

PICKERING B CONTINUED OPERATIONS

1.0 PURPOSE

This evidence presents the Pickering B Continued Operations initiative and the status of the Pickering B Refurbishment project. It provides a summary of the associated actual and budgeted OM&A expenditures over 2007 - 2012. The business case supporting the Pickering B Continued Operations initiative is provided as Attachment 1.

2.0 OVERVIEW

The test period nuclear revenue requirement includes \$92.9M of OM&A costs associated with the Pickering B Continued Operations initiative and \$11.7M of OM&A costs associated with the Fuel Channel Life Cycle Management project. These amounts are included in the Base, Project and Outage OM&A evidence (as indicated in Chart 2). The Fuel Channel Life Cycle Management project supports both Pickering B Continued Operations and Darlington Refurbishment. OPG also seeks approval of a test period nuclear production forecast that reflects the incremental outage days associated with Pickering B Continued Operations, which reduce nuclear production by 1.9 TWh. There are no capital expenditures associated with Pickering B Continued Operations.

There are no test period costs or production impacts associated with the Pickering B Refurbishment project.

In Ex. H1-T2-S1, OPG seeks approval to recover the forecast December 31, 2010 balance in the Capacity Refurbishment Variance Account which includes amounts associated with Pickering B Continued Operations and Pickering B Refurbishment. These entries are detailed in Ex. H1-T1-S1 Table 8.

The initiation phase of the Pickering B Refurbishment project began in June 2006 following the direction from the Province requiring OPG to undertake feasibility studies on refurbishing its existing nuclear plants. OPG has decided not to refurbish Pickering B but to undertake the Pickering B Continued Operations initiative, with the objective of achieving a short-term

1 extension to the operating life of the Pickering B units. The Province concurred with this
2 decision in a letter from the Minister of Energy and Infrastructure to OPG dated February 4,
3 2010 and provided at Ex. D2-T2-S1 Attachment 3.

4
5 The economic assessment of Pickering B Continued Operations contained in the attached
6 business case (Attachment 1) shows that the initiative has substantial value to the Ontario
7 electricity system. OPG estimates the net present value of this initiative to be approximately
8 \$1.1B (2010 dollars). This net present value is based on the difference between the
9 estimated cost of Pickering B's output and the estimated cost of replacement generation. In
10 addition, seeking to confirm its own estimates, OPG approached the Ontario Power Authority
11 ("OPA") and requested that it provide an assessment of the system benefits associated with
12 the Continued Operations initiative. In a letter from the OPA, which can be found at
13 Attachment 2, the OPA concludes that:

14
15 Based on the potential for substantial system benefits, the OPA supports a decision
16 by OPG to proceed with an initial expenditure of funds in the period 2010 – 2012 to
17 assess the feasibility of continued operation of Pickering NGS, and to maintain the
18 option for continued operation should it prove to be feasible. System benefits should
19 be re-assessed before committing additional funds required beyond 2012.
20

21 Section 3.0 provides background on the Pickering B Continued Operations initiative and
22 Pickering B Refurbishment. Section 4.0 provides the status of Pickering B Refurbishment.
23 Section 5.0 sets out the economic justification for the Pickering B Continued Operations
24 initiative and section 6.0 sets out the risk assessment and a cost summary of the initiative.

25 26 **3.0 BACKGROUND**

27 The previously assumed nominal end of life for the Pickering B units was 2014 (for Units 5
28 and 6), 2015 (for Unit 7), and 2016 (for Unit 8). The nominal end of life estimate for the
29 station was predicated on the nominal design life of the key major component (i.e., the
30 pressure tubes). The nominal design life of the pressure tubes was originally projected to be
31 210k Equivalent Full Power Hours ("EFPH").

1 In June 2006, the Minister of Energy directed OPG to assess the feasibility of refurbishing
2 Pickering B (see Ex. D2-T2-S1 Attachment 5). Following this direction, OPG began an
3 assessment of all of the major components in the station. The assessment included a
4 number of specific tasks including a Plant Condition Assessment, an Integrated Safety
5 Review (“ISR”), and supporting work for the Environmental Assessment (“EA”) process. As
6 part of this broader set of work, OPG also explored the feasibility of achieving a short-term
7 extension to the operating life of the Pickering B units beyond their nominal end of life
8 (“Pickering B Continued Operations”).

9 10 **4.0 STATUS OF PICKERING B REFURBISHMENT**

11 The initiation phase of the Pickering B refurbishment project began in June 2006 following
12 the direction from the Province requiring OPG to undertake feasibility studies on refurbishing
13 its existing nuclear plants.

14
15 OPG completed an EA which was accepted by the Canadian Nuclear Safety Commission
16 (“CNSC”) on January 26, 2009. The report concluded that: “taking into account the identified
17 mitigation measures, the refurbishment and continued operation of Pickering B nuclear
18 station is not likely to cause significant adverse environmental effects”.

19
20 OPG also submitted an ISR, comprising more than 2,000 pages of documentation in a 20-
21 volume report, and a Global Assessment to the CNSC in September, 2009. The purpose of
22 the ISR was to assess the plant and the adequacy of programs as compared to current
23 codes and standards (i.e., if a plant was to be constructed today, how would Pickering B
24 compare against this new plant). OPG concluded that the existing Pickering B station
25 demonstrates a high level of compliance with current codes and standards, and can be
26 operated safely today and in the future, should the decision be made to refurbish the plant.
27 The review of these documents is currently underway by the CNSC.

28
29 Further work on Pickering B refurbishment (i.e., beyond the EA and ISR) was put on hold in
30 2009 pending the decision on whether or not to proceed with the refurbishment project.

1 Based on previously completed work, management developed a good understanding of the
2 regulatory requirements, environmental impacts, the scope of the project, the costs of
3 refurbishment, and associated project risks. Concurrent with the refurbishment work, OPG
4 examined and considered the feasibility of continued operations at Pickering B, an initiative
5 which would extend the life of the Pickering B units by four or more years (from 2014/2016 to
6 2018/2020) by taking actions to maximize pressure tube life.

7
8 OPG has decided to pursue the continued operation work program on Pickering B rather
9 than refurbish Pickering B. The major factors in this decision were:

- 10 • the economics of the Pickering B refurbishment
- 11 • the required lead time to procure steam generators and the resulting overlap with other
12 refurbishments, the availability of resources to manage multiple refurbishments in the
13 province
- 14 • the potential economic benefit of the continued operations of Pickering B
- 15 • the need to manage the overall availability of OPG's nuclear fleet

16
17 The Province concurred with this decision in a letter to OPG, as reflected in a letter from the
18 Minister of Energy and Infrastructure dated February 4, 2010 (see Ex. D2-T2-S1 Attachment
19 3).

21 **5.0 PICKERING B CONTINUED OPERATIONS**

22 **5.1 Background**

23 The objective of the Pickering B Continued Operations initiative is to achieve a short-term
24 extension to the operating life of the Pickering B units. With this initiative, OPG will be able to
25 operate the Pickering B Units for a further four calendar years (i.e., Units 5 and 6 from 2014
26 to 2018 and Units 7 and 8 from 2015/2016 to 2020) beyond their previously assumed
27 nominal end of life. OPG's 2010 - 2014 Business Plan includes a forecast of the
28 expenditures and extensions to planned outages required for Pickering B Continued
29 Operations.

1 The economic assessment contained in the attached business case (Attachment 1) shows
2 that the initiative has substantial value to the Ontario electricity system. OPG estimates the
3 net present value ("NPV") of this initiative to be approximately \$1.1B (2010 dollars). This
4 NPV is based on the difference between the estimated cost of Pickering B's output and the
5 estimated cost of replacement generation. In seeking to confirm its own NPV estimates, OPG
6 approached the OPA and requested that it provide an analysis of the system benefits
7 associated with the Pickering B Continued Operations initiative. The OPA's assessment is
8 that there could be substantial benefits to the Ontario electricity system from a short term
9 extension to the operating life of the Pickering B units and that they are supportive of OPG
10 proceeding with the Pickering B Continued Operations initiative during the test period, with a
11 reassessment in 2012 when more information becomes available from the work being
12 undertaken.

13
14 While OPG ultimately decided not to refurbish Pickering B, the assessment of continuing to
15 operate Pickering B beyond its previously assumed nominal end of life showed promise. The
16 assessment showed that with certain incremental maintenance, inspections and analytical
17 programs, there was sufficient confidence that the Pickering B Units could be operated safely
18 and reliably beyond 210k EFPH and that OPG could begin planning on this basis. As a
19 result, the Pickering B Continued Operations initiative was included in OPG's 2010 - 2014
20 Business Plan.

