152, Ex. L4.3-1 Staff-055). OPG did not update its revenue requirement in EB-2016-0152 to
9 reflect the U2EE, and the OEB agreed with this approach, as the impact of any differences
10 would be captured in the Capacity Refurbishment Variance Account ("CRVA"). The U2EE is
11 the baseline against which OPG measured its performance during the execution of the Unit 2
12 refurbishment.

13
14 In its EB-2016-0152 application, OPG provided evidence that it had established the
15 appropriate organization, project controls, change management and oversight to manage,
16 control, report on, and take corrective actions, as required, to be able to provide high
17 confidence of completing the Program safely, on budget, on schedule and with the required
18 quality. OPG sought and received approval from the OEB for in-service additions of
19 \$4,800.2M related to Unit 2 (including the Definition Phase) in 2020 and 2021, as well as
20 \$377.2M related to Unit Refurbishment Early In-Service projects, Facilities & Infrastructure
21 Projects ("F&IP") and Safety Improvement Opportunities ("SIO"), for a total of \$5,177.4M.³
22 The \$377.2M in-service additions for Early In-Service projects, SIO and F&IP were
23 distributed over 2016 (the bridge year in the EB-2016-0152 application) to 2021.

³ 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 Program.

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 ("CNSC"). To meet required in-service dates, OPG commenced execution of SIO work early in the Definition Phase of the Program.

1 In its Decision and Order for EB-2016-0152, the Board stated the following:

2
3 The OEB finds that the planning undertaken by OPG for the DRP was
4 reasonable. The OEB notes that both experts agreed that the planning for the
5 DRP had been conducted according to industry standards. The OEB finds
6 that OPG has developed reasonable project control systems to manage the
7 cost and schedule of the DRP. OPG also performed adequate risk
8 assessment for the project and put in place processes to address risks as
9 they arise.

10
11 The OEB also finds that the oversight structure that OPG has designed to
12 monitor the DRP appears appropriate. As previously discussed, there are
13 multiple layers of oversight with respect to DRP that should allow OPG to
14 react appropriately to potential issues. The oversight for the project includes
15 both internal and external expertise and resources.⁴

16
17 The refurbishment outage of Unit 2 began on October 15, 2016 and was completed on June
18 4, 2020 when the unit was successfully returned to service. Compared to the U2EE, the
19 refurbishment of Unit 2 was completed on budget at \$3,417M.⁵

20
21 Relative to the OEB approved in-service amount in EB-2016-0152 of \$5,177.4M for the
22 refurbishment of Unit 2 (including the Definition Phase), Early-In-Service projects, F&IP and
23 SIO, there is a forecast variance of \$132.7M or 2.5%.

24
25 Ex. D2-2-2 provides an explanation of the variances against the two components which
26 make up the \$5,177.4M OEB approved amounts, i.e., the \$4,800.2M for Unit 2 (including the
27 Definition Phase), and the \$377.2M for Early-In-Service projects, F&IP and SIO.

28
29 Ex. D2-2-9 provides a comparison of actual in-service amounts to OEB approved amounts in
30 EB-2016-0152.

31
32 The successful completion of the Unit 2 refurbishment on budget and reasonably on
33 schedule represented a significant achievement in mega-project execution for OPG.

⁴ OEB Decision and Order, EB-2016-0152, December 28, 2017, p. 36.

⁵ Of the \$3,417M final cost of Unit 2, \$3,340.5M represents the capital in-service amount.

1 In EB-2016-0152, OPG outlined the use of the CRVA to record the revenue requirement
2 impact of any differences between OEB approved amounts and actual in-service additions
3 (and associated timing) to rate base for the DRP. Under the CRVA, if OPG were to
4 experience a variance relative to OEB approved in-service amounts, a balance, either
5 positive or negative, would be recorded in the CRVA. The OEB would review the prudence of
6 any in-service amounts over the approved amounts prior to disposition.

7
8 In this application, OPG is not seeking inclusion of the variance against the EB-2016-0152
9 approved in-service additions in rate base for the purposes of setting payment amounts for
10 the IR term. The revenue requirement impact of the variance would continue to be recorded
11 in the CRVA. Further details regarding the proposed rate base treatment can be found in Ex.
12 B1-1-1.

13
14 OPG also is not seeking clearance of DRP-related amounts in the CRVA in this application.⁶
15 OPG proposes to defer the clearance of any such DRP-related amounts recorded in the
16 CRVA (and inclusion of the variance against the EB-2016-0152 approved in-service
17 additions in rate base) to a future application, which would allow an assessment of the
18 recoverability of DRP-related variances, if any, in the context of the overall performance of
19 the four-unit refurbishment, including the effectiveness of Lessons Learned and Strategic
20 Improvements from the earlier unit refurbishments. OPG's proposed treatment of the
21 variances is consistent with the DRP being a single mega-program as opposed to a
22 collection of smaller projects. Further details regarding the CRVA balances are provided in
23 Ex. H1-1-1, Section 5.6.

24
25 Since EB-2016-0152, in addition to successfully completing the refurbishment of Unit 2, OPG
26 has completed detailed planning and preparations for the refurbishment of Unit 3 including

⁶ Other than the D2O Storage Project (Ex. D2-2-10) and the impacts of capital cost allowance deductions arising from changes in income tax legislation since EB-2016-0152 (Ex. F4-2-1). OPG also did not seek recovery of DRP-related CRVA balances in its EB-2018-0243 application for disposition of deferral and variance account balances, meaning that none of DRP-related CRVA balances accumulated since January 1, 2016 have been sought for clearance to date.

