

ONTARIO POWER GENERATION

1675 Montgomery Park Road, P.O. Box 160, Pickering, Ontario L1V 2R5

August 28, 2017

CD# P-CORR-00531-05055

MR. M. A. LEBLANC
Commission Secretary

Canadian Nuclear Safety Commission
280 Slater Street
Ottawa, Ontario
K1P 5S9

Dear Mr. Leblanc:

Application for Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence

The purpose of this letter is to submit the licence renewal application for the Pickering Nuclear Generating Station (NGS) Power Reactor Operating Licence, PROL 48.03/2018, which expires on August 31, 2018.

Ontario Power Generation (OPG) Incorporated is a Canadian corporation located at 700 University Avenue, Toronto, Ontario, M5G 1X6.

OPG requests a ten-year licence renewal, from September 1, 2018 to August 31, 2028. The Pickering facility consists of eight nuclear reactors and their associated equipment, which were designed to produce electrical power. Six of the units are operational (Units 1 and 4 and Units 5-8) and two units (Units 2 and 3) have been placed in a safe storage state.

OPG also requests Commission approval to operate beyond the current Commission approved limit of 247,000 Effective Full Power Hours (EFPH) on the Pickering 5-8 fuel channels, up to 295,000 EFPH for the lead Pickering unit which corresponds approximately to the intended end of commercial operation (December 31, 2024).

The management and control of operation of the Pickering facility and the nuclear substances, prescribed equipment, and associated prescribed information, are the overall responsibility of Mr. Randy Lockwood, Senior Vice-President of the Pickering NGS.

This licence renewal application demonstrates that Ontario Power Generation is qualified to operate the Pickering NGS and will make adequate provision for the protection of the environment, the health and safety of persons, and the maintenance



of national security and measures required to implement international obligations to which Canada has agreed.

Attachment 1 is included for convenience, to assist in locating specific information within the application corresponding to the requirements of the Nuclear Safety and Control Act and applicable regulations as well as other information that was requested in Reference 1.

Attachment 2 describes, for the 14 CNSC Safety and Control Areas (SCAs), OPG's programs, station performance during the current licence period and planned improvements. The information that is included with this application is in accordance with the requirements of the Nuclear Safety and Control Act and applicable Regulations and further requirements as provided by the CNSC in Reference 1.

This application also provides information to support the Environmental Assessment (EA) under the Nuclear Safety and Control Act (NSCA) that will be conducted by CNSC staff.

Enclosure 1 fulfils the requirements of Section 3(e) of the Class I Nuclear Facilities Regulations by providing information on non-radiological hazardous substances at the nuclear facility.

As communicated in Reference 2, OPG intends to cease commercial operation of all Pickering units on December 31, 2024. Also, note that this licence renewal application encompasses three phases of operational activities over the proposed licence term: continued commercial operation, a stabilization phase (post-shutdown defueling and dewatering), and the early period of a safe storage phase.

OPG's responses to the preliminary list of new CNSC regulatory documents and CSA standards for inclusion in the Pickering LCH under Compliance Verification Criteria (CVC) listed in Attachment 2 of Reference 1, was submitted in Reference 3.

In support of this licence renewal, OPG is undertaking a Periodic Safety Review (PSR) per the requirements of regulatory document RegDoc-2.3.3, "Periodic Safety Reviews". PSR deliverables are being submitted to CNSC staff per the mutually agreed upon schedule outlined in Reference 4.

In summary, OPG is requesting approval from the Canadian Nuclear Safety Commission for a licence renewal for a ten-year term, from September 1, 2018 to August 31, 2028, and approval for operation beyond the current operating limit of 247,000 EFPH up to 295,000 EFPH for the lead Pickering unit which corresponds approximately to the intended end of commercial operation (December 31, 2024).

The information provided within this licence application supports these requests and demonstrates that OPG is qualified to carry on the licensed activities and makes adequate provisions to protect the health, safety and security of persons, and the environment. OPG is committed to safe and reliable operation of the Pickering NGS and continues to meet or exceed all of the legal requirements of the NSCA and the associated regulations.

Consistent with OPG's approach towards open and transparent public communications, OPG will be posting this application on its external web-site www.opg.com.

If you have any questions, please contact Dr. Jack Vecchiarelli, Manager Pickering Relicensing, at (905) 839-6746 extension 5444.



Randy Lockwood
Senior Vice President
Pickering Nuclear

cc: A. Viktorov - CNSC Ottawa
CNSC Site Office - Pickering

References:

1. CNSC letter, A. Viktorov to B. McGee, "Application Requirements for Renewal of the Pickering Power Reactor Operating Licence" September 8, 2016, e-Doc #5034082, CD# P-CORR-00531-04833.
2. OPG Letter, R. Lockwood to G. Frappier, "End Date of Commercial Operations for Pickering NGS", June 28, 2017, CD# P-CORR-00531-04930.
3. OPG Letter, R. Lockwood to A. Viktorov, "Pickering Licence Renewal: Regulatory Documents and Standards Proposed for Inclusion in the Licence Conditions Handbook", August 11, 2017, CD# P-CORR-00531-05087.
4. Protocol, "OPG-CNSC Protocol for the Conduct of a Periodic Safety Review in Support of Pickering NGS Licence Renewal", January 17, 2017, e-Doc 5143721, CD# P-CORR-00531-04725 R001.

Attachments:

1. "Licence Renewal Application Matrix"
2. "Pickering Nuclear Generating Station Power Reactor Licence Application"

Enclosure:

1. OPG Report, "Pickering NGS Hazardous Substances", July 28, 2017,
CD# P-REP-08965-0633695 R001

Attachment 1 to OPG Letter, R. Lockwood to M. Leblanc, "Application for Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence", CD# P-CORR-00531-05055.

Attachment 1

Licence Renewal Application Matrix

(15 pages including this coversheet)

Table 1: Licence Application Matrix – Applicable Regulations

NOTE: Unless otherwise specified, all sections cross-referenced below refer to Attachment 2.

General Nuclear Safety and Control Regulations	
Requirement(s)	Application Cross-Ref.
3. (1) An application for a licence shall contain the following information:	
(a) the applicant's name and business address;	Cover Letter
(b) the activity to be licensed and its purpose;	Appendix A
(c) the name, maximum quantity and form of any nuclear substance to be encompassed by the licence;	Appendix A
(d) a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence;	1.2
(e) the proposed measures to ensure compliance with the <i>Radiation Protection Regulations</i> and the <i>Nuclear Security Regulations</i> ;	2.7 & 2.12
(f) any proposed action level for the purpose of section 6 of the <i>Radiation Protection Regulations</i> ;	2.7.5
(g) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;	2.12
(h) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information;	2.12 & 2.13
(i) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;	1.2, 2.4.2
(j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;	2.11, Appendix A, & Enclosure 1
(k) the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the <i>Act</i> and the regulations made under the <i>Act</i> , including the internal allocation of functions, responsibilities and authority;	2.1.2
(l) a description of any proposed financial guarantee relating to the activity to be licensed;	Appendix B
(m) any other information required by the <i>Act</i> or the regulations made under the <i>Act</i> for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence; and	Throughout

General Nuclear Safety and Control Regulations (cont)	
Requirement(s)	Application Cross-Ref.
<p>(1.1) The Commission or a designated officer authorized under paragraph 37(2)(c) of the <i>Act</i>, may require any other information that is necessary to enable the Commission or the designated officer to determine whether the applicant:</p> <p>(a) is qualified to carry on the activity to be licensed, or</p>	See Tables 2 & 3 in this Attachment 1
<p>(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.</p>	2.8, 2.9, 2.10, 2.12 & 2.13
<p>5. An application for the renewal of a licence shall contain</p> <p>(a) the information required to be contained in an application for that licence by the applicable regulations made under the <i>Act</i> (<i>i.e. in this case: General Nuclear Safety and Control Regulations section 3, Class I Nuclear Facilities Regulations sections 3 and 6, and Nuclear Security Regulations section 3</i>); and</p>	Throughout
<p>(b) a statement identifying the changes in the information that was previously submitted.</p>	Letter
<p>15. Every applicant for a licence and every licensee shall notify the Commission of</p> <p>(a) the persons who have authority to act for them in their dealings with the Commission;</p>	2.1.13
<p>(b) the names and position titles of the persons who are responsible for the management and control of the licensed activity and the nuclear substance, nuclear facility, prescribed equipment or prescribed information encompassed by the licence; and</p>	Letter and 2.1.13
<p>(c) any change in the information referred to in paragraphs (a) and (b), within 15 days after the change occurs.</p>	2.1.13