21
22 The ability of OPG to operate the Pickering B Units beyond 210k EFPH also has implications
23 for the two Pickering A Units. OPG has determined that when there are less than two
24 Pickering B Units in operation, there are significant technical and economic challenges to the
25 economic operation of the Pickering A Units. Pickering A's operation is linked to Pickering B
26 through shared common systems and in particular, power supplies to a special safety
27 system. Given the number of interdependent systems at the Pickering site, a shutdown of
28 Pickering B would require that additional staff and support be assigned to the shut down
29 Pickering B Units to allow the Pickering A Units to continue to safely operate. In addition,
30 OPG would have to satisfy the CNSC that there were adequate redundancies in the electrical
31 power supply to Pickering A in the event that the Pickering B station was not operating. While

1 it would be possible to operate Pickering A after end of life of Pickering B, OPG is not
2 planning to operate the two units at Pickering A with Pickering B shut down.

3
4 OPG, as part of the Pickering B Continued Operations initiative, would extend the service life
5 of Pickering B Unit 7 to 2020 through a combination of incremental maintenance and
6 inspections work programs and potentially shutdowns (it should be noted that there are no
7 shutdowns of Unit 7 planned for the test period). Extending the service lives of Units 7 and 8
8 at Pickering B until 2020 will allow the two Pickering A units to operate until at least 2020.

9
10 OPG will be undertaking incremental work effort for the Pickering B Continued Operations
11 initiative during the 2010 - 2014 period. The required incremental work effort during the 2010
12 bridge year and the 2011 - 2012 test period is in the areas of:

- 13 • Additional Maintenance: OPG will carry out selected and well-defined additional
14 maintenance to improve the material condition of the plant and to ensure the continued
15 fitness-for-service of the plant's major components beyond 210k EFPH.
- 16 • Life Cycle Management Requirements: OPG will undertake additional inspections to
17 confirm component fitness-for-service, increased Spacer Location and Relocation
18 activities, increased pressure tube inspections, feeder inspections and a limited number
19 of feeder replacements, boiler tube inspections and boiler water cleaning activities.

20
21 A portion of this incremental work effort must be undertaken during 2010 – 2012 (with the
22 balance complete by 2014) and will impact the outage duration of the scheduled Pickering B
23 planned outages during this period. If OPG attempted to delay this incremental maintenance
24 and inspection work effort until later, i.e., closer to 2014, the Pickering B Continued
25 Operations option would no longer be available to OPG. The impact on outage duration has
26 been included in the 2010 - 2014 Business Plan with 167 additional planned outage days in
27 the test period corresponding to a reduction of 1.9 TWh in the nuclear production forecast.

28 29 **5.2 Economic Justification**

30 OPG has completed a Pickering B Continued Operations business case (attached as
31 Attachment 1) that demonstrates that extending the operating life of the Pickering B units

1 beyond 2014 - 2016 has substantial value to the Ontario electricity system. OPG estimates
2 the net present value of this initiative to be approximately \$1.1B (2010 dollars). This net
3 present value is based on the difference between the estimated cost of Pickering B's output
4 and the estimate cost of replacement generation. The analysis in the business case
5 assumed operation of Pickering B Units 5 and 6 to 2018 and Pickering B Units 7 and 8 to
6 2020. The calculated benefit to the system includes the value of being able to operate the
7 two units at Pickering A to 2020, estimated at approximately \$400M.

8
9 OPG estimates that the net total additional generation resulting from the short-term extension
10 to the operating life of the Pickering B (and Pickering A) units would be 105 TWh (see
11 Attachment 1, Appendix B).

12
13 In addition, beyond the economic benefits included in the NPV calculation, OPG's business
14 case identifies significant other benefits that flow from pursuing the Pickering B Continued
15 Operations initiative, specifically:

- 16 • Improved reliability of supply by having Pickering B (and Pickering A) available to provide
17 baseload generation during the period 2016 - 2020 while Darlington is scheduled to
18 undergo refurbishment.
- 19 • Helping manage the uncertainties related to new nuclear in-service dates.
- 20 • Other benefits such as the deferral of adding new transmission infrastructure in the
21 Oshawa area that would be required with the shut-down of the Pickering stations.

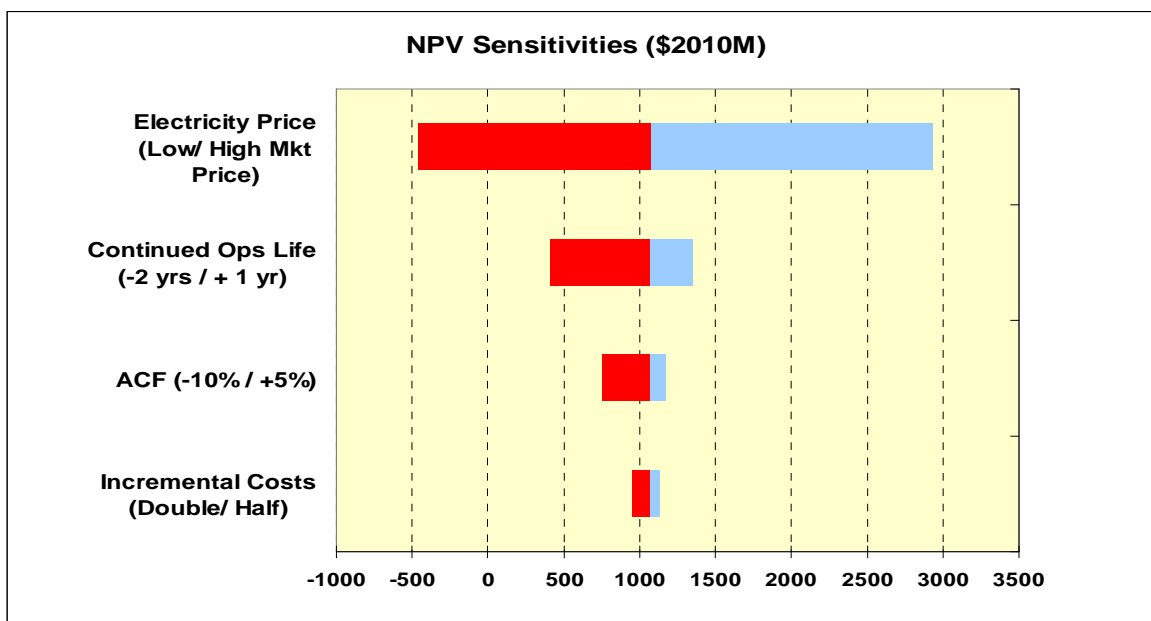
22
23 In addition to valuing Continued Operations based on the forecast value of replacement
24 energy, OPG also assessed the value of the Pickering B Continued Operations initiative at its
25 current nuclear rate. While current rates are not reflective of the future price of electricity in
26 Ontario, they are a simple way of assessing the directional impact on rates from the initiative.
27 OPG's analysis at current rates yields a positive net present value of approximately \$70M.
28 The \$70M figure is lower than the \$1.1B figure quoted above, because the current rate OPG
29 receives for its nuclear output is lower than expected replacement power.

1 OPG also conducted a sensitivity analysis of its conclusion that Pickering B Continued
2 Operations will have a positive benefit on a net present value basis. The sensitivity analysis
3 considered the impacts of various circumstances on the NPV of the project. For example, the
4 analysis considered the impacts on NPV if costs of the initiative were doubled, if the
5 anticipated period of Pickering Continued Operations life were not achieved or if the
6 generation performance of the units were lower than expected. The results of the sensitivity
7 analysis, summarized in Chart 1 below, indicate that the benefits of pursuing Pickering B
8 Continued Operations are quite robust.

9

10

Chart 1



11

12

13 In 2009, OPG engaged in discussions with the OPA for purposes of having the OPA assess
14 OPG's conclusions concerning the positive benefit of Pickering B Continued Operations to
15 the Province. The response of the OPA, which is provided at Attachment 2, confirms there
16 could be substantial benefits to the Ontario electricity system from a short-term extension to
17 the operating life of the Pickering B units. The OPA is supportive of OPG proceeding with the
18 Pickering B Continued Operations initiative during the test period, with a reassessment in
19 2012 when more information becomes available from the work being undertaken.

1 **5.3 Risk Assessment**

2 OPG has identified risks to its ability to achieve the objectives of the Pickering B Continued
3 Operations initiative. The two primary, but manageable, risks are the ability to demonstrate
4 fitness-for-service for the pressure tubes (i.e., the risk that a major component does not
5 continue to meet fitness-for-service requirements) and regulatory (i.e., the risk that OPG is
6 unable to obtain CNSC approval of OPG's fitness-for-service assessment criteria for
7 continued service life of the pressure tubes).