1 the incorporation of Lessons Learned and Strategic Improvements,⁷ and has also
2 commenced the refurbishment of Unit 3. OPG has also advanced detailed planning for Units
3 1 and 4.

4
5 In this application, through exhibits D2-2-1 to D2-2-9, OPG provides an update on the
6 progress of the DRP, and evidence to support its request for approval of in-service additions
7 through 2026, relating to the refurbishment and planned return to service of Units 3, 1, and 4,
8 collectively known as the “Remaining Units”, as set out in Section 2.0.

9
10 More specifically, OPG’s pre-filed evidence demonstrates that:

- 11 • OPG has successfully performed the Unit 2 refurbishment and returned the unit to
12 service.
- 13 • OPG has performed the detailed planning that is necessary, including the incorporation of
14 Lessons Learned from Unit 2 and the implementation of Strategic Improvements, to
15 establish the High Confidence Schedule⁸ and cost estimates for completing the
16 refurbishment of the Remaining Units and the Program in 2026, safely and with quality.
- 17 • Excluding any ultimate impact of the COVID-19 pandemic, the total estimated cost for
18 completing the Program remains within the baseline estimate of \$12.8B, as established
19 at the RQE. While the COVID-19 pandemic is currently estimated to have resulted in a
20 \$150M increase in Program costs, OPG will continue to monitor, assess and explore
21 potential efficiencies during the execution of the Remaining Units’ refurbishments in an
22 effort to complete the Program, inclusive of COVID-19 cost impacts, within the \$12.8B
23 budget established at the time of the RQE. OPG is not seeking approval of any COVID-

⁷ “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 Remaining Units’ refurbishments that are being implemented in addition to Lessons Learned. See Ex. D2-2-3, Sections 4 and 5, for a detailed discussion of Lessons Learned and Strategic Improvements.

⁸ 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. For further discussion of the High Confidence and Working Schedules, please refer to Ex. D2-2-2, Ex. D2-2-3, and Ex. D2-2-5.

1 19 pandemic-related costs in this application, and none are included in the in-service
2 additions presented. Any ultimate variance to the \$12.8B caused by the COVID-19
3 pandemic would be tracked separately and addressed through the CRVA in a future
4 proceeding.

- 5 • OPG has in place the resources, organization and processes necessary to execute the
6 refurbishment of the Remaining Units, and to complete the Program in its entirety, safely,
7 on time, on budget, and to the required quality level.
- 8 • The Government of Ontario, through its most recent Long-Term Energy Plan,⁹ and
9 through a specific endorsement to proceed with the refurbishment of Unit 3,¹⁰ continues
10 to support the completion of the Program.

11
12 The refurbishment outages of the Remaining Units are scheduled to take place over a total
13 span of 73 months (September 2020 to October 2026), including 40 months for Unit 3, 38
14 months for Unit 1, and 37 months for Unit 4.

15
16 Chart 1 provides the planned start dates, end dates and durations per OPG's High
17 Confidence Schedules for the refurbishment outages of Units 3, 1, and 4. As discussed
18 further in exhibits D2-2-3, D2-2-5, D2-2-6, and D2-2-7, the schedules reflect the impact of
19 OPG's response to the COVID-19 pandemic that resulted in a later start date of the
20 refurbishment outage of Unit 3 in 2020 and correspondingly later start dates of the Units 1
21 and 4 refurbishment outages in subsequent years.¹¹ Consistent with the revised Program
22 schedule, the refurbishment outage of Unit 3 began on September 3, 2020.

⁹ Government of Ontario, *Delivering Fairness and Choice – Ontario's Long term Energy Plan 2017*, October 2017.

¹⁰ Government of Ontario, Ministry of Energy News Release, and then MPP for Durham, Granville Anderson's, announcement at the Darlington Energy Centre, February 15, 2018.

¹¹ As a result of the deferred DRP schedule, OPG moved an outage from 2020 to 2021 and also added a regular planned outage in 2021 to support Unit 4 operation until its start of refurbishment. See Ex. E2-1-2 for further discussion.

**Chart 1: High Confidence Schedule Dates for
Units 3, 1 and 4 Refurbishment Outages**

	Start	End	Duration (Months)
Unit 3	3-Sep-2020	2-Jan-2024	40
Unit 1	15-Feb-2022	18-Apr-2025	38
Unit 4	15-Sep-2023	16-Oct-2026	37

Consistent with OPG's plans, OPG has further updated the Program budget and schedule and has completed the Unit 3 Execution Estimate ("U3EE"). The final update to the U3EE was completed in August 2020. The final U3EE included the schedule impacts of the COVID-19 pandemic on the Program, and is the baseline against which OPG and its Board of Directors will measure the company's performance during the execution of the Unit 3 refurbishment. The final U3EE serves as the underlying basis for the in-service amounts requested in this application.

Within the 2022-2026 period, Units 3, 1, and 4 are scheduled to be refurbished and placed in service in 2024, 2025, and 2026, respectively. The total budget to complete the refurbishment of these units is \$6,604.2M, comprising of \$6,444.4M¹² capital and \$159.8M OM&A¹³. A simplified breakdown of the Remaining Units' estimate, based on the final U3EE, is provided in Chart 2 below.

¹² Of the \$6,444.4M capital, \$6,442.6M is being requested in this application for the 2022-2026 rate period. Capital costs of \$1.9M for an early-in-service project associated with Unit 3 are forecast to be placed in-service in 2021.

¹³ Of the \$159.8M of OM&A costs, \$110.5M is being requested in this application for the 2022-2026 rate period (Ex. F2-7-1). The remainder represents actual OM&A expenses in 2019 and forecast OM&A expenses in 2020 and 2021 on the Remaining Units.