Class I Nuclear Facilities Regulations	
Requirement(s)	Application Cross-Ref.
<p>3. An application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the following information in addition to the information required by section 3 of the <i>General Nuclear Safety and Control Regulations</i>:</p> <p>(a) a description of the site of the activity to be licensed, including the location of any exclusion zone and any structures within that zone;</p>	1.2 & Appendix A
(b) plans showing the location, perimeter, areas, structures and systems of the nuclear facility;	1.2
(c) evidence that the applicant is the owner of the site or has authority from the owner of the site to carry on the activity to be licensed;	1.2
(d) the proposed quality assurance program for the activity to be licensed;	2.1
(e) the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on;	Enclosure 1
(f) the proposed worker health and safety policies and procedures;	2.7 & 2.8
(g) the proposed environmental protection policies and procedures;	2.9
(h) the proposed effluent and environmental monitoring programs;	2.9
(i) if the application is in respect of a nuclear facility referred to in paragraph 2(b) of the <i>Nuclear Security Regulations</i> , the information required by section 3 of those Regulations;	2.12
(j) the proposed program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment and the health and safety of persons that may result from the activity to be licensed; and	3.0
(k) the proposed plan for the decommissioning of the nuclear facility or of the site.	2.11.4
<p>6. An application for a licence to operate a Class I nuclear facility shall contain the following information in addition to the information required by section 3:</p> <p>(a) a description of the structures at the nuclear facility, including their design and their design operating conditions;</p>	1.2, 2.3.9, 2.4.1 & 2.4.2
(b) a description of the systems and equipment at the nuclear facility, including their design and their design operating conditions;	1.2, 2.3.9, 2.4.1 & 2.4.2

Class I Nuclear Facilities Regulations (cont)	
Requirement(s)	Application Cross-Ref.
(c) a final safety analysis report demonstrating the adequacy of the design of the nuclear facility;	2.4.2
(d) the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility;	Throughout
(e) the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances;	2.9, 2.11, 2.14 & 2.4.7
(f) the proposed measures to facilitate Canada's compliance with any applicable safeguards agreement;	2.13
(g) the proposed commissioning program for the systems and equipment that will be used at the nuclear facility;	2.5.2
(h) the effects on the environment and the health and safety of persons that may result from the operation and decommissioning of the nuclear facility, and the measures that will be taken to prevent or mitigate those effects;	1.7, 1.8, 2.7, 2.8, 2.9 & 2.11
(i) the proposed location of points of release, the proposed maximum quantities and concentrations, and the anticipated volume and flow rate of releases of nuclear substances and hazardous substances into the environment, including their physical, chemical and radiological characteristics;	2.9
(j) the proposed measures to control releases of nuclear substances and hazardous substances into the environment;	2.9
(k) the proposed measures to prevent or mitigate the effects of accidental releases of nuclear substances and hazardous substances on the environment, the health and safety of persons and the maintenance of security, including measures to	2.10 & 2.12
(i) assist off-site authorities in planning and preparing to limit the effects of an accidental release,	
(ii) notify off-site authorities of an accidental release or the imminence of an accidental release,	2.10.2
(iii) report information to off-site authorities during and after an accidental release,	2.10.2
(iv) assist off-site authorities in dealing with the effects of an accidental release, and	2.10.2 & 2.12.3
(v) test the implementation of the measures to prevent or mitigate the effects of an accidental release;	2.10.2 & 2.12.2
(l) the proposed measures to prevent acts of sabotage or attempted sabotage at the nuclear facility, including measures to alert the licensee to such acts;	2.12.1
(m) the proposed responsibilities of and qualification requirements and training program for workers, including the procedures for the requalification of workers; and	2.2.2, 2.2.3, & 2.2.4
(n) the results that have been achieved in implementing the program for recruiting, training and qualifying workers in respect of the operation and maintenance of the nuclear facility.	2.1.2, 2.1.3, 2.2.1, 2.2.2 & 2.2.3

Nuclear Security Regulations	
Requirement(s)	Application Cross-Ref.
<p>3. An application for a licence in respect of Category I or II nuclear material, other than a licence to transport, and an application for a licence in respect of a nuclear facility referred to in paragraph 2(b) shall contain the following information in addition to the information required by section 3 of the <i>Nuclear Substances and Radiation Devices Regulations</i> or sections 3 to 8 of the <i>Class I Nuclear Facilities Regulations</i>, as applicable:</p> <p>(a) a copy of the written protection arrangements made with a response force, referred to in section 35;</p>	2.12.3
(b) the site plan referred to in section 16;	1.2
(c) a description of the proposed security equipment, systems and procedures;	2.12.1
(d) a description of the proposed on-site and off-site communications equipment, systems and procedures;	2.12
(e) a description of the proposed structure and organization of the nuclear security guard service, including the duties, responsibilities and training of nuclear security guards; and	2.12.1
(f) the proposed plan and procedures to assess and respond to breaches of security.	2.12.1
(g) the current threat and risk assessment.	2.12.1

Table 2: Licence Application Matrix - Additional Information Requested by the CNSC

No.	Item	Application Cross-Ref.
1	Environmental Assessment	1.7, 1.8, 2.9.9 & 2.9.10
2	Cost Recovery	Appendix B
3	Financial Guarantees	Appendix B
4	Improvement Plans and Significant Future Activities	Throughout
5	Licensee Public Information program	3.0
6	Nuclear Liability Insurance	Appendix B
7	Aboriginal Consultation	3.2
8	Summary of OPG programs organized by SCA	See Table 3 of this Attachment 1
9	Documents describing the organizational structure	2.1.2
10	Information on the station performance	1.3
11	Current status of all open Action Items	Appendix D
12	Current status of all open CANDU Safety Issues	Appendix F
13	Current status of all open issues that were discussed during the last Pickering licence renewal	Throughout
14	Current status of all of the reassessment of the FAIs previously closed based on Pickering end of commercial operation of 2020	Appendix E.9

No.	Item	Application Cross-Ref.
15	Proposed operating strategy for Pickering including major challenges and initiatives for the next licensing period	1.1, 1.4, 1.5, 1.6 & Appendix E
16	Results of the Periodic Safety Review (PSR)	Appendix E
17	Effective dates for implementation of the CNSC regulatory documents and CSA standards	Letter (in Reference 4)
18	Information on the end of commercial operation of the facility, including the final shutdown date of each unit.	Letter (in Reference 2)
19	Decommissioning strategy for Pickering NGS, including the applicable decommissioning plans.	2.11.4
20	A plan describing the management of the impact on the organization, human performance, and fitness for service while approaching the shutdown of such units, with the expectation that the plan be implemented 3 years prior to the actual date of shutdown of any unit.	1.6.1
21	A plan describing the preparation for and implementation of the stabilization activities that will be conducted to ensure the safe transition of such units from permanent shutdown to the eventual safe storage state, including information on managing the configuration of Pickering NGS as well as the tasks and processes to implement such configuration.	1.6.2
22	Reference to any regulations by other authorities besides the CNSC, as well as any permits, certificates or licences that have been issued.	Appendix C
23	Description of any other activity to be authorized under the operating licence and the purpose of that activity.	Appendix A
24	Information regarding the receipt, handling and transfer, to an off-site commercial facility, of Cobalt-60 produced at Pickering B, as well as the receipt of spent Cobalt-60 from an off-site facility and storage in the Auxiliary Irradiation Fuel bay at Pickering A.	4.0