8

9 To address these risks, a component of OPG's work activity during 2010 - 2012 is designed
10 to provide increased assurance that the units can be operated reliably until 2018 (for Units 5
11 and 6) and 2020 (for Units 7 and 8). This work includes the Fuel Channel Life Cycle
12 Management Project, which is to be completed in 2012. This OPG-initiated industry effort is
13 being coordinated through the CANDU Owners Group. Successful completion of this
14 initiative would lead to greater certainty around the remaining service lives of all of the
15 CANDU units in Ontario. OPG is also progressing in its ongoing discussions with the CNSC
16 on regulatory issues related to determination of fitness-for-service. OPG needs to complete
17 this work to satisfy the technological and CNSC regulatory issues associated with Pickering
18 B Continued Operations. OPG expects that by undertaking this work activity, OPG will by
19 late-2012 have a high level of confidence regarding its ability to extend the life of the
20 pressure tubes at Pickering B.

21

22 A full description of the fitness-for-service, regulatory and other issues is provided in the
23 business case for Pickering B Continued Operations which is attached as Attachment 1.

24

25 **6.0 COST SUMMARY – REFURBISHMENT AND CONTINUED OPERATIONS**

26 Chart 2, below summarizes OM&A actual and forecast expenditures on the Pickering B
27 Refurbishment project and on Pickering B Continued Operations, from 2007 (Life to Date) to
28 2012. There are no actual or forecast test period capital expenditures over this period.

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2

Chart 2

Pickering B Refurbishment and Continued Operations

Costs (\$M)	Life-to-date 2007 (1)	Actual 2008	Actual 2009	Plan 2010	Plan 2011	Plan 2012	Information Source
Pickering B Refurbishment Project							
- Base OM&A	35.9	9.0	4.3	1.2	0.0	0.0	F2-T2-S1 Table 1
Pickering B Continued Operations Initiative							
- Base OM&A	0.0	0.0	1.6	9.8	17.7	14.7	F2-T2-S1 Table 1
- Outage OM&A	0.0	0.0	2.8	1.9	13.0	10.6	F2-T4-S1 Table 1
- Project OM&A	0.0	0.0	0.4	1.8	19.9	17.0	F2-T3-S1 Table 1
Subtotal Nuclear Operations OM&A (PB CO)	0.0	0.0	4.8	13.5	50.6	42.3	
Fuel Channel Life Cycle Management Project							
- Project OM&A	0.0	0.0	2.5	9.7	7.7	4.0	F2-T3-S1 Table 1

Note 1: F2-T2-S1 Table 2 shows 2007 actual costs, whereas this Chart presents all costs to year-end 2007.

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6.1 Pickering B Refurbishment

There are no OM&A or capital costs budgeted for Pickering B refurbishment for the test period. The vast majority of Pickering B refurbishment Phase 1 activities have been completed as of the end of 2009, including preparation and approval of the EA and the ISR.

Pickering B Refurbishment base OM&A costs were \$9.0M in 2008 and \$4.3M in 2009. The 2010 - 2014 Business Plan includes expenditures of \$1.2M in 2010 in order to obtain CNSC's acceptance of the final ISR report and to close out the Pickering B refurbishment project. The total actual and forecast costs for Phase 1 of Pickering B refurbishment is \$50.4M as shown in Chart 2. Of this amount, \$45.8M had been approved for release by the

1 OPG Board of Directors prior to April 1, 2008 and is therefore eligible for recovery under
2 section 6(2)4 i of O.Reg. 53/05.

3
4 The overall project variance is primarily due to the fact that this was the first time the CNSC
5 process was used to prepare an ISR. The completion of the ISR required more work than
6 originally planned. The knowledge gained with Pickering B refurbishment will be valuable in
7 the preparation of the ISR for the Darlington refurbishment project.

8 9 **6.2 Pickering B Continued Operations**

10 The cost of the Pickering B Continued Operations initiative in the test period is \$92.9M, as
11 summarized in Chart 2 above. There were no expenditures during 2008, \$4.8M in 2009 and
12 \$13.5M is forecast for 2010. The initiative also requires 167.0 additional outage days during
13 2011 - 2012.

14
15 As noted above, the required incremental work effort during the 2010 bridge year and the
16 2011 - 2012 test period associated with the Pickering B Continued Operations initiative is in
17 the areas of additional maintenance and additional inspections of life-limiting equipment.

18
19 In addition to the Pickering B Continued Operations expenditures presented in Chart 2,
20 expenditures for the Fuel Channel Life Cycle Management project support both Pickering B
21 Continued Operations and Darlington refurbishment.

22 23 **6.3 Capacity Refurbishment Variance Account**

24 In EB-2007-0905, the OEB approved establishment of the Capacity Refurbishment Variance
25 Account to record differences between actual and forecast costs, while in EB-2009-0174 the
26 OEB approved continuation of this variance account for 2010. A description of the variance
27 account is provided in Ex. H1-T1-S1.

28
29 OPG is seeking recovery of the variance between actual and forecast 2008 and 2009 costs
30 for the Pickering B Refurbishment and the Pickering B Continued Operations initiative
31 through the Capacity Refurbishment Variance Account as detailed in Ex. H1-T2-S1. OPG

1 also seeks to recover the forecast difference between 2010 expenditures and amounts
2 underpinning current payment amounts, consistent with the methodology approved in EB-
3 2009-0174. To the extent that costs vary from forecast in the test period, OPG also proposes
4 that such cost variances be captured in this account. Further discussion of 2008 - 2010
5 entries in the Capacity Refurbishment Variance Account can be found at Ex. H1-T1-S1.

LIST OF ATTACHMENTS

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- Attachment 1: Business Case for Pickering B Continued Operations
 - Attachment 2: Letter from Amir Shalaby, Ontario Power Authority to Andrew Barrett, OPG. April 1, 2010. Re: Pickering NGS Continued Operation and Darlington Refurbishment
- Note: Attachment 1 is marked “Confidential” because the original document was considered to be confidential. The document provided as pre-filed evidence is not confidential.

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PICKERING B CONTINUED OPERATIONS

1. RECOMMENDATION:

1. Implement Continued Operations as the basis for Business Planning in order to extend the nominal end-of-life of the Pickering B units to 2018 and 2020.
2. Begin the major component work i.e. pressure tube inspections, Spacer Location and Relocation work, boiler maintenance and inspections to allow operation for an additional 4 years or 240,000 EFPH on the pressure tubes.
3. Review the progress of this plan as part of the annual business planning process.

OPG's assessment shows that there is substantial value, estimated at \$1,110million NPV (2010\$), to the Ontario electricity system of being able to operate the Pickering B units for an additional 4 years beyond the previous nominal operating lives of 2014/2016. This translates to approximately 105 TWh of additional power supplied to the province of Ontario. The value to the Ontario electricity system is based on the difference between the cost of Pickering B's output and OPG's evaluation of the likely cost of replacing that output with other sources of generation. This value includes an estimated \$420 million due to being able to continue to operate the two Pickering A units until 2020.

The assessment includes the incremental work required to implement the Continued Operations option (e.g. pressure tube inspections, Spacer Location and Re-location, boiler maintenance and inspections, reactor components inspections), their associated costs, and a generation projection developed for the 2010 to 2014 Nuclear Business Plan. The assessment also includes an incremental impact of 266 planned outage days during the period 2010-2013 and additional costs of approximately \$195 million over the period 2010-2014. The incremental costs and generation impacts associated with implementing the Continued Operations Option in the Business Plan period are shown below:

Financial / Generation	LTD	2010	2011	2012	2013	2014	Total
Funding Class - OM&A (\$M)	4	14	51	42	37	47	195
Generation - Days	-	28	111	56	71	-	266
Generation - TWh	-	-0.3	-1.3	-0.7	-0.9	-	-3.2

While the Pickering B Continued Operations option is attractive economically, it also provides flexibility to OPG and to the electricity system in managing the availability of other nuclear units and potential capacity shortfalls in the 2014 to 2020 period.

Managing the risks around continued operations will be important in achieving success. Risks to being able to achieve Continued Operations fall into the following main categories:

1. Technical/Fitness-for-service Risks: i.e. risk that a major component does not continue to meet fitness-for-service requirements (e.g. being unable to demonstrate that the pressure tubes continue to be fit-for-service based on established technical criteria).
2. Regulatory: i.e. risk that the proposed disposition is not accepted by the CNSC or that there is a change to regulatory limits resulting in OPG being unable to demonstrate continued compliance.
3. Economic: e.g. risk that a previously unknown issue is discovered leading to expensive repair costs and early shutdown of the units.

