REFURBISHMENT AND NEW GENERATION – NUCLEAR

1.0 PURPOSE

The purpose of this evidence is to present an overview description of the nuclear plant refurbishment projects and new nuclear generation development projects (new nuclear build) for the historical and bridge years and test period.

2.0 PROJECT OVERVIEW

Based on current inspection and maintenance plans, Pickering B units are expected to reach the end of their production life over 2014 - 2016 while Darlington units are predicted to come to the end of their production life over 2018 - 2020. Collectively, this represents 5600 MW of electricity generation in the province of Ontario and approximately 25 percent of OPG's installed generating capacity. Similar timelines for potential refurbishments are facing other Canadian Deuterium Uranium ("CANDU") reactors in Canada, as well as other nuclear generators in North America.

Nuclear unit production life is primarily determined by life-limiting components, the replacement or refurbishment of which would require a multi-year outage. Specifically, these components are the fuel channels, steam generators and feeders at Pickering B, and fuel channels and feeders at Darlington. The production life of other station components can be extended through ongoing maintenance or less extensive replacement activities, which would be integrated with normal outage schedules or, if more efficient, be carried out as part of the major outage duration driven by refurbishment of life-limiting components.

Given the long lead times to procure critical components and the need to properly plan and prepare for execution of such major projects, OPG began exploratory work in 2005 to evaluate the feasibility of refurbishing and continuing to operate the Pickering B and Darlington units beyond their currently expected production lives.

In June 2006, the Ontario government directed OPG to begin feasibility studies on refurbishing its existing nuclear plants, and to begin an environmental assessment ("EA") on

refurbishing Pickering B's four nuclear units. In the same directive, OPG was directed by the Ontario government to begin a federal approvals process, including preparation of an EA, for building new nuclear generating units at an existing site. Refurbishment and new nuclear build accountabilities were assigned to the newly-formed Nuclear Generation Development and Services Division.

The need for refurbishment and new build is also being addressed in the Ontario Power Authority's Integrated Power System Plan ("IPSP"). In that context, the Ontario Power Authority, in response to a Directive from Ontario's Minister of Energy, is planning for up to 14,000 MW of nuclear generation to meet Ontario's requirement for base load energy. The IPSP recognizes that refurbishment decisions rest with facility operators and owner (see EB-2007-0707, exhibit D-6-1 page 20 - 21). However, the IPSP "reference plan" and all scenarios analyzed include substantial nuclear refurbishment (EB-2007-0707, exhibit G-1-1 page 2). In addition, given that the lead times associated with a new nuclear unit (EA process and approvals, combined with construction and commissioning of a new nuclear unit) range from nine to twelve years, the IPSP Supply Discussion Paper supports activities to expeditiously proceed with the development of new nuclear units (see EB-2007-0707, exhibit C-8-1 page 76).

2.1 Refurbishment

The goal of a major nuclear unit refurbishment is extension of production life to provide an additional 25 to 30 years of generation following completion of refurbishment. A major nuclear unit refurbishment project would involve a multi-year outage for replacement of life-limiting critical components as noted above, as well as maintenance/replacement of other components which are most cost-effectively done during the extended outage period. Such refurbishment could be carried out as part of a full station outage, or on a unit by unit basis with other nuclear units continuing to operate.

OPG envisages a major refurbishment project being managed in three phases, specifically:

- Phase 1: Assessment and viability recommendation
- Phase 2: Outage planning and preparation

- Phase 3: Refurbishment outage execution

Phase 1 of a refurbishment project is typically funded by base OM&A. Phases 2 and 3, if approved, would typically be funded as capital projects.