Table 3: Licence Application Matrix - SCA Specific Areas

Management System SCA	
Specific Areas Addressed in Application	Section(s)
Management System	2.1.1
Organization	2.1.2 & 2.1.3
Performance Assessment, Improvement And Management Review	2.1.6
Operating Experience (OPEX)	2.1.7
Change Management	2.3.2 & 2.5.2
Safety Culture	2.1.5
Configuration Management	2.1.8
Records Management	2.1.10
Management of Contractors	2.1.4
Business Continuity	2.1.12
Applicable OPG Programs	Section(s)
Nuclear Management System	2.1.1
Nuclear Safety Policy	2.1.1
Managed Systems	2.1.1
Records and Document Control	2.1.10
Business Planning	2.1.11
Nuclear Organization	2.1.2
Organizational Change Control	2.1.2
Contractor Management	2.1.4
Materials Management	2.1.9
Nuclear Safety Oversight	2.1.5
Independent Assessment	2.1.6
Nuclear Safety Culture Assessment	2.1.5

Human Performance Management SCA	
Specific Areas Addressed in Application	Section(s)
Human Performance Programs	2.2.1
Personnel Training	2.2.2
Initial certification examinations and requalification tests	2.2.4
Work organization and job design	2.2.5
Fitness for Duty	2.2.6
Applicable OPG Programs	Section(s)
Human Performance	2.2.1
Technical Procedures	2.3.4
Continuous Behaviour Observation Program	2.2.6
Limits of Hours of Work	2.2.6
Minimum Shift Complement Training	2.2.5
Leadership and Management Training	2.2.2

Operating Performance SCA	
Specific Areas Addressed in Application	Section(s)
Conduct of licensed activity	2.3.1
Procedures	2.3.4
Reporting and trending	2.3.10 & 2.3.11
Outage management performance	2.3.7
Safe operating envelope	2.3.9
Severe accident management and recovery	2.4.6
Accident management and recovery	2.4.6
Applicable OPG Programs	Section(s)
Nuclear Operations	2.3.1
OP&Ps	2.3.1
Safe Operating Envelope	2.3.9
OSRs	2.3.9
Plant Status Control	2.3.2
Chemistry	2.6.6
Operating Experience Process	2.1.7
Corrective Action	2.3.10
Reactor Safety Program	2.4.1
Reactivity Management	2.3.5
Heat Sink Management	2.3.8
Response to Transient	2.3.6

Safety Analysis SCA	
Specific Areas Addressed in Application	Section(s)
Deterministic Safety Analysis	2.4.2
Hazard analysis	2.4.4
Probabilistic safety analysis	2.4.4
Criticality safety	2.4.7
Severe accident analysis	2.4.6
Management of safety issues (including R&D programs)	2.4.8
Applicable OPG Programs	Section(s)
Reactor Safety Program	2.4.1
Risk and Reliability Program	2.4.4
Safety Report (all parts)	2.4.2
Analyses of Record	2.4.2

Physical Design SCA	
Specific Areas Addressed in Application	Section(s)
Design governance	2.5.1
Site characterization	1.2 & 2.9.10
Facility design	2.5.1
Structure design	2.5.1
System design	2.5.1
Component design	2.5.1
Applicable OPG Programs	Section(s)
Conduct of Engineering	2.5.1
Engineering Change Control	2.5.2
Procurement Engineering	2.5.3
Design Management	2.5.1
Configuration Management	2.1.8
Fuel	2.5.4
Pressure Boundary Program	2.5.5
Environmental Qualification	2.5.6
Software	2.5.7

Fitness for Service SCA	
Specific Areas Addressed in Application	Section(s)
Equipment fitness for service/equipment performance	2.6.1
Maintenance	2.6.7
Structural integrity	2.6.4
Aging management	2.6.3
Chemistry control	2.6.6
Periodic inspection and testing	2.6.4
Applicable OPG Programs	Section(s)
Conduct of Maintenance	2.6.7
Integrated Aging Management	2.6.3
Production Work Management	2.6.7
Equipment Reliability	2.6.1
Component and Equipment Surveillance	2.6.2
Reliability and Monitoring of Systems Important to Safety	2.4.3
Major Components	2.6.2
Life Cycle Management Plans	2.6.2
Non-Destructive Examination	2.6.5

Radiation Protection SCA	
Specific Areas Addressed in Application	Section(s)
Application of ALARA	2.7.2
Worker dose control	2.7.3
Radiation protection program performance	2.7.1 thru 2.7.4
Radiological hazard control	2.7.4
Estimated dose to public	2.9.5
Applicable OPG Programs	Section(s)
Radiation Protection	2.7.1
Controlling Exposure ALARA	2.7.2
Occupational Action Levels	2.7.5
Dose Limits and Exposure Control	2.7.5

Conventional Health and Safety SCA	
Specific Areas Addressed in Application	Section(s)
Performance	2.8.1
Practices	2.8.1
Awareness	2.8.1
Applicable OPG Programs	Section(s)
Health and Safety Policy	2.8.1
Conventional Safety	2.8.1
Work Protection	2.3.3

Environmental Protection SCA	
Specific Areas Addressed in Application	Section(s)
Effluent and emissions control (releases)	2.9.3 & 2.9.4
Environmental management system (EMS)	2.9.2
Assessment and monitoring	2.9.3
Protection of the public	2.9.3
Environmental risk assessment	1.7 & 1.8
Applicable OPG Programs	Section(s)
Environmental Policy	2.9.1
Environmental Management	2.9.2
Derived Release Limits and Environmental Action levels	2.9.3

Emergency Management and Fire Protection SCA	
Specific Areas Addressed in Application	Section(s)
Conventional emergency preparedness and response	2.10.1
Nuclear emergency preparedness and response	2.10.2
Fire emergency preparedness and response	2.10.1
Applicable OPG Programs	Section(s)
Emergency Management Policy	N/A*
Nuclear Pandemic Plan	2.1.12
Consolidated Nuclear Emergency Plan	2.10.2
Fire Protection	2.10.1

*OPG-POL-006, "Emergency Management Policy" no longer exists and was removed from the Pickering LCH in 2013.

Waste Management SCA	
Specific Areas Addressed in Application	Section(s)
Waste characterization	2.11.1
Waste minimization	2.11.1
Waste management practices	2.11.1
Decommissioning plans	2.11.4
Applicable OPG Programs	Section(s)
Nuclear Waste Management Program	2.11.1
Waste Management	2.11.1
Decommissioning Planning	2.11.4
Preliminary Decommissioning Plan	2.11.4

Security SCA	
Specific Areas Addressed in Application	Section(s)
Facilities and equipment	2.12.1
Response arrangements	2.12.3
Security practices	2.12.1
Drills and exercises	2.12.2
Applicable OPG Programs	Section(s)
Nuclear Security	2.12.1
Pickering NGS Security Report	2.12.1
Cyber Security	2.12.4

Safeguards SCA	
Specific Areas Addressed in Application	Section(s)
Nuclear material accountancy and control	2.13.1
Access and assistance to the IAEA	2.13.1
Operational and design information	2.13.2
Safeguards equipment, containment and surveillance	2.13.3
Import and export	2.13.4
Applicable OPG Programs	Section(s)
Nuclear Safeguards	2.13.1

Attachment 1 (Page 14 of 14) to OPG Letter, R. Lockwood to M. Leblanc, "Application for Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence", CD# P-CORR-00531-05055.

Packaging and Transport SCA	
Specific Areas Addressed in Application	Section(s)
Package design and maintenance	2.14.1
Packaging and transport	2.14
Registration for use	2.14.3
Applicable OPG Programs	Section(s)
Radioactive material Transportation	2.14.2
Transport Security Plan	2.14.4

Attachment 2 to OPG Letter, R. Lockwood to M. Leblanc, "Application for Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence", CD# P-CORR-00531-05055.

Attachment 2

Pickering Nuclear Generating Station Power Reactor Licence Application

(163 pages including this coversheet)

**Pickering Nuclear Generating Station
Power Reactor Operating Licence Application
August 2017**



**Randy Lockwood
Senior Vice President
Pickering**

**ONTARIOPOWER
GENERATION**

This page intentionally left blank.

Executive Summary

The current Pickering Power Reactor Operating Licence (PROL) 48.03/2018 expires on August 31, 2018. OPG is applying for a 10-year licence renewal of the Pickering¹ Nuclear Generating Station (NGS) to include continued commercial operation of all reactor units until the end of 2024 as well as post-shutdown activities associated with removal of fuel and water in preparation for the safe storage of all units.

