

1 **COMPARISON OF PRODUCTION FORECAST – NUCLEAR**

2 3 **1.0 PURPOSE**

4 This evidence presents period-over-period comparisons of Nuclear production forecasts.
5

6 **2.0 OVERVIEW**

7 Nuclear’s production data from 2005 budget to 2009 plan can be found in Ex. E2-T1-S2 Table 1.
8

9 OPG seeks through its extensive outage planning process to establish accurate and reliable
10 production forecasts, while maintaining challenging targets. However, there are many
11 unanticipated factors that can contribute to variances between actual and forecast production. In
12 particular, *forced extensions of planned outages* can occur because inspections during an
13 outage can lead to unanticipated requirements for additional work to be completed on *critical*
14 *path* before the reactor can be restarted, either for safety, regulatory, or economic reasons.
15

16 The number of planned outage days per station reflects the work activity needed to enable
17 completion of routine maintenance, inspections and project work, which can only be performed
18 while the units are shut-down. The force loss rate (“FLR”) reflects the forecast of the number of
19 unplanned outage days per station, to accommodate any unforeseen events that result in unit
20 shutdowns and forced derates. OPG’s objective is to operate its nuclear generating stations in
21 compliance with all applicable regulations and requisite licences and approvals in a safe,
22 efficient, and cost effective manner. OPG will, in accordance with its Nuclear Safety Policy,
23 conservatively implement unit shutdowns in all circumstances, when in OPG’s assessment the
24 safe operation of the station could be at risk.
25

26 OPG Nuclear’s actual outage schedule (e.g., planned and forced) for 2005 and 2006 are set out
27 in Appendix A and Appendix B, respectively. Appendix C sets out descriptions and related
28 details of each outage in 2005, 2006 and 2007. Appendix C also includes a discussion of
29 OPG’s ongoing initiatives to minimize the reoccurrence of specific outage causal factors such as
30 failures in the primary heat transport system and liquid zone controls. In addition, a discussion
31 of the broad initiatives that have been undertaken by OPG (e.g., investment in plant material

1 condition, improved forced outage readiness, and improved outage planning based in part on
 2 lessons-learned reviews) to transition OPG Nuclear to a more sustainable, reliable, and
 3 predictable level of performance by reducing the number of planned outage days and the level
 4 of forced production losses can be found in section 3 (OPG Nuclear Production Forecast Trend)
 5 in Ex. E2-T1-S1.

6

7 OPG Nuclear's planned outage days by month for 2007 - 2009 are set out in Chart 1 below:

8

Chart 1

9

Nuclear Planned Outage Days by Month 2007 - 2009¹

	2007 Actual	2008 Plan	2009 Plan
Jan	0	0	0
Feb	0	11	0
Mar	23	35	29
Apr	58	48	68
May	53	31	88
Jun	10	10	30
Jul	0	0	6
Aug	0	0	0
Sep	30	19	13
Oct	77	49	36
Nov	60	47	56
Dec	20	4	17
Total	331	254	343

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11 1. Numbers may not correspond to numbers in Ex. E2-T1-S2 Table 2b due to rounding in
 12 Chart 1. The numbers in Ex. E2-T1-S2 Table 2b are based on start dates and end dates
 13 that include mid-day starts.

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3.0 PERIOD-OVER-PERIOD CHANGES – TEST PERIOD

2009 Plan versus 2008 Plan

The OPG nuclear fleet production forecast for 2009 of 49.9 TWh is 1.5 TWh less than the 2008 plan of 51.4 TWh.

The reduction in planned production in 2009 compared to 2008 is driven by a significant increase in the number of planned outage days at Darlington due to the station containment/vacuum building outage (“VBO”). This outage will take all four Darlington units off-line for approximately four weeks. The VBO is required to complete a thorough inspection/maintenance program of the station’s containment system, one of its major safety systems. The inspection/maintenance activities are prescribed by the Canadian Nuclear Safety Commission and are required to maintain Darlington’s operating licence (Canadian Nuclear Safety Commission licensing is further discussed at Ex. A1-T6-S1). Consequently, in 2009 Darlington will require 100.3 additional outage days versus the 2008 plan and produce 2.1 TWh less generation than the 2008 plan.

Other outage work activities planned for Darlington include replacement of feeders which cannot be completed in tandem with the VBO, but must be undertaken by way of a series of separate planned outages. The VBO makes the containment function unavailable, thereby restricting operations and maintenance on systems/equipment that require containment availability. There are also logistical and resource constraints that limit the outage work activities during the VBO.

While 2009 production for the combined nuclear fleet is forecast to be lower than in 2008 due to the VBO at Darlington, OPG is forecasting an 0.3 TWh generation increase at Pickering B due to a 14 day reduction in Pickering B’s planned outage program. The reduction in planned outage days at Pickering B in 2009 compared to 2008 reflects completion of steam generator repairs and service water work in 2008. Pickering A’s planned outage program for 2009 also contains 3 fewer Planned Outage days than the 2008 schedule.

1 Another offset to the negative Darlington VBO impact on production in 2009 is an expectation of
2 additional production in 2009 compared to 2008 due to a decline in the FLR for the combined
3 nuclear fleet. In that regard, OPG's current business plan reflects resolution by 2009 of the
4 derate at Pickering A, which is discussed in the 2008 plan versus 2007 actual comparison
5 below.

6

7 2008 Plan versus 2007 Actual

8 As shown in Ex. E2-T1-S2 Table 2b, the nuclear fleet production forecast for 2008 of 51.4 TWh
9 is 7.2 TWh greater than the 2007 actual production of 44.2 TWh.

10 The forecast improvement in 2008 production is due in part to a reduction in the number of
11 planned outage days from 331.2 days in 2007 to 254.1 days in 2008. The main drivers for the
12 reduction in planned outage days are:

- 13 • The 2007 non-routine primary heat transport valve work at Pickering B will not be repeated
14 in 2008.
- 15 • Darlington's move from two-year to a three-year outage cycle was completed in 2007.
16 Accordingly, only one Darlington unit will go through a planned outage in 2008, reducing by
17 59.2 days the number of planned outage days and increasing by 1.2 TWh Darlington's 2008
18 generation.

19

20 The other main factor driving the forecast of increased production in 2008 as compared to 2007
21 is a targeted improvement in the FLR at Pickering A and Pickering B. For both Pickering A and
22 B, the improvement reflects an expectation that a series of unique, one-time events that
23 attributed to major losses of generation at the Pickering site in 2007 will not be repeated in
24 2008. These events, which are discussed in greater detail in Appendix C, are:

- 25 • Broken adjuster rod cable repair that resulted in a forced extension of the 2006 Pickering A
26 Unit 1 planned outage into 2007.
- 27 • Pickering A forced outages on Unit 1 and Unit 4 due to inter-station transfer bus
28 modifications and liquid zone control system problems.
- 29 • Contamination of Pickering demineralized water supply by a third party contractor
30 inadvertent release of resin into the system.

