COMPARISON OF PRODUCTION FORECASTS

NUCLEAR

1.0 PURPOSE

This evidence presents period-over-period comparisons of nuclear production forecasts for 2013-2021 in support of the approval of OPG’s nuclear production forecast for the test period.

2.0 OVERVIEW

Variances between actual and forecast production in any year or period-over-period variances are typically the result of OPG experiencing more or fewer forced outages (“FO”) or derates, forced extensions to planned outages (“FEPO”), planned outage days or unbudgeted planned outages. Variances may also arise due to station consumption, grid losses and lake water temperature.

Period-over-period variances are presented in Ex. E2-1-2 Table 1 and are explained below.

PERIOD-OVER-PERIOD CHANGES – TEST YEARS

2017 Plan versus 2016 Budget

The nuclear production forecast for 2017 of 38.1 TWh is 8.7 TWh lower than the 2016 Budget of 46.8 TWh. The lower forecast production for 2017 relative to 2016 forecast production is primarily due to the following:

- There are 287 additional planned outage refurbishment days\(^1\) for Darlington as Unit 2 refurbishment continues for the entire year.

- There are 182.4 additional planned outage days\(^1\) for the combined nuclear fleet (additional 42.4 planned outage days for Darlington and additional 140 planned outage days for Pickering). The increase in planned outage days for Darlington is a result of a Single Fuel Channel Replacement on Unit 1, planned derates on Unit 3

---

\(^1\) Darlington “planned outage refurbishment days” includes outage days for units out of service during refurbishment. “Planned outage days” excludes outage days for units out of service during refurbishment.
and 4 due to Unit 2 bulkhead installation, and a mini-outage to install Primary Heat Transport ("PHT") pump motors. The increase of planned outage days for Pickering reflects the additional scope required Pickering Extended Operations.

- There are 10.6 fewer equivalent days in the combined nuclear fleet Forced Loss Rate ("FLR"). While the forecast FLR is maintained year-over-year for Darlington (1.0 per cent) and Pickering (5.0 per cent), with additional planned outage days at both stations, this results in fewer equivalent FLR days.

**2018 Plan versus 2017 Plan**

The nuclear production forecast for 2018 of 38.5 TWh is 0.4 TWh higher than the 2017 Plan of 38.1 TWh. The higher forecast production for 2018 relative to 2017 forecast production is primarily due to the following:

- There are 20.9 fewer planned outage days for the combined nuclear fleet (10.1 fewer planned outage days for Darlington and 10.8 fewer planned outage days for Pickering). The reduction of planned outage days for Darlington is due to no Single Fuel Channel replacement and Planned Derates in 2018 versus 2017. The reduction in planned outage days for Pickering reflects the scope being undertaken in 2018 versus 2017 for Pickering Extended Operations.

- There is no change in the combined nuclear fleet FLR. With a total of 20.9 fewer planned outage days, this results in 0.6 additional equivalent FLR days.

- There is no change in planned outage refurbishment days for Darlington as Unit 2 refurbishment continues for the entire year.

**2019 Plan versus 2018 Plan**

The nuclear production forecast for 2019 of 39.0 TWh is 0.6 TWh higher than the 2018 Plan of 38.5 TWh. The slightly higher forecast production for 2019 relative to 2018 forecast production is primarily due to the following:

- There are 32.9 fewer planned outage days for the combined nuclear fleet (19.2 fewer planned outage days for Darlington and 13.7 fewer planned outage days for Pickering). The reduction of planned outage days for Darlington is a result of one fewer mini-outage to install PHT pump motors, and reduced scope in the Unit 4
outage, offset by additional planned derates. The reduction of planned outage days for Pickering reflects the scope for Pickering Extended Operations.

- There is no change in the combined nuclear fleet FLR. With a total of 32.9 fewer planned outage days, this results in 0.9 additional equivalent FLR days.
- No change in planned outage refurbishment days for Darlington as Unit 2 refurbishment continues for the entire year.

**2020 Plan versus 2019 Plan**

The nuclear production forecast for 2020 of 37.4 TWh is 1.7 TWh lower than the 2019 Plan of 39.0 TWh. The lower forecast production for 2020 relative to 2019 forecast production is primarily due to the following:

- There are 45.8 additional planned outage days for the combined nuclear fleet (64.1 additional planned outage days for Darlington offset by 18.3 fewer planned outage days for Pickering). The increase in planned outage days for Darlington is a result of a Single Fuel Channel replacement during the Unit 1 outage and a planned mini-outage post-refurbishment for Unit 2 to allow vendors to address equipment reliability issues after the Unit 2 refurbishment. The reduction of planned outage days for Pickering reflects the scope for Pickering Extended Operations.
- There is a 1.6 per cent increase (29.6 more equivalent FLR days) in the FLR for the combined nuclear fleet. The FLR for Darlington increases from 1.0 per cent to 4.2 per cent due to post-refurbishment FLR (as discussed in Ex. E2-1-1, section 2.0). This results in 28.4 additional equivalent FLR days at Darlington. The FLR for Pickering remains constant at 5.0 per cent. With a total of 18.3 fewer planned outage days, this results in 1.2 additional equivalent FLR days at Pickering.
- There is one additional planned outage refurbishment day for Darlington due to the leap year. While Unit 2 Refurbishment ends in February 2020, the Unit 3 Refurbishment is scheduled to start immediately thereafter such that planned outage days for the combined units cover the entire year.
2021 Plan versus 2020 Plan

The nuclear production forecast for 2021 of 35.4 TWh is 2.0 TWh lower than the 2020 Plan of 37.4 TWh. The lower forecast production for 2021 relative to 2020 forecast production is primarily due to the following:

- There are 199 additional planned outage refurbishment days for Darlington due to the overlap of the refurbishment of Unit 1 and Unit 3 (starting June 2021).
- There are 68.1 fewer planned outage days for the combined nuclear fleet (131.9 fewer planned outage days for Darlington, offset by 63.9 additional planned outage days for Pickering). The reduction of planned outage days for Darlington is a result of no scheduled planned outages (two units are being refurbished) and the shorter duration of the second planned mini-outage post-refurbishment for Unit 2 in 2021 compared to the similar mini-outage in 2020. The increase in planned outage days for Pickering in 2021 includes the requirement to complete a planned Vacuum Building Outage in addition to the normal planned outages scheduled for that year. There are no planned outage days for Pickering Extended Operations in 2021 as this work will be completed in 2020.
- A 0.6 per cent decrease (16.6 fewer equivalent FLR days) in the combined nuclear fleet FLR. The FLR for Darlington declines from 4.2 per cent to 3.0 per cent due to post refurbishment FLR (as discussed in Ex. E2-1-1, section 2.0). With a reduction of 131.9 planned outage days at Darlington, this results in 13.1 fewer equivalent FLR days. The FLR for Pickering remains constant at 5.0 per cent. With a total of 63.9 additional planned outage days at Pickering, this results in 3.5 fewer equivalent FLR days.

3.0 PERIOD-OVER-PERIOD CHANGES – BRIDGE YEAR

2016 Budget versus 2015 Actual

The nuclear production forecast for 2016 of 46.8 TWh is 2.3 TWh higher than the 2015 actual of 44.5 TWh. The higher forecast production for 2016 relative to 2015 actual production is primarily due to the following:

- There are 78 additional planned outage refurbishment days for Darlington as Unit 2 refurbishment starts in October 2016.
• There are 104.3 fewer planned outage days for the combined nuclear fleet (155.9 fewer planned outage days for Darlington, offset by 51.5 additional planned outage days for Pickering). The reduction of planned outage days for Darlington in 2016 reflects that 2015 had a four unit Vacuum Building Outage as well as an unbudgeted planned outage to replace the PHT pump motors on Unit 1. The increase in planned outage days for Pickering reflects the scope addition of a Single Fuel Channel replacement, Machine Delivery Scrape commissioning and Reactor Building Pressure Test, as well as two unbudgeted planned outages on Unit 1 and Unit 8 offset by a cancellation of a Unit 4 mid-cycle outage.

• There were 48.3 FEPO days in 2015 for the combined nuclear fleet (7.7 FEPO days for Darlington and 40.6 FEPO days for Pickering). The 2016 generation plan assumes outages will be completed on plan resulting in an year-over-year reduction in FEPO days.

• A 1.1 per cent decrease (6.7 fewer equivalent FLR days) in the combined nuclear FLR (a decrease of 3.9 per cent for Darlington and an increase of 2.1 per cent for Pickering).

4.0 PERIOD-OVER-PERIOD CHANGES – HISTORICAL YEARS

2015 Actual versus 2015 OEB Approved

The actual nuclear production of 44.5 TWh for 2015 was 2.1 TWh lower than the 2015 OEB Approved forecast of 46.6 TWh\(^2\). The lower actual production for 2015 relative to 2015 OEB Approved was primarily due to the following:

• There were 48.3 FEPO days in 2015 for the combined nuclear fleet (7.7 FEPO days for Darlington and 40.6 FEPO days for Pickering). The 2015 OEB approved generation plan assumed outages would be completed on plan resulting in a variance between 2015 actual and 2015 OEB approved. The 2015 actual FEPO days for Darlington occurred during the Unit 1 planned outage that followed the Vacuum Building Outage, the Unit 3 planned outage, and the Unit 1 unbudgeted planned outage. The 2015 actual FEPO days at Pickering occurred during the planned Unit 1, Unit 5 and Unit 7 outages.