Phase 1 is an assessment phase, aimed at determining feasibility and financial viability of the refurbishment options. This involves:

- Engineering studies, including a plant condition assessment to assess the condition of the plant, with special focus on the life-limiting components. Studies would be conducted to assess the condition of all major station systems and components. In addition, the logistics/methods/timing for carrying out refurbishment on a multi-unit station would be assessed.
- An EA as required by the *Canadian Environmental Assessment Act*. Identified issues or deficiencies would be assessed for inclusion in the refurbishment project scope.
- An integrated safety review ("ISR") to address key safety factors against modern safety standards. The basis for this study is discussed with the Canadian Nuclear Safety Commission ("CNSC"), and the results used in the preparation of the integrated implementation plan. Identified issues would be assessed for inclusion in the refurbishment project scope.
- An integrated implementation plan that incorporates results of the ISR and EA. The integrated implementation plan requires CNSC acceptance for incorporation into the operating licence.
- Concept studies for replacement of critical life-limiting components (i.e., feeders and fuel channels and for Pickering B, steam generators).
- Generation and assessment of a variety of refurbishment and non-refurbishment scenarios based on the results of the plant condition assessment, ISR, EA, and integrated implementation plan.
- A phase 2 and 3 project schedule and resourced cost estimate, and a recommendation for the Board of Directors consideration, based on an assessment of the business case of all alternatives.

Should the OPG Board decide to proceed with refurbishment of Pickering B, phase 2 of the project is the planning and preparation phase, which involves:

- Project management staff hiring and training, and decision on internal versus external project management.
- Letting of contracts for long lead materials such as steam generator components and fuel channel replacement tooling.
- Procurement of other required material.
- Completion of detailed engineering.
- Site preparation.
- A project schedule and resourced cost estimate for the refurbishment outage execution, to support request for phase 3 approval by the Board of Directors.
- Selection of direct work contractors to execute the major component replacement packages (fuel channels and feeders, steam generators).

Phase 3 of a major refurbishment project is the execution and close-out phase, completing all planned aspects of refurbishment, as well as associated re-commissioning (as required), obtaining licensing approvals and all other activities to return the units to production.

2.1.1 Pickering B Refurbishment

Pickering B Units 5, 6, and 7 are expected to reach end of their production lives in 2014. Phase 1 work is well underway. A recommendation with respect to Pickering B refurbishment options is expected to be provided to the Board of Directors no later than early 2009. The decision with respect to the Pickering B refurbishment option was delayed to allow OPG to assess the results of the environmental assessment and integrated safety review processes currently under way.

Work that is underway is as follows:

- A plant condition assessment was completed in July 2007, the results of which are being incorporated into the ISR referenced below. The plant condition assessment included a review of approximately 60 major systems and their components, across the station, to ensure that requirements for inspections, repairs, replacement and/or modification are

appropriately incorporated into the refurbishment outage or station work programs before and after the refurbishment outage.

- As of August 2007, OPG has assessed all twelve safety factors against modern standards, and has prepared and submitted eleven of the required twelve safety factors reports to the CNSC for approval. The one remaining safety factor report is in the process of being completed and is expected to be submitted in Q2 2008.
- A draft EA report was submitted to the CNSC in June 2007. Preliminary findings are that there are no significant adverse effects, and the majority of the potential effects from a refurbishment project are similar to those of the Pickering A return to service project. Following review by the CNSC and other federal authorities, a final EA study report was submitted to the CNSC in December, 2007. During 2008, the CNSC staff will prepare an environmental screening report for public review and presentation to the Commission for their approval.
- The integrated implementation plan is a compilation of the activities which will be undertaken to address findings of the ISR and EA processes and, as such, cannot be finalized until the EA and ISR are completed. The integrated implementation plan is currently expected to be filed by early 2009, for approval with the CNSC.
- Public Consultations: OPG has conducted stakeholder workshops, held three rounds of open houses across Durham Region and in Toronto, participated in numerous community events and mailed out newsletters and open house invitation cards to approximately 150,000 homes in order to seek public input on the potential refurbishment project.

Phase 1 costs are outlined in Chart 1.

Chart 1

Pickering B Refurbishment Costs, 2005 - 2009, Base and Project OM&A

OM&A Cash Flows (M$)	Category		2005	2006	2007	2008	2009
Refurbishment – Phase 1	Base OM&A	Actual	1.3	11.3	23.3		
		Budget	3.0	8.9	22.0	6.2	
Planned Projects on Hold[1]	Project OM&A	Actual					
		Budget					5.1

[1] In Charts 1 and 2, planned projects on hold reflects previously-identified projects that were put on hold pending a refurbishment decision. Following the OPG Board decision on a refurbishment option, the associated projects would be taken off hold and re-assessed as appropriate based on the OPG Board's decision.