1 For Pickering B, the change reflects improvements made in plant material condition and other
2 initiatives discussed in Ex. E2-T1-S1.

3
4 Offsetting OPG's forecast of improved production in 2008 as compared to 2007 is the reduction,
5 on an annualized basis, of 0.25 TWh related to the derate of the Pickering A Units 1 and 4 that
6 started in August 2007 due to an inability of OPG to obtain Canadian Nuclear Safety
7 Commission concurrence with OPG shutdown system trip set methodology.

8 9 **4.0 PERIOD-OVER-PERIOD CHANGES – BRIDGE YEAR**

10 2007 Actual versus 2007 Budget

11 As shown on Ex. E2-T1-S2 Table 2b, OPG's 2007 actual nuclear generation of 44.2 TWh is 5.7
12 TWh lower than the 2007 budget production of 49.9 TWh.

13
14 Darlington actual generation of 27.2 TWh exceeded the budgeted target of 26.9 TWh, by 0.3
15 TWh. Pickering A and Pickering B experienced several unique, one-time events that resulted in
16 unplanned generation losses. Details surrounding these events can be found in section 3 above
17 and in Appendix C.

18
19 At Pickering A the actual 2007 generation was 3.6 TWh, 3.9 TWh below the 2007 budget of 7.5
20 TWh. The decrease in actual 2007 generation compared to 2007 budget is primarily due to the
21 increased in force loss rate equivalent days in 2007 as a result of a series of unique, one-time
22 events at Pickering, as discussed above, which impaired generation.

23
24 At Pickering B the actual 2007 generation was 13.4 TWh, 2.2 TWh less than the 2007 budget of
25 15.6 TWh. The decrease in actual 2007 generation compared to 2007 budget is due to a
26 combination of additional planned outage days compared to budget and additional forced loss
27 rate equivalent days.

28
29 The main driver to the additional forced loss equivalent days was due to the inadvertent
30 contractor release of resin into the station demineralized water supply which resulted in

1 unscheduled loss of 60 production days and which also resulted in forced extension of planned
2 outage days at Pickering B. Other Pickering B outages are set out in Appendix C.

3
4 At Darlington better than budgeted FLR results (actual 24.6 days forced loss equivalent days vs.
5 budget of 54.5 days) are the main reason for higher than budget production (+0.3 TWh).

6
7 2007 Actual versus 2006 Actual

8 As shown on Ex. E2-T1-S2 Table 2a, OPG's 2007 Actual nuclear generation of 44.2 TWh, is 2.7
9 TWh lower than 2006 actual production of 46.9 TWh.

10
11 A main driver to the decrease in actual generation in 2007 compared to 2006 is the 247.6
12 additional forced loss rate equivalent days experienced in 2007 at Pickering A and Pickering B.
13 This increase and the resulting loss in production, is largely a result of a series of unique, one-
14 time events. These events are described in Section 3 above as well as in Appendix C.

15
16 Changing lake conditions have also contributed to the above average forced losses due to
17 restricted cooling water intake flows caused by algae. While OPG has experienced *forced*
18 *derates* due to algae in the past, the magnitude of algae build-up experienced in 2006 and 2007
19 has been unprecedented. Higher lake water temperatures also impacted production due to
20 reduced condenser efficiency causing lower electrical output. Lost generation due to algae and
21 higher lake water temperatures was 0.3 TWh in both 2006 and 2007.

22
23 The following summarizes the major variances between the 2007 actual and 2006 actual by
24 station:

25
26 At Pickering A:

- 27
- 28 • 65.1 planned outage days and 60.2 forced extension of planned outage days compared to
29 74.0 planned outage days, and 21.0 forced extension of planned outage days in 2006.
 - 30 • 299.6 forced loss equivalent outage days, compared to 108.9 days in 2006.

1 The small reduction in planned outage days was due to the fact that in 2006 Pickering A
2 underwent a unbudgeted planned outage to replace coolers on the primary heat transport
3 system (heavy water circulating system) pump motors.
4

5 With respect to the 2007 FLR, after having experienced 108.9 forced loss equivalent days at
6 Pickering A in 2006 OPG's expectation for 2007 was for improved performance. In particular,
7 Unit 4 had completed its first planned outage in 2006 following the return to service project,
8 during which OPG completed maintenance to address post return to service reliability issue.
9 OPG's 2007 budget therefore anticipated an improvement in Pickering A's FLR in 2007.
10

11 Despite these expectations, Pickering A experienced a further increase in its forced loss
12 equivalent outage days in 2007 (along with increase in FEPO days) largely as result of a series
13 of unique, one-time events that impaired generation, as described in Section 3 and in Appendix
14 C.
15

16 At Pickering B:

- 17 • 131.8 planned outage days and 68.3 forced extension to planned outage days in 2007,
18 compared to 154.5 planned outage days and 120.5 forced extension to planned outage
19 days in 2006.
- 20 • The total number of forced loss equivalent outage days was 159.9 in 2007, compared to
21 84.2 days in 2006.
22

23 The planned outage reduction for Pickering B in 2007 reflects the fact that an extensive
24 Pickering B spacer location and relocation campaign was concluded in 2006. Also, in 2006,
25 Pickering B registered 120.5 days of forced extension to planned outage resulting from primary
26 heat transport pump seal leaks and unplanned steam generator and service water maintenance
27 work, for which corrective actions undertaken in 2007 have managed to mitigate reoccurrence.
28

29 With respect to the FLR, Pickering B experienced a further increase in its forced loss equivalent
30 days in 2007 largely as a result of a series of unique, one-time events that impaired generation,

1 as described in section 3 and in Appendix C, the most significant being the inadvertent release
2 by a third party contractor of resin into the demineralized water system

3
4 At Darlington:

- 5 • 134.3 planned outage days and 2.7 forced extension to planned outage days in 2007,
6 compared to 95.0 planned outage days and 25.5 forced extension to planned outage days in
7 2006.
- 8 • 24.6 2007 forced loss equivalent outage days in 2007, compared to 43.4 days in 2006.

9
10 The increase in planned outage days in 2007 is partly due to Darlington transitioning from a two-
11 year to a three-year outage cycle. There was an increase in the scope of some outage work
12 completed in 2007, including steam generator inspections, because of reduced outage
13 frequency after 2007. In addition, Darlington inspected several fuel channels and replaced some
14 feeders in 2007.