1

Chart 2: Simplified Breakdown of Total Remaining Units Estimate

Program Component	Remaining Units Total Cost (\$M)	Remaining Units Total Cost (%)
Major Work Bundles	4,389	66
OPG Functional Support	1,567	24
Contingency	647	10
Total Cost Estimate	6,604	100
Note: Interest and Escalation are included each of the line items above		

2

3 The Program components listed in Chart 2 are as follows:

4

5 *Major Work Bundles* are logical groupings of work scope, each consisting of a number of
6 individual projects, defined by OPG for purposes of effectively contracting work to OPG's
7 contractors and assigning project management accountabilities. The work to be undertaken
8 through the Major Work Bundles consists of the replacement and rehabilitation of
9 components, inspections, and the completion of upgrades directly related to unit
10 refurbishment. Consistent with what was presented in EB-2016-0152, the Major Work
11 Bundles are: (1) Retube and Feeder Replacement; (2) Turbine Generator; (3) Fuel Handling
12 and Defueling; (4) Steam Generator; and, (5) Balance of Plant.

13

14 *OPG Functional Support* refers to work carried out by groups within OPG's Program
15 Management and Execution Management and Support organizations (referred to as
16 "Functions"). The Functions provide a broad range of support that is critical for the success of
17 the Major Work Bundles and the Program as a whole, including oversight, coordination, and
18 integration among the various contractors and ongoing station operations. It is largely
19 through the Functions that OPG performs its vital role as the Program owner, with overall
20 responsibility for Program management, deliverables, costs and schedule, as well as full
21 integration with the operating units in order to comply with all Canadian Nuclear Safety

Commission (“CNSC”) regulations and safe work practices, including permits and work control, radiation protection, chemistry and environmental controls.

Contingency is an element of the cost estimate that is allocated to manage uncertainty and risk throughout the life of the Program, and which is expected to be spent based on OPG’s in-depth assessment of Program risks and uncertainties that cannot be avoided or fully mitigated.

OPG has made quarterly status reports available to the public through its website since the start of refurbishment of Unit 2, and plans to continue this practice until the completion of the Program. The public report covers the four project pillars of safety, quality, cost and schedule. As well, in accordance with the OEB’s Decision and Order in OPG’s EB-2016-0152 application,¹⁴ OPG has issued detailed annual reports to the OEB at the end of 2018, 2019, and 2020 on the progress of the Program during those respective years. The annual report to the OEB includes a range of measures of safety, quality, cost, and schedule performance. OPG will continue to issue annual reports to the OEB until the completion of the Program.

In Ex. D2-2-10, OPG separately provides evidence to support its request for approval of in-service additions associated with the Heavy Water Storage and Drum Handling Facility (“D2O Storage Project”). OPG completed this complex project in 2020 and it is expected to support all of the Remaining Units’ refurbishments.

2.0 APPROVALS SOUGHT

In the EB-2016-0152 proceeding, the OEB granted envelope approval for OPG’s in-service amount request for Unit 2.¹⁵ Consistent with the OEB’s approval for Unit 2 in EB-2016-0152, in the current application, OPG seeks the following OEB approvals for the DRP:

¹⁴ Ontario Energy Board, *Decision and Order, EB-2016-0152, Ontario Power Generation Inc.*, December 28, 2017.

¹⁵ *Ibid*, p. 41

- 1 • In-service additions to rate base of a total of \$6,442.6M comprised of: (i) \$1.4M in 2023
2 for an Early In-service Project associated with Unit 1, (ii) \$2,505.5M in 2024 on
3 completion of the Unit 3 refurbishment (this includes \$1.6M for an Early-In-Service
4 Project associated with Unit 4); (iii) \$1,907.3M in 2025 on completion of the Unit 1
5 refurbishment; and, (iv) \$2,028.3M in 2026 on completion of the Unit 4 refurbishment;
6 (see Ex. D2-2-9 for details). Should the total aggregate actual additions to rate base be
7 different from the total forecast amount of \$6,442.6M, the revenue requirement impact of
8 the cost variance (and any associated timing variances) will be recorded in the CRVA
9 and any amounts greater than the forecast will be subject to a prudence review in a
10 future proceeding;
- 11 • OM&A expenditures of \$24.2M for 2022, \$23.6M for 2023, \$29.3M for 2024, \$25.0M for
12 2025, and \$8.4M for 2026 (Ex. F2-7-1); and,
- 13 • Approval of cumulative additions to rate base of \$494.7M associated with the D2O
14 Storage Project, consisting of in-service additions of \$160.0M in 2016, \$320.9M in 2019,
15 and \$13.8M in 2020.¹⁶

17 **3.0 EVIDENCE ROADMAP**

18 OPG has approached the evidence for the Program in a similar manner to the evidence
19 provided in its EB-2016-0152 application, so as to facilitate understanding of the planning
20 and execution of the Remaining Units of the DRP.

21
22 OPG's evidence includes a review of performance on the Unit 2 refurbishment. The evidence
23 describes OPG's robust Lessons Learned process, its incorporation of Strategic
24 Improvements into the Remaining Units, and how these are expected to result in efficiencies.
25 OPG's on-going risk assessment process and the schedule and cost estimates for the
26 Remaining Units are all described. Also explained are adjustments to the Program's
27 organizational structure designed to efficiently and effectively manage the overlapping
28 refurbishment outages of the Remaining Units.

¹⁶ OPG also seeks recovery of the portion of the CRVA balance as at December 31, 2019 related to the D2O Storage Project and the impact on DRP-related capital cost allowance deductions arising from changes in income tax legislation since EB-2016-0152, as discussed in Ex. H1-1-1.