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3. BACKGROUND & ISSUES

In June 2006, the Minister of Energy directed OPG to assess the feasibility of refurbishing its existing Pickering B nuclear plant and to begin an Environmental Assessment in support of refurbishing and continuing to operate Pickering B.

OPG's feasibility assessment consisted primarily of a Plant Condition Assessment, an Environmental Assessment and an Integrated Safety Review, as well as, development of conceptual level refurbishment project costs and an economic feasibility assessment. As a part of the feasibility assessment, OPG also explored the continued operation of the Pickering B units beyond their current nominal operating lives. This assessment indicated the potential to operate the units for an additional four years beyond their current nominal operating lives.

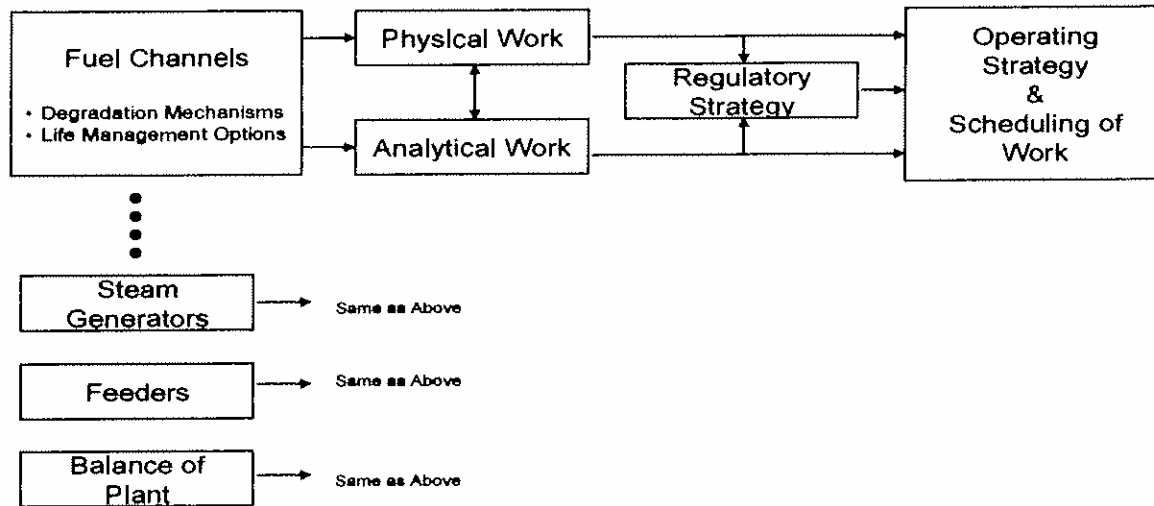
The nominal end-of-service life for the Pickering B units was based on the nominal design life of the key major component, i.e. fuel channels, and was projected to be when the units reached nominally 210,000 equivalent full power hours (EFPH). 210,000 EFPH is equivalent to 30 years operation at approximately 80% capacity factor. With the Pickering B units having come into service in the 1983 - 1986 period, the nominal ends of life of the Pickering B units were projected to be in the 2014 to 2016 period.

The decision on whether a nuclear unit is at the end of its life is primarily an economic one, as major life limiting components can be replaced and physical and procedural modifications implemented to ensure that the units are safe to operate and meet current regulatory codes and standards, if it is economically feasible to do so. For the Pickering B units, the technical life-limiting major components are the fuel channels. This technical life limit is reached when continued fitness-for-service of the leading fuel channels can no longer be assured.

During 2007 - 2009, in conjunction with the assessment of the economic feasibility of refurbishing Pickering B OPG also completed a preliminary assessment which indicated that there was potentially significant economic and strategic value in taking actions to continue to operate the Pickering B nuclear units by up to 4 calendar years beyond their nominal 30-year operating life, whether or not the units were eventually refurbished.

A planning scenario was developed for the continued operation of Pickering B as part of the 2009-2013 business planning process. The purpose of this planning scenario was to identify all of the work required over the remaining current operational life of the plant, necessary to provide confidence in the achievement of continued operation for 4 years beyond their current nominal operating lives. As a result, a team was established to identify the physical work (maintenance and inspections) required on the major components and balance of plant, as well as the analytical work required. The development of a regulatory strategy was also part of this work program. The intent was to scope out all of the work which would be required to provide confidence in the achievement of continued operation of the Pickering B units for 4 years beyond the current nominal operating life. Figure 1 provides a graphical overview of the approach adopted.

Figure 1: Schematic Overview of Work Plan to Develop Continued Operations Planning Scenario



Note: This is a simplified view. Much of the analytical work (e.g. NOP Trip set points) work involves assessing the interaction of the impact of co-incident degradation of multiple systems on the overall performance of the plant.

1.1. Major Components

The continued operation of Pickering B was assessed by OPG to be an economically attractive option for the Ontario electricity system. In addition, given the upcoming expected major refurbishment projects on the provincial fleet of nuclear units, OPG assessed that achievement of Continued Operations would provide significant flexibility to the Ontario electricity system in managing potential capacity shortfalls in the 2014 to 2020 period.

Continued Operation of Pickering B was also recognized as providing enhanced flexibility to OPG to support the management of the overall refurbishment schedule for the nuclear units.

A significant focus of the work scope was to better understand and address any risks to ensure that appropriate activities were built into the Continued Operations planning scenario to mitigate those risks. Some of the key issues with the major components and the balance of plant at Pickering B are discussed in the following sections.

Fuel Channels (Pressure Tubes)

Aging mechanisms affecting the pressure tubes are closely monitored by OPG technical staff and the results of that monitoring are subject to regulatory oversight. This type of regulatory oversight is normal for the nuclear industry. Aging mechanisms include changes in the physical dimensions of the pressure tubes and the ingress of hydrogen into the pressure tubes. The presence of hydrogen, which increases with operating time, leads to an increased potential for defect formation (if pressure tube to calandria tube contact exists) and aging of the material properties of the pressure tubes with time. Thus, OPG must have high assurance that the concentration of hydrogen in the pressure tubes is below certain specified limits.

The highest priority for assuring the integrity of the pressure tubes in Pickering B units is to avoid contact between the pressure tubes and calandria tubes. This requires ensuring that the spacers between the calandria tubes and pressure tubes are in the correct positions to ensure that there can be no contact. The Pickering B units' spacers have been repositioned in an operation known

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as SLAR (Spacer Location and Relocation) to ensure that pressure tube to calandria tube contact up to 210,000 EFPH is precluded. In order to preclude pressure tube to calandria tube contact until at least 240,000 EFPH, an assessment was done to determine the number of channels which would need to be "Re-SLARed". In addition, once spacers are repositioned, there is a need for "re-visits" to the channels to monitor whether the spacers have moved. The proposed work plan for Continued Operations includes allowances in outage plans for both the SLAR work and the re-visits. During the examination of the replaced fuel channel A13 in Unit 7, it was noted that one of the four garter springs was worn. Additional inspections will also be required to measure the pressure tube to calandria tube gap directly.

The next most important aging issue which is being managed is known minor defects on pressure tubes. These defects, which are known to have occurred during commissioning activities, are being closely monitored. The impact of defects is to limit the number of thermal cycles on the pressure tubes (heat-up/cool-down). Defects need to be monitored to provide assurance that there are no additional defects developing, and the current ones remain unchanged. Mitigation includes working with the CNSC to gain acceptance of a methodology for characterizing the risks around known defects. Partial acceptance of that revised methodology has already been achieved. Currently, the number of thermal cycles on each unit is not considered to be life limiting. The work scope for Continued Operations includes actions to continue to gain broader acceptance of a revised methodology.

There are other pressure tube aging mechanisms and regulatory issues which are being managed. While the majority of these are not considered life limiting, these risks include the potential for changes to regulatory requirements and limits. Management has undertaken a comprehensive project, the Fuel Channel Life Management Project, in co-operation with the other operator of CANDU reactors in Ontario, and coordinated through the CANDU Owners Group, in order to progress the technical and regulatory issues which are required to be resolved. The risk table in Appendix B contains some additional details of pressure tube aging mechanisms and potential risks.

Steam Generators

The steam generators in the Pickering B units produce the steam used to drive the turbine-generator set. The tubes in the steam generators serve as a containment boundary as there is hot, pressurized heat transport fluid (heavy water) on the inside of these tubes. A leak in a steam generator tube could, therefore, result in tritiated heavy water entering the secondary side of the plant.