15
16 Darlington's forced loss equivalent outage days at 24.6 days in 2007 reflects continued success
17 in achieving operational results consistent with, or better than its industry peers as discussed at
18 Ex. A1-T4-S3.

19 20 **5.0 PERIOD-OVER-PERIOD CHANGES – HISTORICAL YEARS**

21 2006 Actual versus 2006 Budget

22 As shown on Ex. E2-T1-S2 Table 2a, net generation for the year 2006 was 46.9 TWh, which
23 was 2.5 TWh (five percent) lower than the 2006 budget of 49.4 TWh. Some of the major factors
24 that resulted in actual lower production than budgeted in 2006 are:

- 25 • Actual FLR exceeded budgeted FLR, resulting in unplanned losses exceeding the 2006
26 business plan forced loss rate targets. The unplanned loss was equivalent to 12.2 days of
27 production across OPG's nuclear generating stations.
- 28 • Across OPG nuclear facilities, there were 25 fewer planned outage days in 2006 than in the
29 business plan target. However, despite the 25.0 fewer planned outage days, there were an
30 additional 167.0 days related to unbudgeted *planned outage extensions* and forced

- 1 • extension to planned outage in 2006, such that the 2006 business plan target was exceeded
2 by 142 days.

3
4 2005 Actual versus 2006 Actual

5 Total actual OPG Nuclear generation for the year 2005 was 45.0 TWh, 1.9 TWh less than the
6 2006 Actual of 46.9 TWh. The primary reason for the higher generation in 2006 was the return
7 to service of Unit 1 at Pickering A in 2006. This was partly offset by the forced extension of the
8 2006 Pickering Unit 6 planned outage.

9
10 2005 Actual versus 2005 Budget

11 Total actual OPG Nuclear net generation for the year 2005 was 45.0 TWh, 0.2 TWh lower than
12 the 2005 budget of 45.2 TWh. The main reasons for lower than planned generation include:

- 13 • 63.0 day delay in the commissioning, from lay-up, of Pickering A Unit 1.
14 • Worse than budgeted FLR performance of Pickering A, resulting in forced losses equivalent
15 to 60.1 days more than the business plan target.
16 • 32 more days than business plan target outage days needed to complete planned outage
17 work at Darlington.

18
19 The above losses were partially off-set by:

- 20 • Deferral of the Pickering A Unit 4 outage (66.2 days) to 2006.
21 • 12 fewer than planned business plan targeted outage days to complete planned outage
22 work at Pickering B.
23 • Better than planned FLR performance at Pickering B (52.0 days lower than business plan
24 target) and Darlington (46 days lower than business plan target).

25

LIST OF ATTACHMENTS

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Appendix A: Outage Schedule 2005

Appendix B: Outage Schedule 2006

Appendix C: Forced Outage Report and Summary of Corrective Actions Taken

Attachment 1- Darlington Outage Summary Report

Attachment 2 - Pickering A Outage Summary Report

Attachment 3 - Pickering B Outage Summary Report

1 **APPENDIX A**
2 **Outage Schedule 2005**

3
4 Chart 1 attached to this Appendix A provides a visual display of scheduled and unscheduled
5 outage start dates, end dates, and duration for 2005.

6
7 The following is provided to assist in a review of the information set out in the tables:

8
9 Scheduled outages include planned outages and unbudgeted planned outages. These terms
10 are defined in E2-1-1.

11
12 Unscheduled outages include forced outages, and forced extensions of planned outages. These
13 terms are also defined in E2-1-1.

14
15 Pickering A units 1, 2 and 3 are shown in lay-up mode until, in the case of unit 1, the unit was
16 returned to service in November, 2005.

17
18 The first vertical column in the charts refers to the various nuclear units by station. Units P1, P2,
19 P3 and P4 refer to Pickering A, units P5, P6, P7 and P8 refer to Pickering B units. The
20 Darlington units are referenced as D1, D2, D3 and D4.

21
22 The first horizontal row in the charts, designated "week of", shows the first day of each week of
23 each month of the year for all 52 weeks. For example, by reference to April 2005, April 4 was
24 the first day in the first complete week in April 2005. The next full week commenced April 11.
25 The days that include April 1-3 are captured in the table in the 7 days of the week starting March
26 28.

27
28 Outage duration is also depicted on each chart visually and by start/end date and by number of
29 days during the outage. For example, by reference to Chart 1, Darlington Unit 2 had a
30 scheduled (i.e. planned) outage in the spring of 2005 that commenced in the morning of March

1 18, 2005 and ended May 12, 2005 for a total of 56 days. As well, this unit experienced a forced
2 extension of the planned outage that commenced on May 12, 2005 and ended May 26, 2005 for
3 a total of 14 days. The total duration was 70 days.

Darlington 2005							
Planned Outages & Extensions	Outage Type	Start Date	End Date	Duration (days)	Generation Loss (TWh)	Outage Scope / Description	Management Action to Prevent Recurrence
D2	PO	18-Mar	12-May	55.5	1.24	Outage scope included Feeder inspections/replacements/CIGARS/Boilers/Turbine inspections/SDS2.	Not applicable
	FEPO	12-May	27-May	14.4	0.32	FEPO due to installation problems with Single Fuel Channel Replacement.	Investigation completed. Procedures were enhanced for future installations to address results of investigation. The enhancements to the procedure were verified by the successful completion of 2007 Pickering B fall outage .
D4	PO	15-Apr	29-Apr	13.3	0.3	Unbudgeted Planned Outage. An additional unbudgeted planned outage was added to the 2005 schedule after completion of the 2005 business plan in order to complete Moisture Separator Reheater Inspection and Repair . Without this outage, continued operation would have resulted in significant reduction in the life of the low pressure turbine blade, bundles and casing with increased risk of material damage in the future	Regular inspections carried out as part of subsequent planned outages to minimize potential for unbudgeted planned outages.
	PO	30-Sep	26-Oct	26	0.58	Critical Path of planned outage included SDS 1/2, Turbines, Electrical and Feeder Inspection	Not applicable
	FEPO	26-Oct	2-Nov	7.9	0.18	During routine periodic inspection program on the Heat Transport System, inspections discovered some crack indications in the bleed condenser nozzles.	Discovery work. As a precaution, the outage scope was increased to include inspections of all the large nozzles in the bleed condenser. Inspections added to subsequent forced and planned outage schedules.
Forced Outages	Outage Type	Start Date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
D1	FO	4-Jan	9-Jan	4.5	0.1	Loss of Low Pressure Service Water to the unit. During maintenance on the LPSW strainer backwash system, the strainers became plugged, and water supply pressure fell. Operators reponded to this event as per procedure by shutting down the reactor and turbine and re-establishing cooling water flow.	Screen house rehab project team was put together and all screen houses have been overhauled. Upgrades are being assessed to deal with changing lake conditions.
	FO	24-Sep	26-Sep	2	0.05	A problem with the Unit 1 fuelling unit was detected by Fuel Handling operators and as a result, fuelling was unable to continue and Unit 1 was shutdown	Material conditions evaluated and repairs completed. Procedures reviewed and revised based on investigation of failure.
	FO	29-Sep	1-Oct	2.1	0.05	Unit 1 was pre-emptively shut down for screen wash system repair. Excess silt and algae caused the circulating water screens to become plugged	Screen house rehab project team was put together and all screen houses have been overhauled. Upgrades are being assessed to deal with changing lake conditions.
D2	FO	12-Oct	14-Oct	2.2	0.05	During ground fault troubleshooting, a Unit 2 reactor setback occurred on low deaerator level.	Discovery item. Lessons learned from investigation have been incorporated into troubleshooting procedures for future planned outages.