1 The evidence describes OPG's control, reporting and oversight structures to ensure
2 completion of the Program safely, on time, on budget and with quality. The evidence also re-
3 iterates the need for the Program to comply with all CNSC regulatory requirements, as well
4 as with provincial requirements for nuclear refurbishment as set out in the Province's 2013
5 and 2017 Long-Term Energy Plans ("LTEP").^{17, 18}

6
7 The evidence is organized as follows:

- 8 • Ex. D2-2-1 (Program Overview) provides a summary of the Program, the approvals
9 sought and a description of the relevant regulatory framework, including Ontario
10 Regulation 53/05, the Province's Long-Term Energy Plan and the relevant requirements
11 of the CNSC.
- 12 • Ex. D2-2-2 (Unit 2 Performance) summarizes OPG's performance on the refurbishment
13 of Unit 2.
- 14 • Ex. D2-2-3 (Remaining Units Planning) describes the approach and the status of
15 planning for the Remaining Units. The Lessons Learned process is described, and select
16 examples of key Lessons Learned from the execution of the Unit 2 refurbishment are
17 provided. Strategic Improvements are also described as are the reasons for these
18 Strategic Improvements and the expected impacts on the Remaining Units.
- 19 • Ex. D2-2-4 (Contracts) describes OPG's commercial management approach as well as
20 material amendments to the contracts governing each of the Major Work Bundles since
21 EB-2016-0152.
- 22 • Ex. D2-2-5 to Ex. D2-2-7 (Remaining Units Schedule, Contingency, and Cost) describe
23 the schedules, the updated contingency amounts and the updated cost estimates for the
24 Remaining Units.
- 25 • Ex. D2-2-8 (Program Structure and Oversight) focuses on how OPG will manage the
26 Remaining Units during both the planning and execution phases, including the drivers of
27 organizational changes implemented since the RQE and the approaches to managing the
28 overlapping planning and refurbishment outage periods. OPG's role as Program owner

¹⁷ Government of Ontario, *Achieving Balance – Ontario's Long Term Energy Plan*, December 2013.

¹⁸ Government of Ontario, *Delivering Fairness and Choice – Ontario's Long Term Energy Plan 2017*, October 2017.

1 and the manner in which OPG's various organizational units will manage circumstances
2 that affect scope, schedule, cost and quality during planning and execution of the
3 Remaining Units is recapped. Key controlling activities which will continue to enable OPG
4 to effectively track progress and manage execution risk are also recapped. Finally,
5 OPG's on-going Program Oversight structure (both internal and external oversight) is
6 described.

- 7 • Ex. D2-2-9 (In-Service Amounts) describes the capital in-service additions for the
8 Remaining Units and provides updates to the actual versus planned in-service amounts
9 which were approved in EB-2016-0152 for Unit 2 refurbishment, Unit Refurbishment
10 Early In-Service projects, F&IP and SIO, as well as applicable variance explanations.
- 11 • Ex. D2-2-10 (D2O Storage Project) explains the D2O Storage Project's function, history,
12 planning, construction, commissioning, and cost. It demonstrates that the capital
13 expenditures that OPG placed in service in 2016, 2019 and 2020 are reasonable and
14 appropriate and should be included in OPG's rate base.
- 15 • Ex. D2-2-11 (Independent Studies) provides a summary of two independent expert
16 reports prepared in support of OPG's evidence, and provides the final reports as
17 attachments. The first is from Pegasus Global Holdings, Inc. which provided an
18 assessment of OPG's project management approach and preparedness with respect to
19 the refurbishment of the Remaining Units. The second is from Bates White Economic
20 Consulting, which completed an estimate of the cost to design, engineer, construct and
21 commission the as-built D2O Storage Project.

22
23 A detailed breakdown of the DRP evidence structure is provided as Attachment 1.
24

25 **4.0 REGULATORY FRAMEWORK**

26 **4.1 Ontario Regulation 53/05**

27 Ontario Regulation 53/05 includes certain provisions related to the treatment of DRP in the
28 setting of OPG's payment amounts. These provisions, which are unchanged from EB-2016-
29 0152, are summarized below:

- 30 • The need for the DRP has been established by the regulation. As set out in the
31 regulation, in setting nuclear payment amounts during the period from January 1, 2017 to

1 the end of the DRP, the OEB shall accept the need for the DRP in light of the Ministry of
2 Energy's 2013 LTEP and the related policy of the Minister endorsing the need for nuclear
3 refurbishment.¹⁹

- 4 • If the OEB is satisfied that costs of the DRP were prudently incurred and financial
5 commitments were prudently made, the OEB must ensure that OPG recovers its capital
6 and non-capital costs and firm financial commitments incurred for the DRP.²⁰

7
8 Additionally, Ontario Regulation 53/05 provides for a rate smoothing approach to setting
9 OPG's payments amounts beginning on January 1, 2017 and ending when the DRP ends, as
10 discussed in Ex. I1-3-2.²¹

11 12 **4.2 Long Term Energy Plans**

13 Ontario's December 2013 LTEP stated: "[t]he government is committed to nuclear power. It
14 will continue to be the backbone of our electricity system, supplying about half of Ontario's
15 electricity generation."²² The December 2013 LTEP further stated:

16
17 The government will ensure a reliable supply of electricity by proceeding with
18 the refurbishment of the province's existing nuclear fleet taking into account
19 future demand levels. Refurbishment received strong, province-wide support
20 during the 2013 LTEP consultation process. The merits of refurbishment are
21 clear:

- 22 • Refurbished nuclear is the most cost-effective generation available to
23 Ontario for meeting base load requirements.
24 • Existing nuclear generating stations are located in supportive
25 communities, and have access to high-voltage transmission.
26 • Nuclear generation produces no greenhouse gas emissions.²³

27
28 The December 2013 LTEP sets out a number of principles with respect to the nuclear
29 refurbishment process.²⁴ As provided in EB-2016-0152, Ex. D2-2-1, Attachment 2, OPG's

¹⁹ O. Reg. 53/05, s. 6(2), para. 12(v).