The steam generators at Pickering B have performed well for several years. Among the known aging mechanisms being managed is under-deposit pitting/corrosion of the steam generator tubes. In order to reduce the potential for steam generator tube leaks, the Pickering B Continued Operations work scope includes adoption of an enhanced maintenance regime which includes increased water-lancing to remove deposit build up on the steam generator tube sheets as well as more frequent and comprehensive inspections of the steam generator tubes. The Pickering B steam generators have been assessed to have a high probability of continuing to perform reliably during the Continued Operations period and beyond.

Feeders

The feeder pipes in a nuclear unit transport the heat transport fluid from the pressure tubes in the reactor to a common outlet header from which the fluid is piped to the steam generators and then back from the steam generators via an inlet header to the pressure tubes in the reactors in a closed loop. The primary aging mechanism of concern for the feeders is wall-thinning due to flow assisted

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corrosion. Although feeder pipe cracking has been observed in another CANDU unit, there have been no such observations in OPG units, and the risk of feeder pipe cracking in Pickering B units is assessed to be low.

As the units age, additional feeders will require replacement as they approach the limit of fitness-for-service due to flow assisted corrosion. The Pickering B Continued Operations work scope includes an assessment of the number of feeders which will require replacement during the continued operations period as well as the requirements for on-going inspections. Feeders in the Pickering B units have been assessed to have a high probability of operating reliably during the continued operations period.

Reactor Components

Reactor components include the calandria vessel, the calandria tubes, the reactivity mechanism guide tubes, moderator relief ducts, and calandria external components such as end fittings, reactivity mechanism drives and cables and moderator inlet pipes. While some aging mechanisms are known, there is a limited inspection history within the CANDU industry on many of these components.

Some inspections were carried out during 2008 and 2009 in order to better understand the risks. One aging mechanism for which inspections are necessary during the next several years involves potential calandria tube / Liquid Injection Shutdown System (LISS) nozzle contact. Preliminary results based on a limited inspection are encouraging. Further inspections will be carried out to verify that this is not an issue for Continued Operation.

Risks will remain during the Continued Operations period that aging of some reactor components is taking place which could cause outages or threaten the life of the units. To mitigate these risks, information is being gathered through industry-wide projects being undertaken by the CANDU Owners' Group (COG) and also operational experience is being gathered from other refurbishment projects, e.g. results of calandria internals inspections at the Bruce A and Pt. Lepreau stations.

The Pickering B Continued Operations work scope includes an assessment of the work required to gain greater confidence in the condition of reactor components and the potential risks to reliability of the plant in the Continued Operations period. While there are unknowns, the confidence in achieving 4 years of continued operation for reactor components is generally considered high at this time.

Balance of Plant

A detailed Component Condition Assessment (CCA) of 70 systems, major structures and major components at the Pickering B station was completed in the first half of 2007. The recommendations from these CCAs were assessed to determine the potential impact on costs and reliability in the Continued Operations period. The conclusion of the assessment was that, with the implementation of increased preventive maintenance programs and additional inspections there would be minimal risks to equipment reliability over the Continued Operations period.

The cost of these programs has been estimated at approximately \$58 million over the five year period 2010 – 2014. Electrical and motor maintenance are examples of balance of plant work for which incremental funding has been included.

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Integrated Safety Review and Related Issues

A detailed assessment of Pickering B against modern codes and standards was carried out as part of the Integrated Safety Review process during the assessment of the refurbishment of Pickering B. While the evaluations were done on the basis of refurbishing and continuing to operate Pickering B for an additional 30 years, there are potential cost impacts on the Continued Operations period to address issues identified in the Integrated Safety Review. The economic assessment of Continued Operations includes incremental costs to fund these potential issues.

Impact on Pickering A Operation

Units 1 and Unit 4 are currently in operation at Pickering A. The current predicted end-of-service lives for Pickering A Units 1 and 4 are the end of 2021 and 2027 respectively, assuming independent operation from Pickering B is feasible.

Pickering A's operation is linked to Pickering B through shared common systems and in particular, power supplies to some safety systems. OPG's assessment is that two units on the Pickering B station must be in operation in order to support the Pickering A units. As a result, significant modifications to systems to address this issue will be required to facilitate the operation of Pickering A in the absence of Pickering B. In addition to addressing the technical issues, these modifications and other mitigation actions would need approval by the CNSC.

While it would not be impossible to operate Pickering A after end of life of Pickering B, OPG at this time would not attempt to operate Pickering A with Pickering B shutdown. The costs to operate Pickering A independent of Pickering B would likely equal or exceed the system value.

Impact on Financial Outlook

Should the Pickering B Units be shutdown in the 2014-2016 time period, further review of the potential impact on depreciation costs, severance costs, and the decommission fund would be required.

4. ALTERNATIVES AND ECONOMIC ANALYSIS

The alternatives being analyzed are: (i) plan to operate Pickering B to 210,000 EFPH on the pressure tubes, then shut down the units versus (ii) plan to operate the units to 240,000 EFPH before the units are shutdown. In order to have two units on the Pickering B station in operation to support the Pickering A units, the alternative of operating the Pickering B units to 240,000 EFPH includes an assumption of "modified" outages on Pickering Unit 7 in order to achieve the objective of aligning its life with that of Pickering Unit 8.

ALTERNATIVE 1 –NOMINAL LIFE CASE:

Plan to Operate all Pickering B Units until 210,000 EFPH on the pressure tubes.

In this alternative, no incremental inspections, maintenance, analytical or regulatory strategies would be put in place to try to continue to operate the units beyond 210,000 EFPH on the pressure tubes. The nominal predicted end-of-life dates for the Pickering B Units would be Q2 2014 for P5 and P6, Q1 2015 for P7, and Q2 2016 for P8. The assumption would be that, as 3 Pickering B units would be shutdown by Q1 2015, Pickering A Units 1 and 4 would also be shutdown in Q1 2015.

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ALTERNATIVE 2 - CONTINUED OPERATIONS:

Plan to operate all Pickering B Units until 240,000 EFPH on the pressure tubes. Implement operating strategies to keep two Pickering B units operating to support Pickering A operation.

In this alternative, the incremental inspections, maintenance, laboratory testing, analytical work and regulatory strategies would be put in place to achieve continued operation of the Pickering B units beyond 210,000 EFPH with a target of achieving 240,000 EFPH. In addition, life management outages would be implemented to continue to operate Pickering Unit 7 to the shutdown date of Pickering Unit 8 (i.e. 2020) in order to have the station in a configuration which would support the operation of the Pickering A units for as long as possible.

The continued operations predicted end-of-life dates for the Pickering B Units would be Q2 2018 for P5, P6, and Q2 2020 for P7 and P8. Pickering A Units 1 and 4 would be shutdown co-incident with the shutdown of Pickering Units 7 and 8 in 2020.

The identified incremental work, its associated costs and the impact on generation throughout the 2010-2014 Business Plan period and beyond was assessed. A summary of the impacts of Continued Operations is shown in Appendix C.

Net present values of the alternatives were calculated based on forecast costs and revenues (performance and assumed electricity price). Results were calculated from an Ontario system perspective based on OPG's assessment of the value of the incremental energy and capacity to the Ontario system (OPG's 2009 forecast of System Energy Values (SEVs)).

For Alternative 1, 2010-2014 Business Plan costs and performance, excluding the Continued Operations work, costs and generation impacts, were used and extrapolated where required to current nominal end-of-life dates (2014/2016). For Alternatives 2, 2010-2014 Business Plan costs and performance, including the Continued Operations work, costs and generation impacts, were used and extrapolated to 2018/2020. The Continued Operations costs and performance impacts included such items as SLAR costs, enhanced water-lancing costs, increased planned outage days, and assumed increase in forced loss rates as units' lives are extended beyond the current nominal ends-of-life. In addition, increased costs were postulated during the Continued Operations period in order to maintain a conservative view of the value of Continued Operations. The Net Present Value of the Continued Operation initiative includes the value of continuing to operate the Pickering A units for nominally 4 additional years.

The economic assessment results showed approximately \$1,110 million net present value (NPV) to the Ontario electricity system for additional energy from the Pickering B and A units compared to a 2014/2016 shutdown for Alternative 1. This value includes an estimated \$420 million value of being able to operate the two units at Pickering A until 2020.

In addition, economic impacts that have not been quantified include:

- A positive NPV impact on the decommissioning liability for Pickering.
- NPV savings by deferring potential transmission upgrade costs which OPG believes will be required.