Darlington 2006							
Planned Outages & Extensions	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Outage Scope / Description	Management Action to Prevent Recurrence
D1	PO	27-Oct	10-Dec	44.5	1	Planned outage critical path was three feeder replacements	Not applicable
	FEPO	11-Dec	13-Dec	2.8	0.06	Problems associated with feeder replacement resulted in extension of planned outage	Lessons learned incorporated into D721 feeder replacement program.
D3	PO	23-Mar	13-May	50.5	1.13	Planned outage. Critical path included defuelling, CIGAR inspections, TSS testing, feeder inspections, heat pumps, turbine work and blade inspections	Not applicable
	FEPO	13-May	5-Jun	22.7	0.51	Planned outage was extended by 22.7 days due to fuel handling problems and labour availability during the feeder inspection campaign.	Staffing plan revised for future fuel handling. Modifications were completed on fuelling machine bridges in the unit to eliminate the need for extra panel operators.
Forced Outages	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
D1	FO	25-Oct	26-Oct	1.8	0.04	Unit shut down when a shut-off rod clutch card failed. The unit was placed in a safe and stable state and the 27 Oct planned outage commenced shortly thereafter.	Investigation identified fault. All clutch cards on all units upgraded.
	FO	19-Dec	22-Dec	2.6	0.06	During post-outage testing following completion of the Unit 1 planned outage, the unit experienced a turbine generator trip.	Material condition evaluated and repairs completed.
D2	FO	8-Apr	9-Apr	0.2	0.005	Loss of automatic control of the turbine necessitated a brief outage to replace a turbine control computer board.	Material condition evaluated and repairs completed.
	FO	24-Sep	24-Sep	0.4	0.01	A turbine trip on Unit 2 resulted in approx 10 hours of unplanned outage	Material condition evaluated and repairs completed.
D3	FO	24-Jun	24-Jun	0.5	0.01	Turbine tripped on high bearing vibration.	Material condition evaluated and repairs completed.
	FO	26-Jun	19-Jul	22.5	0.5	D3 was forced offline for 22.5 days due to a precautionary decision to inspect for potential heat damage to vault cables after excess temperatures were recorded inside the reactor vault caused by a faulty feeder cabinet door latch.	Preventive maintenance program on feed cabinet doors implemented for future planned and forced outages.
D4	FO	21-Jan	30-Jan	9.1	0.2	D4 was forced out for 9 days to repair a leaking instrument line in the containment collection	Material condition evaluated and repairs completed.

Darlington 2007 January - December							
Planned Outages & Extensions	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Outage Scope / Description	Management Action to Prevent Recurrence
D2	PO	20-Sep-07	19-Nov-07	59.70	1.34	Planned outage critical path was fuel handling	Not applicable
D3	PO	11-May	26-May	16	0.36	Unbudgetted planned outage required to repair leaking PHT pump seals.	Investigation of pump seal failure identified failure mechanism and enhancements incorporated into rebuild procedure to minimize potential for unbudgetted planned outages.
	FEPO	27-May	29-May	2.7	0.06	FEPO was due to a light water steam leak and stuck main turbine valve during the start up evolution	Material condition evaluated and repairs completed.
D4	PO	9-Mar	6-May	58.5	1.31	Unit 4 was returned to service on May 6th, 5 days earlier than the BP target of 63.5.	Not applicable
Forced Outages	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
D1	FO	29-Jun	3-Jul	4.2	0.09	Unit 1 turbine tripped on an instrumentation fault.	Material condition evaluated and repairs completed. In addition preventative maintenance program reviewed and updated.
	FO	20-Oct-07	20-Oct-07	0.50	0.01	Forced outage required to repair faulty back-up automatic voltage regulator.	Work had been scheduled for spring Darlington planned outage but unit needed to be taken off line for repairs in October 2007.
D4	FO	10-Nov	12-Nov	2.39	0.05	Control adjuster (CA1) dropped fully in core. CCM1 and CCM2 replaced. Poor soldering joints found on CCM1.	Review of failed components traced failure to rework associated with D741 board repairs. Procedure update in place to ensure independent review of repairs.
	FO	13-Nov-07	19-Nov-07	5.28	0.12	Unit shut down as a result of passing RV on gland seal supply line to boiler feed pump.	Problem identified as system configuration problem. Operating manual updated to prevent re-occurrence

Pickering A		2005					
Forced Outages	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
P4	FO	2-Apr	19-Jul	107.3	1.40	P4 was pro-actively shut down for 107.3 days to allow for inspections on feeder pipe elbows in response to new information on feeder thinning rates on Unit 1.	Governance program for primary heat transfer feeders has been established. It provides roles and responsibilities for feeder aging management. Additionally periodic review of operating experience is being conducted on flow accelerated corrosion, in co-operation with external nuclear industry groups (Candu Operating Group and Electrical Power Research Institute). A feeder maintenance strategy is a component of OPG's ongoing business plans.
	FO	22-Nov	4-Dec	11.8	0.15	P4 was forced offline for 11.8 days due to a primary heat transport pump trip on electrical protection.	Lessons learned from Unit 4 force outage resulted in initiation of a program to replace all coolers in Units 1 and 4, which was completed by early 2007. In addition, reprioritization of primary heat transport coolers will ensure there is periodic inspection and maintenance performed on these coolers. Additionally, a programmatic strategy for operating components beyond the manufacturers recommended end of life has been established and component condition assessments governance has been prepared.