This licence application provides the information required to demonstrate that the Pickering NGS meets or exceeds all of the applicable requirements of the *Nuclear Safety and Control Act* (NSCA) and the associated regulations. The application describes the management system and the various programs, processes, and personnel that Pickering has in place to ensure that all work is performed with quality to the appropriate standard and with minimal impact to the public and the environment. Collectively, these elements ensure that safety is the overriding priority in all of the necessary activities undertaken to maintain safe and reliable operation of the station.

Pickering NGS continues to have strong safety performance with a conventional safety performance rating that is in the industry's top quartile. Operational reliability has improved significantly, with two of Pickering's units having record operational runs for Unit 5 and Unit 1 at 632 days and 622 days, respectively. Combined with the best forced loss rate performance in site history at approximately 3% and 4% in 2015 and 2016, respectively, Pickering NGS is continuing to achieve improved and more reliable operation.

Safety analyses demonstrate that the Pickering NGS design is safe, robust and that accident risk is very low. Furthermore, Pickering has strengthened its defence-in-depth by continuing to incorporate the lessons learned from the Fukushima event; by ensuring equipment and procedures are in place and incorporated into periodic drills and exercises for emergency response. Pickering has a comprehensive emergency response plan which also provides the framework for interaction with external agencies. OPG is planning a multi-agency interoperability exercise in December 2017 to test on-site and off-site capabilities to provide emergency response focused on the Pickering site.

In addition, a Periodic Safety Review (PSR) is being completed to further support the 10-year licence renewal. The PSR is a comprehensive assessment of the Pickering NGS design and operation, and it includes reviews of current standards and safety factors in determining what reasonable and practical enhancements will be made to further improve safety. The current PSR results further support the continued safe operation of the Pickering NGS until December 2024.

Moreover, the condition of the plant has been reviewed through component condition assessments, which also ensures that the appropriate maintenance, testing and monitoring is ongoing at Pickering. OPG continues to invest in the plant and continues to perform periodic component inspection to ensure that Pickering meets or exceeds industry standards.

¹ In this document, the terms "Pickering NGS", "Pickering Nuclear", and "Pickering" are used interchangeably. Unless otherwise indicated, they all refer to the Pickering nuclear power plant facility.

OPG is also requesting approval to operate Pickering NGS beyond the current Commission approved limit of 247,000 Effective Full Power Hours (EFPH) on the Unit 5-8 fuel channels, up to 295,000 EFPH for the lead Pickering unit which corresponds approximately to the intended end of commercial operation (December 31, 2024). Pickering has assessed the operation of the fuel channels on all units and assures their fitness for service to the target service life of December 2024 on the basis of sound technical reviews, the established programmatic controls within OPG for managing fuel channel aging, and the availability of mitigating measures where required.

Pickering's relationship with its host community remains strong through healthy, open relationships and sustainable partnerships with community stakeholders, including government, media, business leaders, educational institutions, interest groups, and community organizations. In addition, Pickering strives to ensure transparent disclosure of operations and their potential impacts. OPG also meets with Indigenous communities on an ongoing basis to provide details of nuclear operations and reports, and to discuss interests and any potential concerns over current and future operations of the Pickering NGS.

In support of this licence application, Pickering Nuclear has updated its Environmental Risk Assessment (ERA) which evaluated and confirmed that the risk to human and ecological receptors from exposure to contaminants and physical stressors related to the Pickering NGS and its activities is low. As well, a Predictive Effects Assessment (PEA) was completed in which the potential for adverse effects to human health and the environment from the activities associated with transitioning the station from operation to a safe storage state was evaluated. These studies support the overall conclusion that the Pickering site operates in a manner that is protective of human and ecological receptors residing in the surrounding area. The ERA and PEA reports have been provided to the CNSC staff as inputs for an Environmental Assessment under the NSCA.

As evident throughout the application, OPG asserts that:

- Nuclear safety will be assured such that plant personnel, the public and the environment are protected;
- Systems, structures and components at the plant are fit to continue commercial operation to the end of 2024, and that inspection programs will ensure fitness-for-service during the next licence period;
- Staff are qualified and competent to operate the plant, and this will be maintained through the next licence period, including sufficient staffing numbers;
- Impacts of plant operation to the public, workers, and the environment will continue to be of low risk and adequately mitigated, while continuing to provide the various societal and environment benefits of plant operation;
- Transparency and appropriate public and indigenous consultations will continue, and
- OPG continues to invest in Pickering to support the above objectives, including to improve equipment reliability, assure fitness for service until the end of commercial operations, and to further enhance nuclear safety.

In summary, this licence application contains sufficient information to demonstrate that Pickering NGS meets all of the legal requirements of the NSCA and the associated regulations, and to demonstrate that OPG is qualified to carry on the licensed activity and makes adequate provisions to protect the health, safety and security of persons, and the environment.

Table of Contents

1.0	Overview	11
1.1	<i>Introduction.....</i>	11
1.2	<i>Site Description and Ownership</i>	13
1.3	<i>Station Performance</i>	14
1.4	<i>Nuclear Safety and Equipment Reliability Improvements.....</i>	15
1.5	<i>Continued Operations</i>	16
1.5.1	Fuel Channels	16
1.5.2	Periodic Safety Review (PSR2).....	17
1.6	<i>End of Commercial Operation</i>	18
1.6.1	Sustainable Operations Plan	18
1.6.2	Preparation for Safe Storage.....	19
1.7	<i>Environmental Risk Assessment.....</i>	20
1.8	<i>Predictive Effects Assessment (PEA) 2017.....</i>	21
1.9	<i>Applicable OPG Documents.....</i>	21
2.0	Safety and Control Areas (SCA).....	22
2.1	<i>Management System</i>	22
2.1.1	Management System	22
2.1.2	Organization	24
2.1.3	Staffing Management.....	26
2.1.4	Management of Contractors	27
2.1.5	Safety Culture.....	27
2.1.6	Performance Assessment and Improvement.....	28
2.1.7	Operating Experience (OPEX).....	29
2.1.8	Configuration Management	29
2.1.9	Materials Management.....	29
2.1.10	Records Management	30
2.1.11	Business Planning	31
2.1.12	Business Continuity	32
2.1.13	Applicable OPG Documents	33
2.2	<i>Human Performance Management</i>	33
2.2.1	Human Performance Management Program.....	34
2.2.2	Personnel Training.....	35
2.2.3	Certification	37
2.2.4	Initial Certification and Requalification.....	38
2.2.5	Minimum Shift Complement (Work Organization and Job Design)	38
2.2.6	Fitness for Duty	39
2.2.7	Applicable OPG Documents	40
2.3	<i>Operating Performance.....</i>	41
2.3.1	Operations.....	41

2.3.2	Plant Status Control.....	42
2.3.3	Work Protection	43
2.3.4	Operating Procedures	43
2.3.5	Reactivity Management	43
2.3.6	Response to Transients	44
2.3.7	Outage Management Performance	45
2.3.8	Heat Sink Management.....	45
2.3.9	Safe Operating Envelope	46
2.3.10	Corrective Action Program.....	46
2.3.11	Regulatory Reporting	47
2.3.12	Applicable OPG Documents	47
2.4	<i>Safety Analysis</i>	49
2.4.1	Reactor Safety Program	49
2.4.2	Deterministic Safety Analysis	50
2.4.3	Heat Transport System Aging.....	50
2.4.4	Risk and Reliability Program.....	51
2.4.5	Probabilistic Safety Assessment	51
2.4.6	Severe Accident Management	53
2.4.7	Criticality Safety.....	54
2.4.8	Management of Safety Issues	54
2.4.9	Applicable OPG Documents	54
2.5	<i>Physical Design</i>	57
2.5.1	Conduct of Engineering and Design Management.....	57
2.5.2	Engineering Change Control.....	57
2.5.3	Procurement Engineering	58
2.5.4	Fuel.....	58
2.5.5	Pressure Boundary Program	59
2.5.6	Environmental Qualification	59
2.5.7	Software	59
2.5.8	Applicable OPG Documents	60
2.6	<i>Fitness for Service</i>	61
2.6.1	Equipment Reliability	61
2.6.2	Major Components	62
2.6.3	Aging Management	64
2.6.4	Periodic Inspection and Testing	65
2.6.5	Non-destructive Examination.....	66
2.6.6	Chemistry Control	66
2.6.7	Maintenance	67
2.6.8	FH Reliability.....	68
2.6.9	Maintenance Backlog.....	68
2.6.10	Applicable OPG Documents	69
2.7	<i>Radiation Protection</i>	71
2.7.1	Radiation Protection Program.....	71
2.7.2	Application of ALARA.....	72
2.7.3	Worker Dose Control.....	73