²⁰ O. Reg. 53/05, s. 6(2), para. 4.

²¹ O. Reg. 53/05, s. 5.5 and s. 6(2), paras. 12(i) and (ii).

²² Government of Ontario, *Achieving Balance – Ontario's Long Term Energy Plan*, December 2013, p. 30.

²³ *Ibid*, page 29.

²⁴ LTEP, December 2013, page 29.

demonstrated that its plans for the DRP included a number of specific elements that aligned with the LTEP principles.

Ontario's 2017 LTEP re-iterated support for Ontario's nuclear refurbishment program with the following statements:

The most cost-effective option for producing the baseload generation the Province needs is to refurbish Ontario's nuclear generating stations. Ontario is moving forward with the plans laid out in the 2013 LTEP to refurbish a total of ten units – four units at Darlington and six units at Bruce.²⁵

Refurbishing these ten nuclear units will lock-in more than 9,800 MW of affordable, reliable, and emission-free capacity for the long-term benefit of Ontario.²⁶

4.3 Ontario Government's Continued Support for DRP

In addition to issuing clear policy statements regarding the need for nuclear refurbishment, the Government of Ontario's support for the DRP was affirmed on January 11, 2016²⁷ where the Government of Ontario endorsed OPG's plan to refurbish the four Darlington units. Subsequently, the Government of Ontario endorsed OPG's decision to proceed with the refurbishment of Unit 3, in a news release dated February 15, 2018.²⁸

In its 2019 Budget, the Government of Ontario stated:

The government supports Ontario Power Generation's (OPG) refurbishment project to extend the operating life of the four-unit Darlington Nuclear Generating Station. The Darlington Refurbishment project continues to track on time and on budget and, when finished, will generate low-cost, carbon-free and reliable energy for the people of Ontario for another 30 years.²⁹

4.4 CNSC Regulatory Framework

As provided in EB-2016-0152, the CNSC exercises ongoing regulatory and licensing oversight over nuclear power plants in Canada. Continued operation of Darlington is largely dependent on the work that is required for long term safe operation. OPG is required to

²⁵ Government of Ontario, *Delivering Fairness and Choice – Ontario's Long Term Energy Plan* 2017, p.45.

²⁶ Ibid.

²⁷ See footnote 2.

²⁸ See footnote 10.

²⁹ Government of Ontario, 2019 Budget, p. 92.

1 adhere to the requirements of the *Nuclear Safety and Control Act*, the *Canadian*
2 *Environmental Assessment Act*, all associated regulations, and conditions under its operating
3 license for Darlington. Regulatory requirements are included in the scope, schedule and
4 costs of the Program.

5
6 In accordance with CNSC regulations,³⁰ during the Definition Phase, OPG systematically
7 identified all environmental and safety concerns. This was accomplished through the
8 preparation of an Environmental Assessment ("EA"), an Integrated Safety Review ("ISR"), a
9 Global Assessment Report ("GAR") and an Integrated Implementation Plan ("IIP"). The IIP
10 sets out OPG's commitments to address the identified environmental and safety concerns. In
11 December 2015, the CNSC ruled that OPG had completed an ISR, GAR and IIP in
12 accordance with the regulatory requirements.

13
14 The current Darlington Nuclear Power Reactor Operating License became effective on
15 January 1, 2016. In granting a renewed license in December 2015, the CNSC concluded that
16 OPG is qualified to carry out the proposed refurbishment project. The CNSC provides
17 regulatory oversight to ensure OPG's compliance with the Power Reactor Operating License;
18 this includes oversight of the Program.

19
20 OPG has worked closely with the CNSC to facilitate their oversight of the Program, to ensure
21 that all requirements are satisfied and that regulatory issues would not impact the cost and
22 schedule of the DRP. For example, OPG established a protocol with the CNSC in 2016
23 outlining what information will be provided and what reviews will be conducted, to ensure that
24 regulatory approvals would not impact critical path.

³⁰ Regulatory Document RD-360 (Life Extension of Nuclear Power Plants), later superseded by Regulatory Document REGDOC-2.3.3 (Periodic Safety Reviews) for a nuclear life extension project. The CNSC expects the licensee to demonstrate that the following objectives are met:

- The technical scope of the project is adequately determined through an IIP that takes into account the results of an EA and an ISR;
- Programs and processes that take into account the special considerations of the project are established; and
- The project is appropriately planned and executed.

- 1 As in other areas of the Program, OPG has carried out an in-depth Lessons Learned
- 2 exercise and will implement regulatory process improvements on the Remaining Units to
- 3 continue to provide high assurance that regulatory approvals will not impact critical path.