Pickering A 2006							
Planned Outages & Extensions	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Outage Scope / Description	Management Action to Prevent Recurrence
P1	PO	25-May	8-Jun	14.0	0.18	Unit was shut down for unbudgeted planned outage on May 25th. Critical path is replacement of coolers on the heat transport pump motors.	Lessons learned from Nov 22, 2005 forced outage resulted in initiation of a program to replace all coolers in Units 1 & 4, which was completed by early 2007. In addition, reprioritization of primary heat transport coolers will ensure there is periodic inspection and maintenance performed on these coolers. Additionally, a programmatic strategy for operating components beyond the manufacturers recommended end of life has been established and component condition assessments governance has been prepared.
	FEPO	8-Jun	9-Jun	0.9	0.01	Delay in returning the unit to service due to a light water steam leak.	Equipment breakdown during start up. Material evaluation and repairs completed.
P4	PO	12-Oct	11-Dec	60.0	0.78	Major scope during planned outage includes: feeder replacements, crack inspections, thickness measurements, boiler tube inspections and thermal sleeve replacements, fuel channel turbine & generator inspections.	Not applicable
	FEPO	12-Dec	31-Dec	20.1	0.26	The unit 4 planned outage was primarily extended due to delays in steam generator repairs and due to the inadvertent release by a third party contractor of purification system resin into the feedwater system.	Steam generator repairs completed. Thermal sleeve contractor rating downgraded. See Appendix C Forced Outage Report and Summary of Corrective Actions Taken, i.e. Resin Inclusion Event
Forced Outages	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
P1	FO	14-Jan	17-Jan	3.1	0.04	Unit shutdown due to main output transporter cooling pump failure.	All contactors and relays for all cooling pumps on Units 1 and 4 replaced. Design change to facilitate routine testing of pump power supply. Reviewed & optimized preventive maintenance program.
	FO	18-Jun	25-Jun	7.0	0.09	Unit 1 was shut down due to a faulty ribbon cable in the moderator temperature control circuit resulting in loss of moderator cooling.	Equipment break down represented a single point of vulnerability. An OPG fleet initiative is underway that is focusing preventative maintenance on identified single points of vulnerability to prevent reoccurrence.
	FO	22-Jul	2-Aug	10.7	0.14	Unit 1 was shut down on July 22nd to address problems with the liquid zone control system.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Pickering A Liquid Zone Control
	FO	11-Aug	13-Aug	1.8	0.02	Unit 1 was shut down on August 11th for approximately 48 hours to repair an air conditioning unit in the moderator room.	Material condition evaluated and repairs completed.
	FO	14-Oct	8-Nov	25.0	0.33	Unit 1 was shut down to address problems with liquid zZone control system.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Pickering A Liquid Zone Control
P4	FO	19-Jan	31-Jan	11.9	0.16	Unit 4 was taken off line to investigate abnormalities found with the turbine oil supply pressure due to lube oil pump failure.	Investigation determined that during return from system overhaul, main lube oil impeller had been reassembled incorrectly. Equipment
	FO	9-Sep	14-Sep	5.0	0.07	Unit 4 was shut down to repair turbine release valves.	Material condition evaluated and repairs completed.
	FO	1-Oct	13-Oct	11.7	0.15	Unit 4 was shut down due to address problems with the liquid zone control system.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken, i.e. Pickering A Liquid Zone Control

Pickering A 2007 January - December							
Planned Outages & Extensions	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Outage Scope / Description	Management Action to Prevent Recurrence
P4	FEPO	1-Jan	19-Feb	49.2	0.64	The Unit 4 Dec 12 2006 forced extension to planned outage continued into 2007 as a result of problems with an adjuster rod broken cable.	Procedures improved and reinforcement of procedural use and adherence as a learning tool for the stations
P1	PO	16-Oct	21-Dec	65.1	0.85	Planned outage critical path was feeder inspections	Not applicable
P1	FEPO	21-Dec	31-Dec	11.0	0.14	Planned outage extended due to delays in completion of heat transport maintenance work and a shutdown cooling pump failure that prevented progression of outage.	Delays in heat transport maintenance work due to incorrect parts. Future outages will include a more comprehensive configuration management review for work on or near critical path. Several days also lost due to an unforeseen failure of a SDC pump. No further management action required for this equipment failure.
Forced Outages	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
P1	FO	11-Mar	23-Mar	11.9	0.16	Unit 1 was shut down to repair a crack in a welded joint in the low pressure service water supply line to the moderator heat exchanger.	Failed welded joint occurred due to vibration fatigue. Material condition evaluated and repairs completed.
	FO	5-Jun	16-Oct	133.33	1.73	Units 1 and 4 were shut down when it was discovered that the configuration of Unit 3 Class III inter-station transfer bus (ISTB) power supplies could result in the unavailability of certain control power should a steam line break occur. In addition LZC problems extended the outage.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Pickering A Electrical Supply System and the Pickering A Liquid Zone Control system.
P4	FO	15-Apr	29-Apr	14.2	0.19	Unit 4 was taken off-line to replace heat transport system (HTS) post-accident temperature monitoring detectors (RTDs). While preparing to return the unit to service, a high HTS leakage to collection was discovered. During troubleshooting, a low heat transport pressure transient occurred, resulting in a reactor trip.	Material condition evaluated, problem with RTDs determined as design error. RTDs were replaced. Lessons learned include increased focus going forward on improving design human performance. On HTS leakage, material condition evaluated and cause of leakage repaired. On reactor trip which was human performance related, actions taken on coaching re adherence to procedures.
	FO	4-Jun	4-Oct	121.57	1.58	Units 1 and 4 were shut down when it was discovered that the configuration of Unit 3 Class III inter-station transfer bus (ISTB) power supplies could result in the unavailability of certain control power should a steam line break occur.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Pickering A Electrical Supply System.
	FO	5-Oct	13-Oct	8.09	0.11	Unit shutdown due to spurious safety system trip.	This unplanned safety system trip occurred due to the shutdown system operating as intended. No further management action required.