This filing also includes, very preliminary phase 2 (capital) costs associated with undertaking a major refurbishment project. These are presented in Chart 2, and will be confirmed and revised as necessary as part of the phase 1 work.

Chart 2

Pickering B Refurbishment Costs, 2005 - 2011, Capital Projects

Capital Cash Flows (M$)	Category		2005	2006	2007	2008	2009
Refurbishment - Phase 2	Project Capital	Actual					
		Budget	0	0	0	0	126.1
Planned Projects on Hold	Project Capital	Actual					
		Budget	0	0	0	0	22.7

Refurbishment - Phase 2 cost estimates for 2008/2009 in Chart 2 are associated with first unit refurbishment (expected to commence around 2013, if approved), and will be primarily directed to issuing contracts for long-lead items (primarily associated with steam generators, fuel channel tooling) and issuing a contract for a project management partner (should the external project management option be selected).

Base OM&A, project OM&A and project capital budgets as noted in Chart 1 and 2, have been approved by the OPG Board. In this regard, section 6 (2) 4 of O. Reg. 53/05 specifically contemplates recovery of costs for refurbishment activities. A description of the associated deferral account and confirmation of OPG's compliance with the conditions is discussed in Ex. J1-T1-S1, and is applicable to both Pickering B and Darlington refurbishment activities.

2.1.2 Darlington Refurbishment

As the first Darlington unit is expected to reach end of production in 2018 which is later than Pickering B. Phase 1 Darlington refurbishment work is scheduled to start in 2008, with an expected Board of Directors decision on refurbishment options in 2010.

In 2008 and 2009, Darlington Phase 1 work will include a screening level economic assessment (providing a very preliminary assessment of refurbishment option viability),

subsequent commencement of engineering studies including a plant condition assessment, an Integrated Safety Review, and a public communications and consultation program.

Major activities associated with an EA for Darlington refurbishment are currently scheduled to occur after the test period following the completion of environmental assessment work for new nuclear build, although expenditures for EA work will be incurred in 2008/2009 for preparatory activities and some preliminary data collection.

Phase 1 costs are outlined in Chart 3 below.

Chart 3

Darlington Refurbishment Costs, 2005 - 2009

OM&A Cash Flows (M$)	Category		2005	2006	2007	2008	2009
Refurbishment – Phase 1	Base OM&A	Actual			0.4		
		Budget			0.7	18.5	22.7

As the Board of Directors decision on refurbishment options for Darlington is not anticipated until 2010**,** there are no phase 2 (capital) costs for Darlington in this filing.

Base OM&A budgets as presented in Chart 3 were approved by the Board of Directors as part of the business planning process. Recovery of costs is discussed above (section 2.1.1).

2.2 New Nuclear Build

The planning for new nuclear units is a complex and significant undertaking. Substantial work must be done in support of:

- Evaluating possible technologies and selecting a preferred alternative.
- Defining the overall project scope and execution strategy.
- Obtaining necessary regulatory approvals.
- Developing and executing a procurement strategy for the chosen technology, and the vast amount of supporting materials and equipment.

- Consulting with the public on the potential impacts of new nuclear construction and operations, and maintaining an informed local community throughout the planning process.
- Preparing the site for construction and arranging for infrastructure necessary to support the station.
- Constructing and commissioning the generating unit and supporting systems.
- Recruiting and training staff operate the station.

The upfront work includes extensive effort related to:

- Activities for carrying out an EA under the *Canadian Environmental Assessment Act*.
- Activities for obtaining required governmental licences, authorizations, permits or other approvals.
- Activities for evaluating the available nuclear plant technology options in support of selecting the technology to be deployed in Ontario.
- Activities supporting project definition and the eventual procurement of the plant and/or related components.