1

ATTACHMENTS

2 Attachment 1: Detailed Breakdown of Evidence Structure

Attachment 1: Detailed Breakdown of Evidence Structure

The Darlington Refurbishment Program (“DRP” or “Program”) evidence is organized into 11 different schedules as follows:

Ex: D2-2-1: Darlington Refurbishment Program Overview

1.0 Program Summary

2.0 Approvals Sought

3.0 Evidence Roadmap

4.0 Regulatory Framework

4.1 Ontario Regulation 53/05

4.2 Long Term Energy Plans

4.3 Ontario Government’s Continued Support for DRP

4.4 CNSC Regulatory Framework

Attachments

Attachment 1: Detailed Breakdown of Evidence Structure

Ex: D2-2-2: Unit 2 Performance

1.0 Overview

2.0 Unit 2 Execution Estimate

3.0 Quality Performance

4.0 Schedule Performance

4.1 Unit 2 Feeders – Function, Procurement and Installation

4.1.1 Function of Feeder Pipes

4.1.2 Feeder Pipe Procurement

4.1.3 Feeder Pipe Installation Approach

5.0 Cost Performance

1	6.0	Oversight
2	7.0	Reporting
3	8.0	Rate Base and Capacity Refurbishment Variance Account Treatment
4		Attachments
5	Attachment 1:	Darlington Refurbishment Program 2018 Annual Report
6	Attachment 2:	Darlington Refurbishment Program 2019 Annual Report
7		
8		Ex: D2-2-3: Remaining Units Planning
9	1.0	Overview
10	2.0	Unit-Over-Unit Scope Differences
11	2.1	Program Scope Development Process
12	2.2	Scope Differences – Unit 2 to Units 3, 1, and 4
13	3.0	Remaining Units Planning
14	3.1	Planning Strategy
15	3.2	Planning Process Overview
16	3.3	Planning Milestones
17	3.4	Unit 3 Planning and Current Status
18	3.5	Units 1 and 4 Planning and Current Status
19	4.0	Lessons Learned
20	4.1	The Lessons Learned Process
21	4.1.1	Phase 1: Identification and Documentation
22	4.1.2	Phase 2: Evaluation and Incorporation
23	4.1.2.1	Lessons Learned Monitoring

1	4.1.3	Phase 3: Verification
2	4.2	Application of Lessons Learned
3	5.0	Strategic Improvements
4	5.1	Examples of Strategic Improvements
5	5.1.1	Organizational Evolution
6	5.1.2	Engineering Replication
7	5.1.3	Darlington Unit 3 Innovations Project
8	5.1.4	Radiation Protection Improvements
9	5.1.5	Training Effectiveness Improvements
10	5.1.6	Trades Labour Hybrid Schedule
11	5.1.6.1	Trades Availability, Training and Proficiency
12	5.1.6.2	Project Management Team Availability, Training and Risk
13		Mitigation
14	5.1.6.3	Construction Leadership
15	5.1.6.4	Schedule and Cost Management
16	6.0	Collaboration with Bruce Power
17		Attachments
18	Attachment 1:	OPG-MAN-00120-0019, Project Phase Gate Management
19	Attachment 2:	NK-38-MAN-09701-10005, Sheet MLST, R002, Refurbishment
20		Unit Planning Milestones
21	Attachment 3:	NK-38-MAN-09701-10005, Sheet WIN, R000, Refurbishment
22		Unit Planning Window Milestones
23	Attachment 4:	NK-38-GUID-09701-10054, R001, Nuclear Refurbishment
24		Lessons Learned

Attachment 5: Schematic of OPG's Lessons Learned Process

Attachment 6: Summary of Feeder Lessons Learned and Actions

Attachment 7: Powering Ontario Together, 2018 Report on Nuclear Collaboration

Attachment 8: Joint Bruce Power/OPG Letter to the Minister of Energy, Northern Development and Mines and the Associate Minister of Energy re: Bruce Power/OPG Collaboration, November 19, 2019.

Ex: D2-2-4: Unit 2 Performance

1.0 Overview

2.0 Contract Management

2.1 Collaborative Contract Management

2.1.1 The One Team Approach

3.0 Major Contracts

3.1 Contracting Overview

3.2 Retube and Feeder Replacement

3.2.1 Amendments 7 to 10 to the RFR EPC

3.2.2 Amendments 11 and 12 to the RFR EPC contract dated November 3, 2020 and December 11, 2020 respectively (each effective as of October 17, 2019)

3.2.1.1 Revised Execution Phase Target Cost

3.2.1.2 The Unit 2 Credit

3.2.1.3 Revised Execution Phase Cost Incentive/Disincentive

3.2.1.4 Execution Phase Working Schedule Incentive

1	3.2.1.5	Revised Execution Phase Project Change Directive Terms
2	3.2.1.6	Revised Pricing Terms for Owner Specified Materials and
3		Goods
4	3.2.1.7	Enhanced Collaboration Terms
5	3.3	Turbine Generator
6	3.3.1	TG Engineering Services and Equipment Supply and Field Services
7		Agreement
8	3.3.2	TG Engineering Procurement and Construction Agreement
9	3.3.2.1	Amendment 5 dated November 3, 2020 (with effect as of
10		October 17, 2019)
11	3.4	Fuel Handling and Defueling
12	3.5	Steam Generator
13	3.6	Balance of Plant
14	Attachments	
15	Attachment 1:	Summary of the Major Work Bundles
16	Attachment 2:	Darlington Refurbishment Contract Program Management Plan
17	Attachment 3:	Summary of the RFR EPC contract with CanAtom
18	Attachment 4:	RFR EPC Agreement Amendment #7
19	Attachment 5:	RFR EPC Agreement Amendment #8
20	Attachment 6:	RFR EPC Agreement Amendment #9
21	Attachment 7:	RFR EPC Agreement Amendment #10
22	Attachment 8:	RFR EPC Agreement Amendment #11
23	Attachment 9:	RFR EPC Agreement Amendment #12