Pickering B 2005						Page 1 of 2	
Planned Outages & Extensions	Outage Type	Start Date	End Date	Duration (days)	Generation Loss (TWh)	Outage Scope / Description	Management Action to Prevent Recurrence
P5	PO	10-Feb-05	27-Jun-05	137.0	1.78	Critical path work during planned outage was through fuel channel and boiler inspections.	Not applicable
	FEPO	27-Jun-05	06-Jul-05	9.0	0.12	Planned outage was forced extended by 9 days due to light water leak in the shutdown cooling heat exchanger and a hydrogen gas leak into the stator cooling water system in the generator.	Corrective actions include development of a preventive maintenance task to pressure/vacuum test the generator stator winding/end core cooling for leaks and improving the thoroughness of inspections on this equipment during future planned outages.
P6	PO	31-Aug-05	23-Dec-05	114.0	1.48	Critical path work during planned outage was through fuel channel, boiler and turbine inspections. There was a reduction of 14 days to the planned outage by way of a deferred start-date due to a change in outage duration related to a universal delivery machine installation and a single fuel channel replacement	Not applicable
	FEPO	23-Dec-05	01-Jan-06	8.4	0.11	Force extension of planned outage due to shutdown cooling pump 4 mechanical pump seal replacements. Also planned outage was extended (into 2006) to remove materials left inadvertently in steam generator following maintenance.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Shutdown SDC Seal Performance. Efforts to improve performance re foreign material exclusion (FME) are focused on human performance improvement. Recent FME initiatives at OPG include specialized FME training for maintenance; FME benchmarking to best-in-industry and revising procedures as required.
Forced Outages	Outage Type	Start Date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
P5	FO	01-Nov-05	16-Nov-05	14.3	0.19	Unit forced outage to investigate intermittent noise coming from Low Pressure Turbine No. 3.	Investigation completed and minor equipment defects were repaired. The frequency and intensity of noise events were significantly reduced but not eliminated. Unit returned to service with enhanced monitoring in place. Turbine overhaul in subsequent outage corrected problem completely.
	FO	15-Dec-05	17-Dec-05	2.1	0.03	Turbine trip caused by turbine control hydraulic system filters plugging, while the standby system was out of service for a planned inspection.	Investigation completed and procedures reviewed and revised to eliminate cause of failure.
	FO	19-Aug-05	20-Aug-05	1.8	0.02	Multi-unit shutdown (see below) due to high influx of algae into screen house.	Investigation completed on multi-unit outage including effectiveness of screenhouse modifications, operating strategies, design review of screen house. Lessons learned implemented and various actions undertaken to prevent recurrence, e.g. install lake condition monitoring in order to develop an understanding of algae behaviour, determine the optimal response strategy to a debris run event, install meteorological data showing the precursors to algae runs at Pickering.

Pickering B 2005						Page 2 of 2	
Forced Outages	Outage Type	Start Date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
P6	FO	30-Jul-05	05-Aug-05	6.5	0.08	Forced Outage due to high primary heat transport leakage to collection. Emergency coolant injection system MV52 replaced.	Investigation determined that leakage was packing failure and equipment was repaired. Performance maintenance review conducted to ensure maintenance frequency is appropriate.
	FO	19-Aug-05	22-Aug-05	2.9	0.04	Multi-unit shutdown due to high influx of algae into screen house.	Investigation completed on multi-unit outage including effectiveness of screenhouse modifications, operating strategies, design review of screen house. Lessons learned implemented and various actions undertaken to prevent recurrence, e.g. install lake condition monitoring in order to develop an understanding of algae behaviour, determine the optimal response strategy to a debris run event, install meteorological data showing the precursors to algae runs at Pickering.
P7	FO	01-Jan-05	02-Jan-05	1.6	0.02	Forced outage continues due to full stream heavy water leak from shutdown cooling pump 4.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - SDC Pump Seals
	FO	08-Jan-05	10-Jan-05	2.6	0.03	Turbine trip on loss of excitation due to AVR power supply fault.	Investigation determined that the AVR power supply problems caused the AVR to fail off. An electronic card was repaired. Failure mode of card was inspected to prevent recurrence.
P8	FO	14-Apr-05	20-Apr-05	5.5	0.07	Unit forced out due to failure of bleed condenser spray control valve CV113.	Process equipment failure. Material condition evaluated and repairs conducted.
	FO	06-Aug-05	09-Aug-05	3.2	0.04	Reactor trip during SDS2 maintenance.	Investigation completed and attributed to human performance (i.e. incorrect application of correct component verification). Procedures revised, inappropriate employee behaviours addressed, enhanced field training implemented and the Human Performance Working Committee were requested to develop and implement new relevant processes.
	FO	10-Aug-05	12-Aug-05	2.9	0.04	During re-start from forced outage, Unit 8 turbine generator tripped at 28% due to loss of excitation.	Investigation conducted and identified vulnerabilities with field breakers. Maintenance checks, inspections and cleaning were conducted to improve reliability of field breakers. Implemented improved preventive maintenance processes for all units.
	FO	19-Aug-05	21-Aug-05	2.1	0.03	Multi-unit shutdown due to high influx of algae into screen house.	Investigation completed on multi-unit outage including effectiveness of screenhouse modifications, operating strategies, design review of screen house. Lessons learned implemented and various actions undertaken to prevent recurrence, e.g. install lake condition monitoring in order to develop an understanding of algae behavior, determine the optimal response strategy to a debris run event, install meteorological data showing the precursors to algae runs at Pickering.

Pickering B 2006							
Planned Outages & Extensions	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Outage Scope / Description	Management Action to Prevent Recurrence
P6	FEPO	01-Jan-06	05-Feb-06	35.4	0.46	Continuation of forced extension (of Aug 2005 planned outage) to remove materials left inadvertently in steam generator following maintenance.	Efforts to improve performance re foreign material exclusion (FME) are focused on human performance improvement. Recent FME initiatives at OPG include specialized FME training for maintenance; FME benchmarking to best-in-industry and revising procedures as required.
P7	PO	21-Apr-06	28-Apr-06	6.5	0.08	Unbudgeted planned outage required for maintenance on stuck shutdown cooling system inlet valve MV4, and bleed circuit CV104 repair.	Investigation completed and cause of failure determined. Maintenance procedures revised for future outages to capture lessons learned.
	PO	14-Sep-06	16-Nov-06	63.0	0.82	Planned Outage for SLAR, heat transport system valve maintenance, service water outage, and reactor face work.	Not applicable
	FEPO	28-Apr-06	05-May-06	7.1	0.09	Extension due to primary heat transport D2O leakage to collection. Critical path is through repair of main circuit and ECI valves.	Investigation completed and cause of failure determined to be failed packing in two MV's. The MV's were repacked and returned to service. Extent of condition evaluated for other MV's and no further action was recommended at the time; subsequently proactive packing of critical MV's was scoped into future planned outages.
	FEPO	16-Nov-06	01-Jan-07	45.3	0.59	P7 planned outage was extended by 45.3 days in 2006. The extension was necessary to complete service water system maintenance and replace shutdown cooling pumps seals. The outage was further extended due to steam generator chemistry issues arising from the inadvertent release by a third party contractor of feedwater purification system resin into the demineralized water supply.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Resin Inclusion Event and Improved SDC Seal Performance.
P8	PO	27-Feb-06	23-May-06	85.0	1.10	Critical path work during planned outage was through fuel channel, boiler and turbine inspections and maintenance.	Not applicable
	FEPO	23-May-06	25-Jun-06	32.6	0.42	The P8 planned outage was extended by 32.6 days primarily due to primary heat transport pump seal failure, replacement of shutdown cooling pump seals and problems with heat transport pressure control, and resource availability due to concurrent unit 7 outage.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Primary Heat Transport Pumps and Improved SDC Seal Performance.
Forced Outages	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
P5	FO	28-Oct-06	15-Nov-06	17.5	0.23	Forced outage due to high levels of combustible gasses in the main output transformer.	Investigation determined problem with defective high voltage lead and third party forensic analysis supported evaluation. Extent of condition evaluated and no further actions were required.
	FO	02-Dec-06	12-Dec-06	9.5	0.12	P5 was forced offline for 9 days due to primary heat transport pump seal failure	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Primary Heat Transport Pumps.
P6	FO	20-Dec-06	01-Jan-07	11.5	0.15	P6 was forced offline for 11 days in 2006 due to the inadvertent introduction by a third party contractor of purification system resin into the feedwater system treatment plant.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Resin Inclusion Event.
P7	FO	27-Aug-06	14-Sep-06	18.2	0.26	P 7 was forced offline for 18 days as a response to increasing primary heat transport leakage to the containment collection system.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Primary Heat Transport Pumps.
	FO	03-Jul-06	07-Jul-06	3.5	0.05	Boiler level transient due to failed level controller	Investigation determined problem to be faulty level controller. Extent of condition evaluation completed by plant design with result that all analog controllers have been replaced with digital in all units.
P8	FO	15-Jan-06	18-Jan-06	3.5	0.05	Unit transient occurred caused by turbine runback	Investigation completed and various actions implemented to prevent recurrence, e.g. maintenance procedures were revised to incorporate improved diagnostics methods, and implemented a major procedure revision for troubleshooting critical equipment.