2.7.4	Radiological Hazard Control	75
2.7.5	Occupational Radiation Protection Action Levels	76
2.7.6	Applicable OPG Documents	76
2.8	<i>Conventional Health and Safety</i>	76
2.8.1	Conventional Health and Safety Program	76
2.8.2	Applicable OPG Documents	78
2.9	<i>Environmental Protection</i>	79
2.9.1	Environmental Policy.....	79
2.9.2	Environmental Management System (ISO 14001)	80
2.9.3	Protecting the Public	80
2.9.4	Spill Management Program.....	85
2.9.5	Environmental Monitoring Program	86
2.9.6	Regulatory Compliance	88
2.9.7	Fish Impingement and Entrainment.....	89
2.9.8	Thermal Plume	90
2.9.9	Environmental Risk Assessment.....	90
2.9.10	Predictive Effects Assessment.....	92
2.9.11	Biodiversity and Wildlife Habitat Council.....	94
2.9.12	Fisheries Act Authorization	95
2.9.13	Applicable OPG Documents	95
2.10	<i>Emergency Management and Fire Protection</i>	96
2.10.1	Fire Protection and Conventional Emergency Preparedness and Response	96
2.10.2	Nuclear Emergency Preparedness Program.....	98
2.10.3	Applicable OPG Documents	104
2.11	<i>Waste management</i>	104
2.11.1	Waste Minimization, Segregation and Characterization.....	105
2.11.2	Waste Storage and Processing	107
2.11.3	Interim Dry Storage of Irradiated Fuel	107
2.11.4	Decommissioning Plans.....	107
2.11.5	Preparation for Management of Waste from Transition to Safe Storage State	108
2.11.6	Applicable OPG Documents	109
2.12	<i>Security</i>	109
2.12.1	Nuclear Security Program	109
2.12.2	Drills and Exercises	111
2.12.3	Response Arrangements	111
2.12.4	Cyber Security	112
2.12.5	Applicable OPG Documents	113
2.13	<i>Safeguards and Non-Proliferation</i>	113
2.13.1	Nuclear Safeguards Program.....	113
2.13.2	Operational and Design Information.....	114
2.13.3	Safeguards Equipment and Surveillance	114
2.13.4	Import and Export	115
2.13.5	Applicable OPG Documents	115
2.14	<i>Packaging and Transport</i>	115

2.14.1	Package Design and Maintenance.....	115
2.14.2	Radioactive Material Transportation	116
2.14.3	Registration for Use.....	117
2.14.4	Transport Security Plan	118
2.14.5	Applicable OPG Documents	118
3.0	Licensee Public Information Program	119
3.1	<i>Public Information Program</i>	119
3.1.1	Key Yearly Activities	119
3.1.2	Station reporting	120
3.1.3	Welcoming Visitors.....	120
3.1.4	Community Outreach	121
3.1.5	Community Committees	122
3.1.6	Environmental Partnerships and Programs	123
3.1.7	Employee Communications.....	123
3.1.8	Applicable OPG Documents	124
3.2	<i>Aboriginal Consultation</i>	125
4.0	Program for Cobalt-60.....	127
4.1	<i>Cobalt-60</i>	127
4.2	<i>Applicable OPG Documents</i>	127
5.0	References	128
	Appendix A – Activities and Nuclear Substances to be Encompassed by the Licence	130
	Appendix B - Financial Guarantee, Nuclear Liability Insurance and Cost Recovery	132
	Appendix C - Licences, Internal Authorizations, Certificates and Summary of Environmental Regulatory Requirements	135
	Appendix D – CNSC Action Items.....	141
	Appendix E – Periodic Safety Review (PSR2)	145
	Appendix F - CANDU Safety Issues	161

Table of Figures

Figure 1 - Pickering NGS Timeline	12
Figure 2 - Nuclear Management System	23
Figure 3 - Pickering Organizational Chart.....	25
Figure 4 - Pickering Event Free Day Resets	35
Figure 5 - Misposition Type by Year	42
Figure 6 - Equipment Reliability Index (ERI)	62
Figure 7 - Chemistry Performance Index (CPI)	67
Figure 8 - Maintenance Backlog	69
Figure 9 - Site Collective Radiation Exposure	73
Figure 10 - Precursor Tritium Uptakes	74
Figure 11 - Whole Body EPD Dose Alarms.....	74
Figure 12 - Pickering All Injury Rate vs. Target	77
Figure 13 - Radiological Emissions to Water	81
Figure 14 - Radiological Airborne Emissions	82
Figure 15 - Radioactive Dose to the Public.....	87
Figure 16 - Radioactive Dose Relative to Natural Background Radiation	87
Figure 17 - Fish Diversion System.....	89
Figure 18 - Biodiversity.....	94
Figure 19 - Exercise Unified Response Montage	100
Figure 20 - Pickering Emergency Mitigation Equipment.....	100
Figure 21 - Sample Wireless Public Alerting Service	101
Figure 22 - 2015 Pickering Nuclear Community Information Session.....	121
Figure 23 - Information Sharing Session and Station Tour.....	121
Figure 24 - Tuesdays on the Trail – Summer 2016	122
Figure 25 - Joint DNGS and PNGS CAC meeting June 2015.....	122
Figure 26 - Students helping to raise salmon eggs in the Pickering Information Centre.....	123

Tables

Table 1 - Summary Data for Pickering NGS	14
Table 2 - Pickering In-service Dates.....	14
Table 3 - Records Management Performance.....	31
Table 4 - Number of Pickering Certified Staff (May 1, 2017)	37
Table 5 - Document Numbers for Pickering Safety Analysis	50
Table 6 - Environmental Infractions for the Period 2013-2017.....	88
Table 7 - Emergency Response Performance Indicators.....	99
Table 8 - Radioactive Material and Packaging.....	117

1.0 Overview

1.1 Introduction

Ontario Power Generation (OPG) is responsible for approximately half of the electricity generation in the Province of Ontario. Nuclear power from the Pickering Nuclear Generating Station (NGS) supplies 14% of Ontario's electricity needs. Its major benefits include - low operating costs and virtually no Greenhouse Gas (GHG) emissions.

The current Pickering Power Reactor Operating Licence (PROL) 48.03/2018 expires on August 31, 2018. OPG is applying for a 10-year licence renewal of the Pickering NGS, including continued commercial operation of all reactor units until December 2024 as well as post-shutdown activities associated with removal of fuel and water in preparation for the safe storage of all units.

As explained in OPG's submission to the 2017 provincial government's *Long Term Energy Plan*, continued commercial operation of Pickering until 2024 will ensure the province has a reliable source of GHG-free, baseload electricity to carry it through the refurbishment of the Darlington NGS and the initial Bruce NGS units, saving ratepayers as much as \$600 million. That represents an estimated reduction of GHG emissions of 17 million tonnes, and the equivalent environmental impact of removing 3.4 million cars per year from Ontario's roads. Continuing to operate the Pickering NGS until 2024 is also associated with 4500 direct and indirect jobs across Durham Region.

This application provides the information required to demonstrate that Pickering meets or exceeds all of the requirements of the *Nuclear Safety and Control Act* (NSCA) and the associated regulations. As well, a Periodic Safety Review (PSR) will be completed to support the 10-year licence period. A PSR is a comprehensive assessment of Pickering's design and operation. Its purpose is to confirm that there is a high level of safety throughout the operating life and, through a review of current codes and standards and safety factors, determine what reasonable and practical enhancements can be made to further improve safety.

An integrated safety review was completed for Pickering Units 1-4 prior to the return to service in the early 2000's (Reference 1). At that time, extensive modifications to improve safety and reliability were installed on Units 1 and 4 (Units 2 and 3 were placed in the safe storage state).

An integrated safety review for Pickering Units 5-8 was completed in 2009 for continued operation of the station (Reference 2). OPG committed to complete safety enhancements and reliability improvements; all of which have been completed.