1	Attachment 10:	Summary of Turbine Generator ESESFSA contract with
2		General Electric
3	Attachment 11:	ESESFSA Amendment #3
4	Attachment 12:	ESESFSA Amendment #4
5	Attachment 13:	ESESFSA Amendment #5
6	Attachment 14:	Summary of the TG EPC contract with CanAtom
7	Attachment 15:	TG EPC Amendment #3
8	Attachment 16:	TG EPC Amendment #4
9	Attachment 17:	TG EPC Amendment #5
10	Attachment 18:	Summary of the Steam Generator EPC contract with the
11		BWXT/Candu JV
12	Attachment 19:	Steam Generator EPC Amendment #3
13	Attachment 20:	Summary of the ESMSA contract
14	Attachment 21:	Amended and Restated ESMSA contract with CanAtom

15

16 **Ex: D2-2-5: Remaining Units Schedules**

17 1.0 Overview

18 2.0 Schedule Development and Management

19 2.1 Schedule Development and Management at the RQE

20 2.1.1 Formation of the Baseline Schedule

21 2.1.2 Schedule Management

22 3.0 Remaining Units Schedule

23 3.1 Remaining Units Program Schedule

24 3.2 Unit Schedules - Development and Refinement

1	3.2.1	Lessons Learned
2	3.2.2	Strategic Improvements
3	3.2.3	Developing Robust Schedule Logic
4	3.2.4	Reviewing the Overlapped Periods
5	3.3	Remaining Units Schedules
6	3.4	Unit-Over-Unit Efficiencies
7	Attachments	
8	Attachment 1:	OPG's Multi-Level Scheduling Approach
9	Attachment 2:	Unit 3 Level 1 Working Schedule
10	Attachment 3:	Unit 1 Level 1 Working Schedule
11	Attachment 4:	Unit 4 Level 1 Working Schedule
12		
13	Ex: D2-2-6: Remaining Units Contingency	
14	1.0	Overview
15	2.0	Contingency Development
16	3.0	Contingency Amounts
17	3.1	Base Estimates and Contingency Amounts
18	3.2	Remaining Units' Contingency Amounts
19	3.2.1	Factors Driving Reduced Contingency Need
20	3.3	Control and Approval of Contingency Usage
21	Attachments	
22	Attachment 1:	Explanation of Monte Carlo Simulation
23		

Ex: D2-2-7: Remaining Units Cost

1.0 Overview

2.0 Program Budgets

2.1 Release Quality Estimate

2.2 Unit 2 Execution Estimate

2.3 Unit 3 Execution Estimate

3.0 In-Service Amounts

3.1 Unit 3 versus Unit 2

3.2 Units 1 and 4 versus Unit 3

3.3 Major Work Bundle Costs

3.3.1 Remaining Units Retube and Feeder Replacement

3.3.2 Remaining Units Turbine Generators Costs

3.3.3 Remaining Units Balance of Plant Costs

3.3.4 Remaining Units Fuel Handling and Defuelling Costs

3.3.5 Remaining Units Steam Generators Costs

Attachments

Attachment 1 Ontario Power Generation, Darlington Refurbishment – Final Unit 3 Execution Estimate, For Approval by Board of Directors, August 13, 2020

Attachment 2: Burns/Modus Report, Unit 3 Execution Estimate, Darlington Refurbishment Project, Burns McDonnell/Modus Strategic Solutions, March 5, 2019

Attachment 3: Independent Oversight Team, Report on Darlington Unit 3 Execution Estimate, Burns McDonnell/Modus Strategic Solutions, November 11-12, 2019