More details on the key risks and risk mitigation activities are provided in Appendix A. Each risk is also rated in terms of the confidence that these risks can be successfully mitigated.

Results of the economic assessment were tested for sensitivity to key inputs such as:

- (i) assumed electricity price regime
- (ii) the length of continued operation life achieved
- (iii) generation performance
- (iv) costs of incremental work such as SLAR, enhanced water lancing, and component condition assessment mandated work, etc.

Figure 2 shows the results of some of the key sensitivity analyses performed.

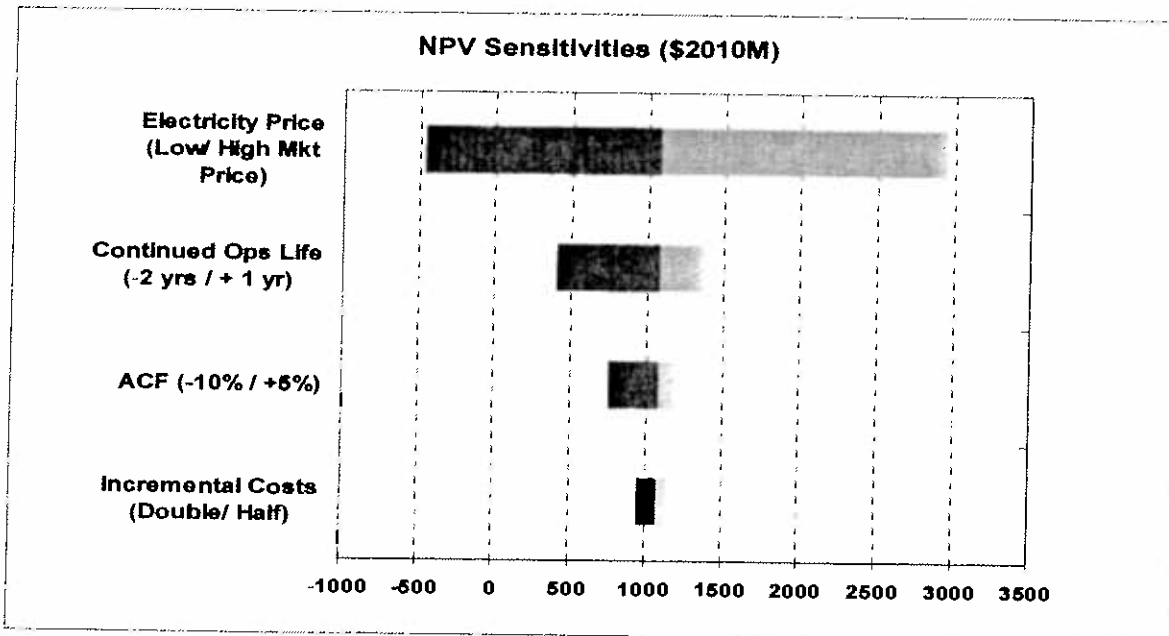


Figure 2: Results of Key Sensitivity Analyses

The sensitivity analysis shows that the expected value is insensitive to the cost of the incremental work, e.g. a doubling of the costs of all of the work reduces the expected value of Continued Operations by approximately \$220 million. The expected value is, however, very sensitive to the assumed electricity price regime. In a high priced regime, the value of the output from Pickering A and B in the Continued Operations period could be as high as \$2,850 million. A low priced regime is an extreme scenario resulting from low electricity demand and low gas prices.

In addition, a sensitivity test was performed assuming a price equivalent to OPG's current regulated nuclear rate (minus one-time variance account adders) of \$53/MWh real, i.e. unescalated for the period 2010 to 2020. This is equivalent to a price which is declining in nominal terms at the rate of inflation. At this price, the value of Continued Operations to the Ontario Electricity system was assessed to be \$70 million.

As well, a sensitivity test was performed assuming a price equivalent to OPG's current regulated nuclear rate (minus one-time variance account adders) of \$53/MWh nominal, i.e. escalated for the period 2010 to 2020. This is equivalent to a price which is flat in nominal terms. At this price, the value of Continued Operations to the Ontario Electricity system was assessed to be \$580 million.

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5. THE PROPOSAL

1. Implement Continued Operations in order to extend the nominal end-of-life of the Pickering B units to 2018 and 2020.
2. Begin the major component work i.e. pressure tube inspections, Spacer Location and Relocation campaigns, boiler maintenance and inspections to preserve the option to continue to operate the units for an additional 4 years or 240,000 EFPH on the pressure tubes.
3. Review the economic feasibility of this plan as part of the annual business planning process.

The work to be completed in the Continued Operations work program and the current estimated costs are summarized as follows:

- Life Cycle Management & Inspection Programs
- Other Planned Outage Activities
- Component Improvements (as a result of the Component Condition Assessments)
- Feeder Replacement (incremental feeders needing to be replaced to enable continued operations)
- Fuel Channel Life Management Project
- Enhanced Boiler Water Lancing
- Other Projects

6. QUALITATIVE FACTORS

Deferral of Potential Staff Reductions

By deferring the shutdown of the station by 4 years, there may be greater opportunities to smooth the redeployment of staff to the Darlington refurbishment project, as well as, to the Darlington New Nuclear project and operations, if that project proceeds.

Socio-Economic Impacts

Pickering Nuclear is a major employer within Durham Region. In 2009, approximately 2,700 people were directly employed at PNGS A and PNGS B. Pickering Nuclear and associated OPG facilities contribute significantly to the tax base of the City of Pickering. Pickering Nuclear has attracted nuclear related businesses, helping to establish a Durham Energy Industry Sector Cluster (e.g. Eastern Power, Eco-tech, Black and MacDonald, AREVA, New Horizons Systems Solutions, etc.). Continued operation of Pickering A and B defers the impacts of the shutdown of Pickering on the Durham Region by 4 years.

Air Emissions Impacts

If the Pickering plant is not in service there would likely be a greater demand for gas-fired replacement generation to be required to meet the electricity system load in the 2014 to 2020 period, with the associated impacts on air emissions.

Impacts on Decommissioning Liability

The current decommissioning liability for Pickering B is established based on shutdown dates in the 2013 to 2015 period. Should the station be shutdown at later dates, there would be a potential societal benefit due to deferral of the costs of decommissioning. However, note that should the shutdown of Pickering A be advanced to coincide with the shutdown of Pickering B, there would be

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a slight increase in the present value of the Pickering A decommissioning liability relative to current estimates.

Transmission Impacts

A number of issues would need to be addressed when the Pickering B units are retired, including replacement supply, capacity of the Cherrywood transformers and the 230 kV system, system voltage support and security risk. Due to its importance to the GTA system, the transmission changes required would likely be complex and extensive. Such a decision would remove up to 3,000 MW (including Pickering A) of internal generation from the GTA. The combination of a third 500 kV supply line to Parkway T.S. and the Oshawa Area station could address the Pickering B retirement from a transmission supply perspective. However, the additional loss of the Pickering A units would necessitate a review of generation development in the area as well as area load supply, possibly in the form of a third major supply line to Toronto.

Based on OPA plans, the development of the Oshawa Area TS (approximately \$150M) would be required to be advanced from the 2018-2020 timeframe to the 2014-2016 timeframe if Pickering B were to shutdown at the present end of service lives.

These advancements of transmission infrastructure improvements have a net present value impact and are an additional benefit of Pickering B Continued Operations.

7. RISKS

Risks to being able to achieve Continued Operations of the Pickering B units fall into the following main categories:

1. Technical/Fitness-for-service Risks: i.e. risk that a major component does not continue to meet fitness-for-service requirements (e.g. being unable to demonstrate that the pressure tubes continue to be fit-for-service based on established for technical criteria).
2. Regulatory: i.e. risk that the proposed disposition is not accepted by the CNSC or that there is a change to regulatory limits resulting in OPG being unable to demonstrate continued compliance.
3. Economic: e.g. risk that a previously unknown issue is discovered leading to repair costs and early shutdown of the units for economic reasons.

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8. POST IMPLEMENTATION REVIEW

The strategic work outlined in this Business Case is intended to provide greater certainty in the achievement of Continued Operations for Pickering B. The incremental work and expenditures required will be reviewed in each business planning cycle.

Physical Work (Inspections & Maintenance):

- (i) Results of planned pressure tube inspection.

Technical Analyses / Regulatory Strategy:

- (i) Verify that the Continued Operations work scope is being progressed.

Strategic Questions

- (i) What is the current status of the plans for refurbishing the Darlington units and how have any changes to those plans affected the strategy for Pickering B Continued Operations?
- (ii) How are the plans for new nuclear build progressing and how do any changes affect the strategy for Pickering B Continued Operations.