The objective of this subsequent PSR, referred to as PSR2, is to build on the previous assessments and to confirm that the design, operation and safety-significant structures, systems, and components support continued safe operation of the Pickering units to the end of 2024 (Reference 3). The PSR2 is a forward looking assessment focusing on changes to requirements since the last applicable assessment. The current PSR2 results confirm that the condition of Pickering NGS supports the additional years of commercial operation in consideration of new

operating experience since the last assessments. Moreover, the PSR2 seeks to identify additional practical safety enhancements to further improve the already low risk of plant operation, beyond those that have been implemented or that are committed to be implemented.

OPG is also requesting approval to operate beyond the current Commission approved limit of 247,000 Effective Full Power Hours (EFPH) for the Pickering 5-8 fuel channels, to 295,000 EFPH for the lead Pickering unit which corresponds approximately to the intended end of commercial operation (December 31, 2024). Pickering has assessed the operation of the fuel channels on all units and assures their fitness for service to the target service life of December 2024 on the basis of sound technical reviews, the established programmatic controls within OPG for managing fuel channel aging, and the availability of mitigating measures where required.

Pickering NGS Timeline

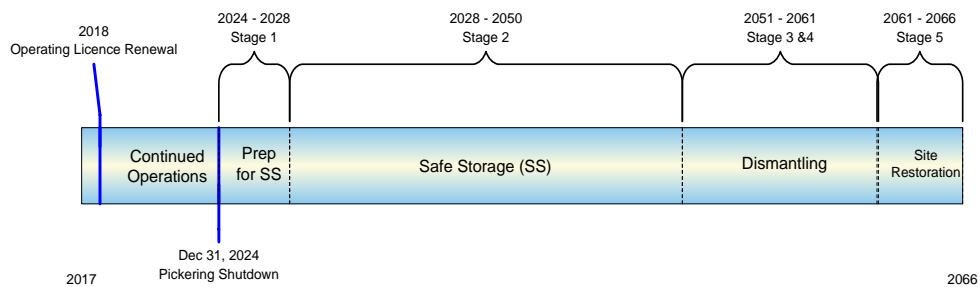


Figure 1 - Pickering NGS Timeline

Figure 1 shows the planned timeline for Pickering NGS, starting at licence renewal.

During the 10-year licence term, Pickering NGS plans to continue commercial operation and shut down all units by December 31, 2024 (Reference 4). After shutdown, the fuel and the heavy water will be removed from the reactors and the safe storage phase will begin.

The long term post-shutdown activities involve multiple stages.

Stage 1: Activities which are required to place the units in the safe storage state, as described in the Stabilization Activity Plan (SAP). These will be completed in order to place the units into a state that will be maintained until decommissioning (Reference 5).

Stages 2 – 5: These stages are covered in the Preliminary Decommissioning Plan (PDP). (Reference 6)

In support of this licence application, Pickering Nuclear has an updated Environmental Risk Assessment (ERA) which evaluated and confirmed that the risk to human and ecological receptors from exposure to contaminants and physical stressors related to the Pickering NGS and its activities is very low. As well, a Predictive Effects Assessment (PEA) was completed which evaluated the potential for adverse effects to human health and the environment from the activities associated with transitioning the station from operation to a safe storage state. These studies support the conclusion that the environment in the vicinity of the Pickering NGS is adequately protected. The ERA and PEA reports have been provided to the CNSC as inputs for an Environmental Assessment under the NSCA.

1.2 Site Description and Ownership

Pickering NGS has eight reactor units. Currently, six units are operating and two of the units are in the state of safe storage.

The Pickering nuclear facility is located on the north shore of Lake Ontario in the City of Pickering in the regional municipality of Durham, Province of Ontario. The site is approximately 32 km east-northeast of downtown Toronto and 21 km southwest of the City of Oshawa at latitude 43° 49' N and longitude 79° 04' W. The site occupies a land area of 240 ha in lots 17 to 22 inclusive in the Broken Front Concession. The total frontage of the site along the Lake Ontario shoreline is approximately 2260 m. The transmission egress right-of-way which leads north from the site boundary is 155 m in width and occupies part of lots 19 and 20 in the Broken Front Concession.

There are a number of watercourses in the vicinity of Pickering NGS. The two major ones closest to the site are Duffins Creek, 2.2 km to the east, and the Rouge River, 4 km to the west.

The Pickering A and Pickering B safety reports provide detailed and extensive information on the facility and the systems, structures and component design. This information can be found in Part 1 of the safety reports. Further information is provided below in Table 1 and Table 2.

The Pickering site is shown in the following OPG drawing, NK30-D0A-10200-0001, *Building Development Site Plan*.

The reactor units are numbered 1 to 4, from east to west, and the other reactor units are numbered 5 to 8, from west to east starting from the center of the plant.

The Pickering site is owned by Ontario Power Generation Inc, and owned by the Province of Ontario; the title/deed is available upon request.

Summary Data - Pickering NGS	
Number of Units	8
Operational Units	6
Safe Storage Units	2 (Units 2 and 3)
Net Power Output (Electrical)	2 x 515 MWe (Units 1 and 4)
Net Power Output (Electrical)	4 x 516 MWe (Units 5,6,7, and 8)
Maximum Power (Thermal) per Unit	1744 MW(t) to yield 540 MWe (gross)
Nuclear Steam Supply System	CANDU Pressurized Heavy Water Reactor
Containment Structure	Reinforced Concrete

Table 1 - Summary Data for Pickering NGS

	In-Service Dates (Operational Units)
Unit 1	July 29, 1971
Unit 4	June 17, 1973
Unit 5	May 10, 1983
Unit 6	February 1, 1984
Unit 7	January 1, 1985
Unit 8	February 26, 1986

Table 2 - Pickering In-service Dates

1.3 Station Performance

At the Pickering NGS, the safety of the employees, neighbours and the environment is the overriding priority.

OPG's drive towards achieving zero injuries remains at the forefront of the business. During the current licensing period, Pickering NGS has demonstrated excellent safety performance throughout its operations.

In 2014, Pickering reached 11 million hours without a lost time accident with an All Injury Rate of 0.22 which represented best ever performance for the station. In November 2016, OPG received the Canadian Electricity Association's President's Gold Award of Excellence for Employee Safety in recognition of the company-wide All Injury Rate and Accident Severity Rate performance for 2013, 2014 and 2015.

Pickering NGS has achieved excellent operating performance in the current licensing period with two units attaining records for continuous on-line operation for Unit 5 with 632 days and Unit 1 with 622 days. Combined with the best forced loss rate performance in site history at 3% and 4% in 2015 and 2016, respectively, this shows that Pickering NGS is continuing to achieve improved and more reliable operation.

Human Performance is a station priority at Pickering. Pickering has achieved its best ever performance in this area, with the lowest number of Site Event Free Day Resets (SEFDR). In 2016, Pickering had 1 event against a target of 2. The 2017 target is 2 SEFDR and at the end of the second quarter, Pickering has 0 SEFDR which is in the top quartile of the industry.

In the CNSC annual evaluation of industry performance, Pickering has achieved a rating of Fully Satisfactory (FS) for operating performance in 2015 and 2016 and an overall rating of FS for both years.

In 2017, Pickering achieved excellent outage performance for the Unit 5 maintenance outage. Pickering met its conventional safety, nuclear safety, radiation safety and environmental targets while executing the maintenance work and returning the unit back to service, in time to meet the committed date to the public.

In summary, Pickering NGS has maintained a strong track record of safe and reliable operation, and is qualified to carry on the activities and make adequate provisions to protect the public, workers, and the environment over the requested 10-year licence term.

1.4 Nuclear Safety and Equipment Reliability Improvements

During the previous licence renewal process for Pickering in 2013, OPG indicated that it would continue to invest in the Pickering plant to improve safety and reliability through to the end of commercial operation. At that time, in addition to the regulatory work to ensure safe operation of the fuel channels, OPG committed to including \$200M in the business plan, for reliability improvements (Reference 7). Over the course of four years from 2011 - 2014, the work that was completed targeted reliability improvements to equipment, material condition improvements to the plant, and additional inspection and maintenance activities to continue to confirm fitness for service of major components in the life extension period. Additionally, 2000 reliability and material condition improvements initiatives were completed by either replacing or maintaining equipment, including 129 pumps, 106 motors, and 688 valves. Completion of this maintenance helps to ensure that the station will operate reliably to deliver the electrical generation forecast until the end of commercial operation.