1

2 **Ex: D2-2-8: Program Structure and Oversight**

3 1.0 Overview

4 2.0 Organization for Remaining Units Execution

5 2.1 Program Management by Enterprise Project Management Office

6 2.2 DRP Organization to Manage the Remaining Units

7 2.2.1 Refurbishment Execution - Unit 3

8 2.2.1.1 Major Work Bundle Project Management Teams

9 2.2.1.2 Operations and Maintenance

10 2.2.2 Refurbishment Support

11 2.2.2.1 Construction Support

12 2.2.2.2 Work Management

13 2.2.2.3 Quality Management

14 2.2.2.4 Lessons Learned and Strategic Initiatives

15 2.2.3 Refurbishment Planning – Units 1 and 4

16 3.0 Change Management

17 4.0 Reporting

18 5.0 Oversight

19

20 **Ex: D2-2-9: In-Service Amounts**

21 1.0 Overview

22 2.0 IR Term Capital In-Service Amounts

23 2.1 Unit Refurbishment – Remaining Units Amounts

2.2 Unit Refurbishment – Remaining Units Early In-Service Projects

3.0 D2O Storage Project

4.0 Comparison of In-Service Amounts

4.1 2021 Budget versus 2021 OEB Approved

4.2 2020 Budget versus 2020 OEB Approved

4.3 2019 Actual versus 2019 OEB Approved

4.4 2018 Actual versus 2018 OEB Approved

4.5 2017 Actual versus 2017 OEB Approved

4.6 2016 Actual versus 2016 OEB Approved

Ex: D2-2-10: The D2O Storage Project

1.0 Overview

2.0 Introduction

2.1 What is the D2O Storage Project

2.2 The Purpose of the D2O Storage Project

2.2.1 Supporting DRP

2.2.2 Addressing Ongoing Darlington Operational Needs and the TRF

2.3 OPG's Request and Ratemaking Treatment

2.4 D2O Storage Project Business Case Summaries

2.5 Expert Report

3.0 Description of the D2O Storage Facility

3.1 Overview

3.2 The Seismic Dike (Elevation 87 m)

1	3.3	The Drum Processing Area (Elevation 100 m)
2	3.4	Process and Building Support Systems (Electrical and Mechanical) (Elevation
3		107.8 m)
4	3.4.1	Electrical System
5	3.4.2	Mechanical Systems
6	3.4.3	Monitoring and Alarm Systems
7	3.5	The Roof (Elevation 115 m)
8	4.0	Origins of the D2O Storage Project
9	4.1	Operational Improvements to Heavy Water Storage and Handling
10	4.2	Advancing the Operational Improvement Project
11	5.0	Merging the Refurbishment Heavy Water Storage and Operational Improvement
12		Projects to Form the D2O Storage Project
13	5.1	Initial Assessment of Refurbishment Storage
14	5.2	Alternatives Evaluated
15	5.2.1	Stand Alone Building
16	5.2.2	Additional Storage in an Existing Structure
17	5.2.3	Construction of a Refurbishment Only Storage
18	5.2.4	Construction of a Drum Warehouse
19	6.0	Development of the D2O Storage Project
20	7.0	Contracting for the D2O Storage Project
21	7.1	Initial Contracting Efforts
22	7.2	Contracting Under the ESMSA
23	7.2.1	The ESMSA

1 7.2.2 Initial Competitive Procurement for the D2O Storage Project under the
2 ESMSA

3 8.0 Designing and Constructing the D2O Project

4 8.1 Project Execution by Black & McDonald: Overview of the Project Plan and
5 Timelines

6 8.2 Initial Planning and Design

7 8.2.1 The Context of Design Changes within Darlington

8 8.2.2 Design Work

9 8.3 OPG's Commitment to Safe Construction

10 8.4 Site Clearing and Preparation

11 8.4.1 Soil Management

12 8.4.2 Dewatering

13 8.5 Relocation of Buried Services

14 8.5.1 Buried Services

15 8.5.2 Low Pressure Service Water Line

16 8.5.3 Tie-ins for Piping Connections

17 8.5.4 Other Buried Services

18 8.6 Installing the Caisson Wall and Excavating the Seismic Dike

19 8.6.1 Caisson Installation and Tie-backs

20 8.6.2 Excavation

21 8.7 Temporary Trailers

22 8.8 Continuing Difficulties Completing Design

23 8.9 Efforts to Recover Project Cost and Schedule

24 8.10 Scope Review

1	8.11	Termination of Black & McDonald and Settlement
2	8.11.1	Termination
3	8.11.2	Settlement
4	9.0	Project Execution by OPG and the Second Project Procurement
5	9.1	Assumption of Subcontracts and Retaining ES Fox
6	9.2	Sub-Slab and Rock Anchor Installation
7	9.3	Seismic Dike Foundation Slab and Walls
8	9.4	Seismic Dike Topping Slab
9	10	Project Execution by the SNC-Lavalin/Aecon Joint Venture
10	10.1	Retention of an EPC Contractor to Complete the Project
11	10.2	CanAtom Begins Work Pursuant to a Limited Notice to Proceed
12	10.3	Review of RCMT Design and the CanAtom's Proposed Redesign
13	10.4	CanAtom Assumes Control of the Project Site
14	10.5	Piping Installation in the Seismic Dike
15	10.6	Pouring the Seismic Dike Top Slab and Erecting the Building Frame
16	10.7	Pipe Chase Excavation, Shoring and Construction
17	10.8	Storage of Unit 2 Heavy Water During Construction
18	10.9	Completing the Building Envelope, Pouring Floor Slabs and Constructing the
19		Causeway
20	10.10	Construction Slowdown and Dispute Over Redesign
21	10.11	OPG Negotiates a Comprehensive Settlement with CanAtom
22	11.0	Project Completion
23	11.1	CanAtom Resumes Construction
24	11.2	Project Phase 2 – Completion Pursuant to the Revised Statement of Work

1	12.0	Commissioning and Related Activities
2	12.1	Pre-Commissioning
3	12.2	Commissioning
4	13.0	Business Case Summaries for the D2O Storage Project
5	13.1	2006 Developmental Release Business Case Summary for the Operational
6		Improvement Project
7	13.2	The 2011 Draft Developmental Business Case
8	13.3	June 2012 Full Release Definition Business Case Summary
9	13.4	August 2012 Partial Release Execution Business Case Summary
10	13.5	2013 Full Release Execution Business Case Summary
11	13.6	2015 Superseding Release Execution Business Case Summary
12	13.7	2018 Superseding Release Execution Business Case Summary
13	14.0	Conclusion
14		Attachments
15	Attachment 1:	Introduction to Heavy Water and its Use in CANDU Reactors
16	Attachment 2:	D2O Storage Project - Key Documents
17	Attachment 3:	List of Acronyms Associated with the Project
18	Attachment 4:	Timeline of the Major Project Milestones
19	Attachment 5:	Temporary Storage of Unit 2 Heavy Water
20		
21		Ex: D2-2-11: Independent Studies
22	1.0	Independent Assessment of OPG's Preparedness to Refurbish Units 3, 1, and 4
23	2.0	Independent Cost Estimate of the As-Built Heavy Water Storage Facility
24		Attachments

1	Attachment 1:	Pegasus Global Holdings, Inc. – Testimony of Dr. Patricia D.
2		Galloway
3	Attachment 2:	Pegasus Global Holdings, Inc. Engagement Letter
4	Attachment 3:	Bates White Economic Consulting - Report: Construction Cost
5		Estimate for the Darlington Nuclear Generating Station D2O
6		Storage Project
7	Attachment 4:	Bates White Economic Consulting Engagement Letter
8		