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Appendix A: Summary of Key Technical, Regulatory, Reputation and Economic Risks Associated with Continued Operations

Risk Description	Consequence	Mitigation Strategy	Impact on Continued Operations	Prob. of Success (Very High, Medium, Low, Very Low Unknown)	Industry Issue or unique to Pickering B?
Technical Risks – Pressure Tubes					
Pressure tube to calandria tube contact	Potential for defect formation	Technical: SLAR all channels to 240k EFPH. SLAR revisits to address potential for post-SLAR spacer movement. Currently, the risk is being managed by probabilistic assessments and targeted revisits.	Additional planned outage days in Generation Plan to execute SLARs and SLAR "re-visits" to assure contact-free operation to 240,000 EFPH.	2yrs - High 4 yrs - Med	Unique to Pick B and some other Candu units.
Pressure tubes - hydrogen ingress to body of tube and rolled joint	Embrittlement of pressure tubes	Technical: Sampling of P/Ts (Scrape) to trend ingress rates. Laboratory testing to demonstrate P/T integrity at higher hydrogen concentrations Regulatory: Provide evidence to regulator to obtain increased limits	Potential additional time in outages to conduct sampling activities if limits cannot be changed, potential to exceed limits near end of Continued Operations period	2yrs - High 4 yrs - Med	Industry
Pressure tube defects	Defect growth	Technical: Monitor in-service defects every outage; manage heat up/cool down cycles Regulatory: Gain acceptance of new assessment methodologies	Potential need to extend forced outages to inspect and disposition defects.	2yrs - High 4 yrs - High-Med	Problem more acute for Pickering B
Technical Risks – Reactor Components					
Calandria tube defects	Leaking calandria tubes – unit shutdown	Developing – Tooling, procedures and capability are in place in the event of future failures.	Judged to be low probability.	2 yrs – Very High 4 yrs - High	Industry
Liquid Injection Shutdown System Nozzle / Calandria tube contact	Leaking calandria tubes – unit shutdown	Technical: Inspections in upcoming outages and replacements of fuel channels if required. Tooling, procedures and capability are in place.	Could lead to a small number (less than 10) of pressure tube and calandria tube replacements .	2yrs – High 4yrs - High	Industry
Other Calandria Internals (e.g.): • Guide tubes spring de-tensioning • Moderator Inlet Nozzles • Moderator relief ducts	Failure to demonstrate fitness-for-service	Technical: Operating Experience from Bruce Power and NB Power refurbishments Planned inspections in Pickering A, B and Darlington over the next several years. Information sharing with COG and establishment of joint project to address inspection data.	Some components cannot be inspected except in a refurbishment outage. Unforeseen aging mechanisms can lead to a prolonged outage or shutdown.	2yrs – Very High 4 yrs –Very High	Industry

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 * Associated with OPG-PROC-0050-R001, Procedure for Developing and Documenting Business Cases

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Appendix A: Summary of Key Technical, Regulatory, Reputation and Economic Risks Associated with Continued Operations

Risk Description	Consequence	Mitigation Strategy	Impact on Continued Operations	Prob. of Success (Very High, Medium, Low, Very Low Unknown)	Industry issue or unique to Pickering B?
Technical Risks –Boilers					
Boiler tube leak • Under deposit pitting / corrosion	Unacceptable number of boiler tube leaks	Technical: Increased water lancing and inspections	Small release of tritium to the environment.	2yrs - High 4 yrs – High	Both
Technical Risks –Feeders					
Feeders • Feeder thinning	Failure to demonstrate fitness-for-service.	Technical: Well established program of feeder inspections and replacements each outage. Regulatory: Working with regulator to gain acceptance of Advanced Stress Analysis which can reduce the number of feeder replacements.	Number of feeders tends to vary from year to year but the proposed number to be replaced does not threaten the viability of the station.	2yrs - Very High 4 yrs – High	Industry (less of an issue at Pickering B)
Technical Risks –Balance of the Plant					
Balance of Plant • Turbine/generator • Emergency Power Generators • Screenhouse (algae management) • Electronic components	Possible derates or forced outage.	Technical: Combination of maintenance strategies, life cycle and project upgrades will ensure equipment is kept available.	Incremental costs, forces loss rates and outage delays	4 yrs - High.	Both

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Appendix A: Summary of Key Technical, Regulatory, Reputation and Economic Risks Associated with Continued Operations

Risk Description	Consequence	Mitigation Strategy	Impact on Continued Operations	Prob. of Success (Very High, Medium, Low, Very Low Unknown)	Industry issue or unique to Pickering B?
Regulatory Risks Integrated Safety Review and Environmental Assessment (Mandated Regulatory Upgrades to support continued operation) <ul style="list-style-type: none"> • Fish Impingement & Entrainment • Effects of Thermal Plume • CCA mandated upgrades • Safety Analysis / ISR 	Fish Impingement and Entrainment must be addressed.	Technical: Implement modifications to address fish impingement and entrainment. Regulatory: Work underway with the CNSC to fully define potential requirements and develop an action plan. Prepare a plan to assess and potentially address thermal plume mitigation.	Regulatory (power reduction due to reduced operating margin is possible). May impact Base OM&A costs	2 yrs- High 4 yrs - Medium	Both, but Pickering B may be the focus
Scope / Economic Regulator acceptance of the fitness-for-service approach to determining station end-of-life.	Regulatory attention; (for safety analysis, potential derates due to reduced operating margin is possible).	Work with regulator to continue to get acceptance to fitness-for-service approach.	Inability to obtain regulator acceptance could result in regulatory imposed shutdown prior to end of Continued Operations period.	4 yrs - High	Both, but Pickering B may be the focus
Unforeseen major equipment failure,	Major outages for repairs or shutdown of a unit or entire plant prior to expected duration of continued operations period.	Technical: Where possible, perform inspections of equipment which fall into the category of potential life limiting; where not possible, continue to monitor OPEX from other units and refurbishment projects and sponsor industry technical assessments. Economic: Implement a phased funding strategy (minimize incremental investments in Continued Operations) until greater technical and regulatory certainty can be achieved.	Outages for unforeseen repairs or shutdown of a unit or the plant.	2 yrs – Very High 4 yrs – Very High.	Both

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For Internal Project Cost Control

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APPENDIX B: Impacts on Generation of Pickering B Continued Operations

Title: Pickering B Continued Operations

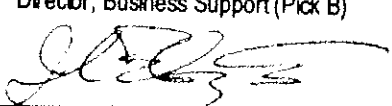
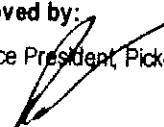
Work Program Impacts		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Pick B	Life Cycle Mgmt & Insp Programs	27	65	0	45	N/A	N/A	N/A	N/A	N/A	N/A	N/A	137
	Other Planned Outage Activities	1	46	56	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	129
	Total Incremental PO Days	28	111	56	71	N/A	N/A	N/A	N/A	N/A	N/A	N/A	266
	Total Incremental/Decremental TWh	-0.3	-1.2	-0.7	-1.1	4	9.5	14.4	14.2	11.3	6.4	3.4	61.9
PA & PB Pick A	Total Incremental/Decremental TWh	N/A	N/A	N/A	N/A	0.6	7.8	7.6	7.7	7.8	8	3.3	43.1
	Total Incremental/Decremental TWh	-0.3	-1.2	-0.7	-1.1	4.6	17.3	22.2	21.9	19.1	16.4	6.7	105

APPENDIX C: COST SUMMARY

ONTARIOPOWER GENERATION	Summary of Estimate	Date	17-Feb-10
		Project #	NA

Facility Name:	Pickering B
Project Title:	Pickering B Continued Operations

Estimated Cost in Million \$										
Year	2010	2011	2012	2013	2014	2015	2016	Totals	%	
Life Cycle Mgmt & Insp Programs	1.8	8.8	4.9	4.4	5.2			35.1		
Other Planned Outage Activities	1.3	8.3	9.7	4.8	2.5			26.6		
Component Improvements	8.6	13.6	10.6	15.6	9.5			57.8		
Feeder Replacements					8.9			8.9		
Fuel Channel Life Mgmt Project	1.3	4.9	3.9	2	0.5			12.5		
Enhanced Water Lancing		12	7.8	3.6	7.8			31.2		
Other Projects	0.5	3	5.3	6.3	3			18.1		
Interest										
Contingency										
Totals	13.5	50.5	42.2	36.7	47.4			190.2		

Prepared by: Director, Business Support (Pick B) 	Approved by: Site Vice President, Pickering B 
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APPENDIX D: Financial Modelling – Assumptions

Cost Assumptions:

1. Base OM&A, Capital and OM&A projects, and Outage OM&A costs for Pickering B are consistent with the 2010-2014 Business Plans for those stations. These costs were extrapolated to the period 2015-2020.
2. Incremental costs for Pickering B Continued Operations are as shown in Appendix C.