Pickering B 2007 January - December							
Planned Outages & Extensions	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Management Action to Prevent Recurrence	
						Outage Scope / Description	Management Action to Prevent Recurrence
P5	PO	02-Apr-07	11-Jun-07	69.4	0.90	Planned outage for Fuel Channel inspections, High Pressure Service Water outage, and Heat Transport Low level Drain State maintenance.	Not applicable
	FEPO	11-Jun-07	05-Jul-07	24.7	0.32	Forced extension of the planned outage due to site electrical system test failure. During this forced extension, additional work included SDC pump seal changes, and primary heat transport pump seal replacement.	Investigation completed and repairs made to site electrical system. A number of actions implemented on maintenance and installation procedures, testing procedures, and design parameters, including, for future outages, improving response to test failures by assembling troubleshooting team in advance of test. See Appendix C Forced Outage Report and Summary of Corrective Actions Taken, i.e. Primary Heat Transport Pumps and Improved SDC Seal Performance.
P6	PO	10-Sep-07	12-Nov-07	62.4	0.81	Planned outage for feeders and boiler inspections, single fuel channel replacement, high pressure service water outage, and auxiliary power system commissioning.	Not applicable
	FEPO	12-Nov-07	27-Nov-07	15.6	0.20	Forced extension to the planned outage due to unanticipated electrical equipment deficiencies, SDC heat exchanger leak repair liquid zone control troubleshooting and repairs.	Investigation completed, and repairs made to affected systems and components.
P7	FEPO	01-Jan-07	28-Jan-07	28.0	0.36	Continuation of Nov 2006 force extension of Unit 7 planned outage due to resin ingress and recovery activities.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken, i.e. Resin Intrusion Event.
Forced Outages	Outage Type	Start date	End Date	Duration (days)	Generation Loss (TWh)	Description	Management Action to Prevent Recurrence
P5	FO	28-Jan-07	14-Feb-07	16.9	0.22	Forced outage as unit transient due to partial loss of Class II power, resulting in SDS1 and 2 trips.	Investigation conducted and actions implemented. Based on Original Equipment Manufacture input, field modifications implemented to prevent recurrence.
	FO	19-Jul-07	01-Aug-07	13.1	0.17	Unit forced outage to repair shutdown cooling pump seals.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken, i.e. Improved SDC Seal Performance.
	FO	09-Aug-07	12-Aug-07	3.4	0.04	Forced outage due to high influx of algae.	OPG experienced a multi-unit outage in 2005 due to a high influx of algae (see Unit P5 FO August 2005). After this most recent event, an investigation was conducted and immediate concerns addressed. Given the unprecedented level of algae in 2007, the 2005 corrective action plan is being further enhanced to improve organizational readiness for algae intrusion events
	FO	01-Dec-07	04-Dec-07	2.7	0.03	Forced outage due to turbine trip during testing.	The trip is associated with obsolescence issues (solenoid valves replacement required). A strategy to do the test at low power or to take short planned outages to replace the solenoid valves is being prepared.
P6	FO	01-Jan-07	13-Jan-07	12.5	0.16	Continuation of Dec 2006 force outage of unit 6 due to resin ingress and recovery activities.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken, i.e. Resin Intrusion Event.
P7	FO	14-Mar-07	23-Mar-07	9.1	0.12	Unit forced outage due to severe leak on Bleed Condenser Reflux return valve.	Investigation determined problem to be failed weld on NV, repairs conducted. Over the past several years, OPG has taken steps to improve its welding program to provide effective control and management of welding processes. Also on an ongoing basis OPG has procedures to evaluate the quality of legacy welds in all units.
	FO	02-Jun-07	12-Jun-07	9.9	0.13	Force outage due to primary heat transport leakage to collection. Critical path work is through shutdown cooling pump maintenance	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Primary Heat Transport Pumps and Improved SDC Seal Performance.
	FO	23-Sep-07	27-Sep-07	3.8	0.05	Unit forced out due to leak from heat transport main circuit valve.	Investigation completed and condition corrected. A leak mitigation strategy was developed for the station. Also a root cause investigation has been performed to address similar occurrences. Other susceptible valves were scoped into the next planned outage.
P8	FO	07-Jan-07	26-Jan-07	19.2	0.25	Unit forced outage for resin ingress and recovery activities.	See Appendix C Forced Outage Report and Summary of Corrective Actions Taken - Resin Intrusion Event.
	FO	15-Aug-07	22-Aug-07	7.0	0.09	Forced outage to repair bleed condenser motorized valve.	Investigation completed and condition corrected by valve repair and repack. No further action required.

1 **APPENDIX C**

2
3 **FORCED OUTAGE REPORT AND**
4 **SUMMARY OF CORRECTIVE ACTIONS TAKEN**

5
6 Attachments 1, 2 and 3 to this Appendix provide details (i.e. outage type, start date, end date,
7 duration, generation loss, description of reasons for the outage and corrective actions taken) for
8 2005, 2006 and 2007 (January - July) as contemplated by the OEB's filing guidelines. OPG has
9 a well-established corrective action program that establishes the processes that ensure that all
10 deficiencies that adversely impact, or may adversely impact plant operations, personnel, nuclear
11 safety, the environment or reliability, are identified and corrected.