Furthermore, OPG committed to finish the modifications for the quick-connections of electrical and water tie-in points to the station systems in order to streamline the deployment of the Emergency Mitigating Equipment (EME). As well, OPG committed to implement field modifications to ensure power is restored to essential station equipment in order to protect containment and post-event monitoring. The design modifications to complete all of the field installations have been completed and implementation is in progress and is expected to be completed in 2017 (Reference 8).

In addition, in 2014 at the request of the Commission, OPG committed to a risk improvement plan that encompassed a combination of physical improvements, changes to operating procedures, and improvements to analysis methodology in order to further reduce the calculated risk for Pickering, focusing on the Pickering A units. Pickering has provided an annual update to the CNSC on the risk improvement plan, and significant risk reductions have been shown (Reference 9).

The results of the fifteen safety factor reviews which were defined for the PSR process have been completed and included in the PSR2. These safety factors cover all aspects important to the safety of an operating nuclear power plant. The results have been reviewed and summarized in Safety Factor Reports that have been submitted to the CNSC. These reports conclude that there are no fundamental safety issues and that OPG has in place effective programs and processes for continued safe operation of the Pickering NGS until 2024. Also, the PSR2 seeks to identify additional practical safety enhancements to further improve the already low risk of plant operation, beyond those that have been implemented or that are committed to be implemented.

In summary, nuclear safety will continue to be assured and plant reliability maintained such that the risk of Pickering NGS operation remains low and plant safety and reliability improves during the next licence term. This is supported by continued investment for the Pickering NGS.

1.5 Continued Operations

This section substantiates that the key systems, structures, and components at Pickering are fit to continue commercial operation to the end of 2024, and that inspection and maintenance programs will ensure fitness-for-service during the next licence term.

1.5.1 Fuel Channels

Pickering has assessed the operation of the fuel channels on all units and the assessment has shown there is additional margin on fuel channel fitness-for-service limits to the original target service life of December 2020 (References 10 and 11). Therefore, safe operation is assured beyond the current operating limit of 247,000 Effective Full Power Hours (EFPH) with continued demonstration of fitness for service.

Pickering has also assessed the operation of the fuel channels on all units and assures their fitness for service to the new target service life of December 2024 on the basis of sound technical reviews, the established programmatic controls within OPG for managing fuel channel aging, and the availability of mitigating measures where required (Reference 12). Based, in part, on Reference 12, fitness for service of the fuel channels is assured up to 295,000 EFPH.

The condition of the fuel channel components is regularly monitored via inspection programs, consistent with the life cycle management approach used for all major components, ensuring that fuel channel component condition remains within the licensing basis and fitness-for-service criteria of the CSA N285.4 and N285.8

standards. OPG has robust processes in place for responding to inspection or surveillance results should they not satisfy the prescribed acceptance criteria, and to relevant OPEX that could impact fuel channel fitness-for-service or plant operability or safety.

Aging mechanisms in Pickering Unit 5-8 fuel channels have been reviewed and the results provided to CNSC staff. Observed degradation rates are consistent with predictions and no new degradation mechanisms have been identified. OPG has provided a preliminary burst test plan for CNSC staff review that covers the required range of test parameters to further validate the cohesive zone fracture toughness model and expand its validity to cover projected hydrogen equivalent concentrations at the target operating life. The plan accounts for projected conditions in inlet and outlet regions at the target operating life, operating and transition temperature conditions, inter-tube variability, and as-found states. This plan will be finalized and submitted to CNSC by the fall of 2017. It should be noted that the plan will be subject to change depending on ongoing test results and identified research requirements, and it will be adapted, if required to continually demonstrate fitness for service.

In consultation with industry, OPG will continue to discuss fuel channel-related issues with CNSC staff to ensure regulatory expectations are understood and met.

In summary, based on inspections, reviews, research and development work, confirmatory actions in the life management plans for assuring ongoing fitness-for-service, and use of mitigating actions, OPG is confident of continued demonstration of fitness for service of fuel channels for safe operation of all Pickering units to the end of 2024 and up to 295,000 EFPH for the lead Pickering unit.

1.5.2 Periodic Safety Review (PSR2)

The PSR process serves to further support continued operation over the licence renewal term. In the PSR2 for Pickering, the fifteen safety factors that have been reviewed cover all aspects important to the continued safe operation of the plant. It has been concluded that there are no fundamental safety issues and that OPG has in place effective programs and processes for continued safe operation of the Pickering NGS until 2024.

The results have been reviewed and summarized in Safety Factor Reports that have been submitted to the CNSC. Gaps identified from these safety factor reviews are currently being assessed in a global assessment. The objective of the global assessment is to provide an overall assessment of the safety of the plant, and to arrive at a judgement of the plant's suitability for continued operation on the basis of a balanced view of the results from the reviews of the separate safety factors. Consistent with the requirements of IAEA SS-25, the global assessment is being conducted by an interdisciplinary team with appropriate expertise in operations, design and plant safety, including appropriate participants from the safety factor reviews, and members who are independent from the safety factor review teams.

Preparation of the Global Assessment Report (GAR) is being conducted to summarize the assessments and document the global assessment by presenting the

results, assessing the overall defence-in-depth of the plant, and documenting the conclusions, corrective actions, and enhancements to be considered. The GAR will include a ranked list of the global issues with identified actions, and with rationale for the ranking. In accordance with Reference 13, the GAR will be submitted to the CNSC by October 31, 2017.

The enhancements resulting from the global assessment that will be implemented, will be documented in an Integrated Implementation Plan (IIP) which will provide the proposed timeline for the implementation of the enhancements. In accordance with Reference 13, the Pickering PSR2 IIP will be submitted to CNSC staff, for acceptance, by November 30, 2017.

1.6 End of Commercial Operation

The *Pickering Site Strategic Plan*, P-PLAN-09314-00003 R0, provides an overall view of Pickering's strategy, as it approaches the end of commercial operation. It references the primary documents that govern the timeline from operation to decommissioning; namely the *Sustainable Operations Plan*, the *Stabilization Activity Plan* and the *Preliminary Decommissioning Plan*.

1.6.1 Sustainable Operations Plan

OPG will continue to ensure safe, reliable operation of Pickering as it transitions to the end of commercial operation. Processes will remain in place to ensure Pickering NGS is operated and maintained using sound nuclear safety and defence-in-depth practices.

A Sustainable Operations Plan (SOP) is developed to address the challenges that arise due to the transition from an operating station to the End of Commercial Operation (ECO). The SOP is based on each of the 14 Safety and Control Areas (SCA). Pickering NGS recognizes that safe operation is based on the maintenance of both a healthy safety culture and the programs associated with each of the 14 SCAs. In the SOP, OPG will document actions and define stand-alone supplemental measures to existing programs (arrangements, activities or actions) which will be implemented as resolutions.

This plan will be submitted to the CNSC 5 years prior to the shutdown of the Pickering station. A progress update will then be provided annually, in mid-December.

The 2016 SOP (Reference 14) submitted to the CNSC, was prepared based on an assumed end of commercial operations date of 2020. There are currently stand-alone supplemental measures in three SCAs with plans in development. These are in the areas of Organizational Change, Human Performance, and Maintenance and Reliability.

For Organizational Change, OPG will develop a plan to ensure capable, competent staff remains at Pickering through the transition to ECO, safe storage and decommissioning. It will include a change management plan which will look at the

impacts of the Pickering shut down on both Pickering operations and on the broader Nuclear and OPG organization and staff. The plan will cover activities related to leadership alignment, engagement of staff, internal and external communications, training and development, assessing and managing impact on the business policies, processes and practices, assessing and managing impact on people, assessing and managing business readiness. Oversight will be provided and metrics will be established to monitor performance of the transition to the new organization and ensure continued safe operations.