The Ontario Power Authority, through the IPSP has indicated its planning assumptions with respect to the amount and required timing of new nuclear generation. The IPSP recognizes the potential for up to four new nuclear generating units and up to 4,800 MW being developed (EB-2007-0707, exhibit D-6-1 page 17 - 18) with potential in-service dates starting as early as 2018 for a first unit.

In response to the June 2006 directive, OPG began planning the work required to obtain the necessary federal approvals, including planning for preparation of the EA. In addition, OPG initiated the review of available reactor designs in 2007 (collaboratively with Bruce Power), and completed the review in December 2007. As noted in Chart 4, there were only nominal expenditures in the historic years ($0.3M in 2006), associated with: retaining staff and consulting support for the new nuclear project; submission of site preparation licence application (September 2006), and initial public consultation and communication sessions (November 2006).

A preliminary base OM&A budget of $10M per year was established in the 2007 – 2011 business plan for new nuclear build activities in the Nuclear Generation Development and Services Division, and approved by the Board of Directors as part of the business planning process. Work undertaken in 2007 included:

- EA Activities
    - Submission of a project description to the CNSC, in support of establishing EA guidelines
    - Commencement of baseline studies and data collection in support of the EA
    - Development and implementation of a public consultation and community communications program
- Governmental licence, permit and authorization activities
    - Commencement of site preparation planning studies
- Technological assessment activities
    - Assessment of the nuclear technology options for possible deployment at the Darlington site

The funding requirements and key deliverables were reviewed and further refined in the 2008 - 2010 business plan. Some of the drivers for revising the work schedule and cost estimates were the federal approvals process, available technology, and experience in other countries that are also engaged in development of new nuclear power generation. In 2008 and 2009, the following major work activities are expected to be undertaken:

- Completion of the environmental assessment baseline study (2008)
- Preparation of draft environmental assessment guidelines and terms of reference (2008)
- Preparation of final environmental assessment guidelines and terms of reference (2009)
- Site evaluation completion (2008)
- Preliminary construction application submission (2009)

- Final site preparation license application submission (2009)
- Various procurement and planning activities, such as vendor assessment and selection

Chart 4 below, provides the actual costs for 2006 and 2007 along with cost estimates resulting from the 2008 - 2010 business planning process:

Chart 4

Pre-development New Nuclear Build Costs, Base OM&A (2008-2010 Business Plan)

OM&A Budget (M$)		2005	2006	2007	2008	2009
New Nuclear Build	Actual		0.3	11.2		
	Budget			10.0	75.3	67.2

Base OM&A costs as noted in Chart 4 has been approved by the OPG Board. In this regard, O. Reg. 53/05, as recently amended, specifically contemplates recovery of costs incurred and firm commitments made in the course of planning and preparation for the development of new nuclear generation facilities. A description of the associated deferral and variance account and confirmation of OPG's compliance with the conditions is discussed in Ex. J1-T1-S1, and is applicable to the new nuclear build activities.

3.0 EXPENDITURE SUMMARY

Chart 5 below, sets out actual (2005 - 2006) and forecast (2007 - 2009) base OM&A, project OM&A, and capital expenditures on the Pickering B refurbishment, Darlington refurbishment, and new nuclear build initiatives.

Chart 5

Program Cost Summary

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Line No.	Program ($M)	Cost Category	2005 Budget	2005 Actual	2006 Budget	2006 Actual	2007 Budget	2007 Actual	2008 Plan	2009 Plan
			(a)	(b)	(c)	(d)	(e)		(f)	(g)
1	**Base OM&A**	Pickering B Refurb	3.0	1.3	8.9	11.3	22.0	23.3	6.2	0.0
2		Darlington Refurb	0.0	0.0	0.0	0.0	0.7	0.4	18.5	22.7
3		New Nuclear Build	0.0	0.0	0.0	0.3	10.0	11.2	75.3	67.2
4		**Total Base OM&A**	**3.0**	**1.3**	**8.9**	**11.6**	**32.7**	**35.0**	**100.0**	**89.9**
5	**Project OM&A**	Pickering B Refurb	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**5.1**
6	**Project Capital**	Pickering B Refurb	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**148.8**