• There were 141 additional planned outage days for the combined nuclear fleet (78.9 additional planned outage days for Darlington and 62.2 additional planned outage days for Pickering). The increase in planned outage days was due to the three un-budgeted planned outages to address equipment related issues on Units 1 and 8 at Pickering and on Unit 1 at Darlington, partially offset by fewer planned outage days for the Unit 2 and Unit 4 Vacuum Building Outage and the cancellation of the Pickering Unit 4 mid-cycle outage.

• There was a 0.8 per cent increase (8.1 fewer equivalent days) in the combined nuclear FLR (an increase of 3.9 per cent for Darlington and a decrease of 2.6 per cent for Pickering).

2015 Actual versus 2014 Actual

The actual nuclear production for 2015 of 44.5 TWh was 3.5 TWh lower than the 2014 actual nuclear production of 48.1 TWh. The lower actual production for 2015 relative to 2014 actual production was primarily due to the following:

• There were 7.1 fewer FEPO days for the combined nuclear fleet (7.7 more FEPO days for Darlington offset by 14.8 fewer FEPO outage days for Pickering).

• There were 239.9 additional planned outage days for the combined nuclear fleet (174.8 additional planned outage days for Darlington and 65.2 additional planned outage days for Pickering). The increase in planned outage days for Darlington in 2015 was mainly due to the Vacuum Building Outage. The increase in planned outage days for Pickering reflects the scope increase in the planned outages, the un-budgeted Unit 1 planned outage to repair Calandria Inlet Valves, and the un-budgeted Unit 8 Planned outage to repair the Liquid Injection Shutdown System in 2015, offset by the cancellation of the planned mid-cycle outages in 2014 and 2015.

• There was a 1.6 per cent decrease (109.4 fewer equivalent days) in the combined nuclear FLR (an increase of 3.4 per cent for Darlington and a reduction of 7.8 per cent for Pickering).

2014 Actual versus 2014 OEB Approved
The actual nuclear production of 48.1 TWh for 2014 was 0.9 TWh lower than the 2014 OEB Approved forecast of 49.0 TWh\(^3\). The lower actual production for 2014 relative to 2014 OEB Approved was primarily due to the following:

- There were 55.4 additional FEPO days for the combined nuclear fleet (all at Pickering). For Pickering, 7.5 FEPO days were due to the Unit 7 planned outage being extended to address Heat Transport pressurization and warm up oscillations, 13.6 FEPO days were due to the Unit 8 outage being extended for Fuel Handling reliability program maintenance, and 34.3 FEPO days were due to the Unit 4 planned outage being extended to repair a section of the heat transport system.

- There were 7.0 additional planned outage days in 2014 compared to the OEB approved plan for the combined nuclear fleet (15.0 more planned outage days for Darlington offset by 8.0 less planned outage days for Pickering).

- There was a 1.5 per cent increase (56.9 more equivalent days) in the combined nuclear fleet FLR (an increase of 0.3 per cent for Darlington and an increase of 3.0 per cent for Pickering).

### 2014 Actual versus 2013 Actual

The actual nuclear production for 2014 of 48.1 TWh was 3.4 TWh higher than the 2013 actual nuclear production of 44.7 TWh. The higher actual production for 2014 relative to 2013 was primarily due to the following:

- There were 152.0 fewer FEPO days for the combined nuclear fleet (39.8 fewer FEPO days for Darlington and 112.2 fewer FEPO days for Pickering).

- There were 11.7 additional planned outage days for the combined nuclear fleet (52.4 fewer planned outage days for Darlington offset by 64.1 additional planned outage days for Pickering). The reduction in planned outage days for Darlington was due to a single planned outage at Darlington in 2014, compared to two outages in 2013, consistent with the 3 year outage cycle at Darlington. The increase in planned outage days for Pickering resulted from the deferral of the Pickering Unit 4 outage from 2013 to January 2014. The deferral was slightly offset by the mid-cycle outages being

cancelled on Unit 1 and Unit 5.

- There was a 1.5 per cent decrease (16.8 fewer equivalent FLR days) in the combined nuclear fleet FLR (a decrease of 3.3 per cent for Darlington and an increase of 1.0 per cent for Pickering).