Financial Assumptions:

1. Cost escalation rates used are consistent with those provided on the Corporate Finance Intranet.
2. A nominal discount rate of 7% was applied in all analyses.

Operating Life Assumptions:

1. Current nominal operating life of 210,000 Equivalent Full Power Hours (EFPH) for each of the Pickering B units was used in the Nominal Life Case. The Continued Operations Case was assessed at a nominal operating life of 240,000 EFPH (nominally 4 calendar years of Continued Operations).
2. Sensitivities on operating life were done at 225,000 EFPH and 248,000 EFPH, i.e. nominally for 2 and 5 calendar years of continued operations.

Energy Production Assumptions:

1. For the Base Case, energy production assumptions are consistent with the 2010-2014 Business Plan for Pickering B, but excluding the impact of outage extensions caused by Continued Operations for Pickering B.
2. For the Continued Operations Case:
 - » Energy production assumptions for the 2010 to 2014 period are based on the Business Plan for Pickering B, including the impact of outage extensions caused by Continued Operations, i.e. the incremental planned outage days shown in Appendix B. In addition, in the 2015-2018 period, 2010 – 2014 Business Plan period energy production levels were projected forward with some conservative assumptions added regarding energy production.
 - » Sensitivities on capability factors were performed for range of plus 5% to minus 10% around the nominal values.

Other Assumptions:

1. OPG 2009 median assumptions regarding future Ontario system development, gas prices etc, were used as the bases from which to evaluate the value to the Ontario electricity system. Sensitivities were run for a number of scenarios which would lead to for example a Low Price regime and also a High Price regime. Two special sensitivities were also run where the energy production from Pickering B was valued at a) 5.3 ¢/kWh real (current 2010 regulated rate, minus adjustments for variance accounts, assumed with no increases (i.e. only adjusted for inflation adjustment), and b) 5.3 ¢/kWh nominal (i.e. no adjustment for inflation) over the remaining life of Pickering A and B.
2. For the Continued Operations Case, it is assumed that life management of Pickering B Unit 7 would be implemented in order to be able to operate that unit to the nominal end of life date of the Unit 8, the unit with the longest remaining life. This is to ensure that two Pickering B units are in operation in order to facilitate continued operation of the Pickering A station for as long as possible.



April 1, 2010

Andrew Barrett
Vice President – Regulatory Affairs and Corporate Strategy
Ontario Power Generation
700 University Avenue,
Toronto Ontario
M5G 1X6

Dear Andrew,

Re: Pickering NGS Continued Operation and Darlington Refurbishment

The purpose of this letter is to comment on proposals by Ontario Power Generation (“OPG”) for the continued operation of Pickering NGS and the refurbishment of Darlington NGS.

Continued Operation of Pickering NGS

OPG has provided the Ontario Power Authority (“the OPA”) with the following information regarding their proposal for the continued operation of Pickering NGS:

- Two of the four generating units that are currently in operation at the Pickering B Nuclear Generation Station (“Pickering NGS”) are assumed to have a nominal end of life of 2014, and the remaining two units at that station are assumed to have a nominal end of life of 2016. In addition, OPG is not planning on operating the Pickering A units once there are less than two operating units at Pickering B. A work program is currently underway to establish the feasibility of extending the nominal life of the Pickering B units by four years. If determined to be feasible, it would enable the operation of two of the six generating units to be extended through the years from 2014 to 2018 and the operation of the remaining four generating units to be extended through the years from 2018 to 2020. The results of this work program are expected to be known in late 2012.
- To preserve the option of continued operation beginning in 2015, it will be necessary for OPG to incur \$105 million in additional OM&A costs from 2010 to 2012 when the feasibility of continued operation is expected to be known. In addition, it will be necessary to increase the amount of time the generating units are undergoing planned outages during the period prior to 2015 in order to perform the necessary preparatory work. Details are outlined in the attached summary provided by OPG.

- Based on the information provided by OPG, the OPA has assessed that the continued operation of Pickering NGS will provide electricity at a price of approximately \$50 per MWh.

The OPA believes that substantial system benefits could potentially arise from the continued operation of Pickering NGS during the period from 2014 to 2020. During this period, generating units at Darlington NGS and possibly at Bruce B NGS are expected to be out of service for refurbishment, and gas-fired generation will therefore be on the margin for many hours. Generation from Pickering NGS will replace generation from gas-fired resources or similarly-priced imports, and will result in lower overall system costs and emissions.

For example:

The incremental energy produced by Pickering NGS during the period 2014 – 2020 as the result of continued operation is forecast to be 104 TWh at a total incremental cost of 5.4 B\$. This represents a unit cost of about 51 \$/MWh (see attached information provided by OPG).

For gas prices in the range of 6 \$/MMBtu to 8 \$/MMBtu and an assumed carbon price of 20 \$/ton, the variable operating cost for typical gas-fired generation with a typical heat rate of 7,000 MBtu/MWh would be in the range of 52 \$/MWh to 66 \$/MWh, which is up to 15 \$/MWh higher than the cost of Pickering NGS energy.

Depending on the amount of gas-fired generation or similarly-priced imports replaced by Pickering NGS generation, the overall system benefit could be up to 1.6 B\$ (104 TWh multiplied by 15 \$/MWh) due to the reduction of system costs.

Although the above example illustrates the potential for substantial system benefits, there could be some conditions under which system benefits are substantially reduced or become negative. These include lower than expected system demands, lower than expected gas or carbon prices, or higher than expected continued operation costs.

Based on the potential for substantial system benefits, the OPA supports a decision by OPG to proceed with an initial expenditure of funds in the period 2010 – 2012 to assess the feasibility of continued operation of Pickering NGS, and to maintain the option for continued operation should it prove to be feasible. System benefits should be re-assessed before committing additional funds required beyond 2012.

If required, the OPA is prepared to provide more details on its assessment of integrated power system impacts of Pickering continued operation at a later date.

Refurbishment of Darlington NGS

The Integrated Power System Plan (“IPSP”) filed with the Ontario Energy Board in August, 2007 outlines reasons why nuclear refurbishment is an attractive option. At Exhibit D, Tab 6, Schedule 1, Page 20, it states the following:

Subject to economic viability, refurbishment is an attractive option for the following reasons:

- *Compared to the new nuclear build option, refurbishment provides a shorter lead-time advantage as a result of unit refurbishment outages...;*

- *Refurbishment utilizes existing generation infrastructure, sites and transmission infrastructure thereby minimizing the associated environmental footprint;*
- *Local and surrounding community support for the continued operation of the Pickering, Bruce and Darlington generating stations is strong; and*
- *Experience from past and current refurbishment projects, both domestically and internationally, is leveraged on an on-going basis. This could result in improved project cost and schedules.*

With respect to Darlington NGS:

1. OPA re-affirms the position outlined in the IPSP evidence as applied to the refurbishment of Darlington NGS.
2. OPG has expressed a high degree of confidence that the project will have a Levelized Unit Energy Cost (LUEC) of between 6 and 8 cents per kilowatt-hour (2009\$). If this proves to be the case, refurbishment of Darlington would be an economic alternative in comparison to the cost of other baseload resources.

For example:

The comparable LUEC of combined cycle gas turbines (“CCGTs”) would be in the range from 10 to 15 cents per kilowatt-hour based on the following assumptions:

- *a nominal overnight capital cost of 1,000 \$/kw*
- *a service life of 20 years*
- *an annual capacity factor of 87%,*
- *an average gas price of 8 \$/MMBtu, and*
- *average carbon prices ranging from 50 \$/ton to 200 \$/ton (a more appropriate assumption for the period 2020 to 2050.)*

Above dollar amounts are in 2009 constant dollars.

Other types of baseload resources such as new nuclear or renewable sources are also expected to have higher costs than Darlington refurbishment.

3. The OPA understands that the Darlington Refurbishment project will be subject to stringent project management controls which will require that certain milestones be achieved before proceeding to a subsequent phase and before authorizing the expenditure of funds associated with activities in that phase.

The OPA therefore supports the refurbishment of Darlington NGS based on expected electricity costs in the range of 6 to 8 cents per kilowatt-hour.



Amir Shalaby
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Ontario Power Authority