12
13 As set out in the attachments, there are certain events that have significantly impacted the
14 overall forced losses during the period, specifically:

- 15 • Pickering A liquid zone control
16 • Primary heat transport pumps
17 • The 2006/2007 resin inclusion event
18 • Pickering A electrical supply system
19 • Shutdown cooling (SDC) pump seals

20
21 To date, OPG has largely been successful in identifying root causes and has taken aggressive
22 actions in an effort to mitigate reoccurrence. Descriptions of these events along with an overview
23 of OPG's corrective actions are provided below:

24
25 **Pickering A Liquid Zone Control**

26 The liquid zone control ("LZC") system is the primary reactor power control device in a CANDU
27 reactor. As noted at Ex. F2-T2-S1, while OPG's 10 nuclear units are all heavy water moderated
28 CANDU reactors, they reflect three generations of design philosophy and technology. Pickering
29 A was designed in the 1960's, Pickering B in the 1970's, and Darlington in the 1980's. While the

1 LZC system at Pickering A represents the first generation of large scale CANDU reactor power
2 control systems, it continues to meet current design standards.

3
4 There have been some equipment-related hardware problems detected within the LZC system.
5 These hardware problems have been corrected during forced outages (e.g., failed zone level
6 transmitter, instrument line issues).

7
8 In addition, on a number of occasions since 2004, operating staff at Pickering A have observed
9 unexpected variability in system parameters that were inconsistent with today's operating
10 expectations. The ability to see these observations is primarily due to enhanced monitoring
11 equipment installed before the 1997 shutdown.

12
13 As a precautionary measure, OPG, in accordance with our Nuclear Safety Policy, shut the
14 reactor down until engineering and maintenance staff could ensure that the reactor power control
15 system was performing within today's operating expectations. This was achieved through a
16 series of technical reviews and investigations. A significant limitation and complicating factor in
17 completing these technical investigations is that the unexpected variability in system parameters
18 is only apparent when the unit is at power. Very limited troubleshooting can be done "at power"
19 due to reactor safety considerations.

20
21 Corrective actions taken to date include adding additional instrumentation to aid troubleshooting
22 and upgrading operating procedures to incorporate the lessons learned over the past four years.

23
24 In addition, OPG has conducted extensive maintenance on the unit 4 LZC system, replacing or
25 overhauling many of the critical components. This has led to improved performance on this unit
26 This same maintenance work was completed on unit 1 during a fall 2007 outage and is expected
27 to lead to improved unit 1 performance in 2008.

28
29 Pickering A LZC is being subjected to an extensive and continuing investigation as OPG seeks
30 to better understand the problems. OPG's goal is to define and evaluate cost effective solutions
31 that will improve the reliability and performance of the LZC.

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Primary Heat Transport Pumps

At Pickering B, the main driver of primary heat transport pump performance is the seals on the primary heat transport main circulating pump. These seals fail due to the failure of pins intended to prevent the spinning of the pump bearing housing. OPG has a program, to be completed by 2012, to replace the seals at its Pickering B units based on the age of the seals. New bearing housings fitted with an upgraded design are being installed. The primary heat transport pumps at Pickering A have been inspected and no issues have been found with them.

2006/2007 Resin Inclusion Event

All Pickering B units experienced forced outages or planned outage extensions due to steam generator chemistry issues arising from the inadvertent release of a resin into the demineralized water system in late December 2006. This release was by a third-party contractor and the source of the resin was the feed water purification system. Following this event, OPG implemented a resin cleaning strategy review. Teams from Pickering A and Pickering B were established to investigate the extent of the condition across the two stations. They concluded that a failed internal resin screen and a missing downstream resin trap in the vendor owned and operated water treatment plant led to the resin passing into the demineralized water systems at the stations.

Lessons learned from this investigation are currently being implemented at Pickering B as follows:

- OPG Staff are meeting routinely with the vendor to ensure that appropriate control measures are being taken.
- Daily water treatment plant walk downs are being conducted jointly by OPG staff and the vendor to identify and correct plant deficiencies in a timely manner.
- A project is currently underway to install an extra strainer, shut off valve and enhanced monitoring system on the demineralized water line, downstream of the water treatment plant.
- OPG is working with the nuclear industry, through World Association of Nuclear Operators (“WANO”), to share its experiences with others.

1 Another key lesson was the need to enhance the focus on asset preservation. To support this,
2 chemistry procedures are being redesigned to be followed by a review and approval for
3 implementation. Also, a workshop for OPG's licensed staff is being planned for late 2007.
4 Furthermore, OPG is reviewing and improving procedures that track vendor quality performance.

5
6 Pickering A Electrical Supply System

7 Pickering units 4 and 1 were shutdown in June 2007 due a discovery that the Pickering inter-
8 station transfer bus was not meeting its design intent. The inter-station transfer bus supplies
9 back-up 600 volt power from Pickering B to Pickering A and is an important safety feature of
10 Pickering A. Field tests had confirmed that the inter-station transfer bus was not able to supply
11 all the emergency loads in terms of voltage drop and current carrying capacity. As a result, a
12 decision was made, in accordance with our Nuclear Safety Policy, to shutdown both units.

13
14 Modifications to the design of the inter-station transfer bus were made to increase its ability to
15 supply voltage, increase current carrying capacity and decrease units 2 and 3 loads. In addition,
16 OPG developed comprehensive test plans to validate the performance of the modified inter-
17 station transfer bus.

18
19 The modifications included the installation of over six kilometers of new cables. The load
20 reduction involved over 200 discrete non-critical loads on units 2 and 3 (since units 2 and 3 are
21 shut down, these changes can be made with no impact on safety). OPG also conducted
22 extensive reviews (over 300) of other similar designs to ensure no design issues exist.

23
24 To minimize the duration of the 2007 inter-station transfer bus forced outage, some limitations
25 were placed on the scope of the modifications. These limitations impose minor outage-related
26 maintenance restrictions on Pickering B and operational restrictions on Pickering A. These
27 restrictions marginally increase the probability of being forced to shut down one or more units or
28 extend an outage in order to maintain safety margins. These restrictions will be removed once
29 additional modifications are installed.

1 Improve Shutdown Cooling (SDC) Pump Seal Performance:

2 In response to previous failures of SDC pump seals at Pickering B, a newly designed pump seal
3 was procured from AECL. During 2006 and 2007 the upgraded pump seals were installed in the
4 shutdown cooling pumps on two of the four Pickering B units based on the original equipment
5 manufacturer's recommendation. Unfortunately, the new pump seals have failed as well. An
6 investigation in conjunction with AECL is underway.