2013 Actual versus 2013 Budget

The actual 2013 nuclear production of 44.7 TWh was 3.3 TWh lower than the 2013 Budget of 48.0 TWh. The lower actual production for 2013 relative to 2013 Budget was primarily due to the following:

- There were 207.4 FEPO days for the combined nuclear fleet (39.8 FEPO days at Darlington and 167.6 FEPO days at Pickering). At Darlington, 19.7 FEPO days were due to the Unit 2 outage being extended for Primary Heat Transport activities and 20.1 FEPO days were due to Unit 4 outage being extended to repair Generator Seal Oil Heat Exchanger 1 and 2. At Pickering, 4.5 FEPO days were due to Unit 6 outage being extended to perform repairs on Steam Relief Valves, 53.4 FEPO days due to Unit 5 outage being extended to repair problems with the Main Output Transformer Isolated Phase Bus, and 109.7 FEPO days were due to the Unit 1 outage being extended from 2012 into 2013 due to a fire in the Lube Oil Purifier system.

- There were 82.6 fewer planned outage days for the combined nuclear fleet (almost no change to the planned outage days for Darlington and 82.7 fewer planned outage days for Pickering). The reduction of planned outage days for Pickering was a result of the deferral of the Pickering Unit 4 outage to January 2014.

- There was a 2.5 per cent increase (63.2 more equivalent FLR days) in the combined nuclear fleet FLR (an increase of 3.3 per cent for Darlington and an increase of 1.6 per cent for Pickering).
## Table 1

Comparison of Production Forecast - Nuclear

<table>
<thead>
<tr>
<th>Line No.</th>
<th>Business Unit</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>(b)</th>
<th>(c)</th>
<th>(d)</th>
<th>(e)</th>
<th>(f)</th>
<th>(g)</th>
<th>(h)</th>
<th>(i)</th>
<th>(j)</th>
<th>(k)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Actual</td>
<td>Change</td>
<td>Budget</td>
<td>Actual</td>
<td>Change</td>
<td>OEB Approved</td>
<td>Actual</td>
<td>Change</td>
<td>OEB Approved</td>
<td>Actual</td>
<td>Change</td>
<td>OEB Approved</td>
<td>Actual</td>
</tr>
<tr>
<td>1</td>
<td>114.3</td>
<td>88.8</td>
<td>-25.5</td>
<td>95.5</td>
<td>98.0</td>
<td>2.5</td>
<td>0.0</td>
<td>106.3</td>
<td>161.6</td>
<td>56.2</td>
<td>0.0</td>
<td>143.3</td>
<td>117.2</td>
<td>38.1</td>
</tr>
<tr>
<td>2</td>
<td>114.3</td>
<td>88.8</td>
<td>-25.5</td>
<td>95.5</td>
<td>98.0</td>
<td>2.5</td>
<td>0.0</td>
<td>106.3</td>
<td>161.6</td>
<td>56.2</td>
<td>0.0</td>
<td>143.3</td>
<td>117.2</td>
<td>38.1</td>
</tr>
<tr>
<td>3</td>
<td>114.3</td>
<td>88.8</td>
<td>-25.5</td>
<td>95.5</td>
<td>98.0</td>
<td>2.5</td>
<td>0.0</td>
<td>106.3</td>
<td>161.6</td>
<td>56.2</td>
<td>0.0</td>
<td>143.3</td>
<td>117.2</td>
<td>38.1</td>
</tr>
<tr>
<td>4</td>
<td>114.3</td>
<td>88.8</td>
<td>-25.5</td>
<td>95.5</td>
<td>98.0</td>
<td>2.5</td>
<td>0.0</td>
<td>106.3</td>
<td>161.6</td>
<td>56.2</td>
<td>0.0</td>
<td>143.3</td>
<td>117.2</td>
<td>38.1</td>
</tr>
<tr>
<td>5</td>
<td>114.3</td>
<td>88.8</td>
<td>-25.5</td>
<td>95.5</td>
<td>98.0</td>
<td>2.5</td>
<td>0.0</td>
<td>106.3</td>
<td>161.6</td>
<td>56.2</td>
<td>0.0</td>
<td>143.3</td>
<td>117.2</td>
<td>38.1</td>
</tr>
<tr>
<td>6</td>
<td>114.3</td>
<td>88.8</td>
<td>-25.5</td>
<td>95.5</td>
<td>98.0</td>
<td>2.5</td>
<td>0.0</td>
<td>106.3</td>
<td>161.6</td>
<td>56.2</td>
<td>0.0</td>
<td>143.3</td>
<td>117.2</td>
<td>38.1</td>
</tr>
</tbody>
</table>

### Notes:
1. OEB Approved nuclear production in 2014 is 49.0 TWh per EB-2013-0321 Decision with Reasons p. 39.
2. OEB Approved nuclear production in 2015 is 46.6 TWh per EB-2013-0321 Decision with Reasons p. 39.
3. PO days excludes planned outage days for Darlington units out of service during Darlington refurbishment.