The Human Performance Initiative involves maintaining continuous monitoring and improvement of human performance to minimize the likelihood of nuclear safety events throughout the transition to the end of commercial operation. This will be achieved by systematically identifying and addressing error likely situations, reducing organization vulnerability and by challenging the integrity of defenses. Initiatives within the program also include communications, field presence and surveillance to promote human performance improvement, as well as utilizing benchmarking of similar plants and internal operating experience to maintain or improve human performance while in transition to the end of commercial operations.

The Maintenance and Reliability Strategy involves determining the maintenance plans and activities to be performed prior to and after the shutdown of the units. In order to ensure safe and reliable operation of each unit at Pickering, existing programs and procedures will be used for equipment maintenance and reliability strategies during the transition to the end of commercial operation. Procedures and processes will ensure that all of the maintenance necessary to ensure safe and reliable operation up to the shutdown of each unit is identified, as well as the maintenance necessary to sustain the systems that will be relied upon during the stabilization and safe storage phases.

Any supplementary actions which are not covered under these three areas will be addressed in the SOP in order to support safe and reliable operation of Pickering.

In summary, nuclear safety will be assured through to the end of commercial operation and staffing levels and competency will be appropriately maintained, while maintaining reliable plant operation and protecting the public, workers and the environment.

1.6.2 Preparation for Safe Storage

Preparation for Safe Storage includes the period leading up to the end of commercial operations as planning activities are carried out, as well as the execution of Stabilization activities which will safely transition the station from its current electricity generating state to its Safe Storage State (SSS).

The goal of Stabilization is to defuel the reactors of spent fuel, dewater systems containing tritiated heavy water, and remove from service systems no longer required to support the operation of the station. Although the station will no longer generate power, an operational footprint will be required to continue to support operational and regulatory requirements, such as the storage and removal of fuel

from the irradiated fuel bays, storage of heavy water, and ongoing monitoring and security activities.

The Stabilization of the station from its current electricity generating state to its SSS will follow a phased approach, where the phases will be characterized by milestones in hazard reduction. The operational need for Structures, Systems and Components (SSCs) at each phase will be determined by a thorough and systematic review process, considering both regulatory and system requirements across all 14 CNSC safety and control areas. SSCs not required for the operation of the station in the SSS will be placed in a passive safe state.

OPG operating experience (particularly from Darlington Refurbishment and Pickering Units 2 and 3 Safe Storage) as well as benchmarking of local and international industry experience has been integral to informing preparations for Safe Storage and will continue to do so as planning efforts progress.

OPG will continue to provide periodic updates to the CNSC with regards to the preparations for the execution of the Stabilization of the Pickering station.

More information on OPG's planning efforts for the stabilization of station and the SSS can be found in the Stabilization Activity Plan. (Reference 5)

Information on the Safe Storage phase can be found in the Preliminary Decommissioning Plan (PDP). (Reference 6)

In summary, nuclear safety will be assured during this transitional period and staffing levels and competency will be appropriately maintained, while continuing to protect the public, workers and the environment during this phase of operation.

1.7 Environmental Risk Assessment

OPG has completed an updated Environmental Risk Assessment (ERA) for Pickering Nuclear. The ERA includes a Human Health Risk Assessment (HHRA), and an Ecological Risk Assessment (EcoRA), for radiological and non-radiological contaminants and physical stressors.

The ERA evaluated the risk to relevant human and ecological receptors from exposure to contaminants and physical stressors related to Pickering and its activities. The ERA report P-REP-07701-00001, *Environmental Risk Assessment for Pickering Nuclear* was submitted to the CNSC (Reference 15).

In summary, the studies confirm that Pickering is continuing to operate in a manner that is protective of human and ecological receptors residing in the surrounding area.

A more detailed summary of the ERA is provided in Section 2.9.9.

1.8 Predictive Effects Assessment (PEA) 2017

OPG undertook a Predictive Effects Assessment (PEA) to evaluate the potential for adverse effects to human health and the environment from the activities associated with transitioning the station from operation to a Safe Storage with Surveillance state.

The PEA encompasses both the Stabilization Phase and the Safe Storage with Surveillance Phase. The PEA report, P-REP-07701-00002, *Predictive Effects Assessment for Pickering Nuclear Safe Storage* was submitted to the CNSC (Reference 15).

Overall the change from power generation to the Stabilization and Safe Storage with Surveillance Phases will result in reductions in emissions from the Pickering NGS. Noise, atmospheric emissions, waterborne emissions and thermal discharges will all be reduced as Pickering NGS moves from the current operational condition to a safe storage state.

No interactions were identified that are predicted to pose an unacceptable risk to humans or the environment during the Stabilization and Storage with Surveillance activities proposed. Therefore, no new mitigation is required based on the conclusions of the Predictive Effects Assessment.

During both the Stabilization and Storage with Surveillance Phases, OPG's environmental programs will be maintained, and updated as needed. Emission control measures and discharge limits are specified within specific permits. These permits and in-design mitigation measures will remain in place until such a time that it can be demonstrated, in discussion with the regulator as applicable, that they are no longer required.

The PEA concludes that there are no predicted potential adverse effects from the Stabilization and Safe Storage with Surveillance activities proposed.

In summary, this supports that the impacts of the post-shutdown operational activities on people and the environment will continue to be of low risk and adequately managed. A more detailed summary of the PEA is provided in Section 2.9.10.

1.9 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook. Further applicable documents are identified in Sections 2 to 4.

Document Number	Document Title
NK30-D0A-10200-0001	Building Development Site Plan
NA44-SR-03120-00001	Pickering Nuclear 1-4 Safety Report – Facility Description
NK30-SR-03120-00001	Pickering Nuclear 5-8 Safety Report – Part 1
OPG-PROG-0001	Information Management
N-PROG-RA-0012	Fire Protection
P-LIST-71400-00001	Application of CSA N293-07 to Structures, Systems and Components for Pickering Nuclear

2.0 Safety and Control Areas (SCA)

2.1 Management System

Pickering has a fully mature and effective management system that meets or exceeds all applicable regulatory requirements and related objectives. It enables OPG to continuously monitor and manage performance against those objectives, and maintain a healthy safety culture.

The following subsections describe the objectives, key results from the current licensing period, and planned improvements over the next licensing period. These discussions also support that:

- nuclear safety will continue to be assured such that plant personnel, the public and the environment are protected (e.g., Sections 2.1.1 and 2.1.5),
- staff are qualified and competent to operate the plant, and this will be maintained through the next licence period, including staffing numbers (Sections 2.1.2 and 2.1.3)
- OPG continues to invest in Pickering NGS to improve plant safety and reliability and to assure fitness for service until the end of commercial operations (Sections 2.1.11)

2.1.1 Management System

The *Nuclear Safety Policy*, N-POL-0001 establishes guiding principles for OPG nuclear employees stating that nuclear safety shall be the overriding priority in all activities performed in support of OPG nuclear facilities and that nuclear safety shall have clear priority over schedule, cost and production. The policy requires that everyone demonstrate respect for nuclear safety and conduct themselves in a manner consistent with the traits of a healthy nuclear safety culture. In accordance with the policy, the Nuclear President and Chief Nuclear Officer (CNO) is accountable to the CEO and the Board of Directors to establish a management system that fosters nuclear safety as the overriding priority.

The charter N-CHAR-AS-0002, *Nuclear Management System* takes authority from the *Nuclear Safety Policy*, and is in compliance with Canadian Standard Association (CSA) N286-12, *Management System Requirements* for Nuclear Facilities.

OPG's nuclear management system provides the framework for programs, standards and other governing documents and processes which collectively ensure that OPG's Pickering Nuclear Generating Station operates safely and that safety is the foremost consideration in management decisions and actions (see Figure 2 - Nuclear Management System).

Every employee in the organization is responsible and held accountable for complying with the expectations of the charter and referenced programs, and for ensuring their actions are deliberate and consistent with protecting worker health and safety, the health and safety of the public, and the environment.

The *Managed Systems* program, N-PROG-AS-0001 provides direction to management to develop and implement management practices and controls. Programs and processes are created such that all applicable regulatory requirements and codes and standards are embedded and integrated within the nuclear management system including aspects of health, safety, environment, security, economics and quality.

The management system effectiveness is reviewed by the Nuclear Executive Committee (NEC) as part of ongoing oversight. Program performance is assessed in the areas of management and leadership, performance execution and continual improvement. The oversight by the NEC members ensures that problem areas are identified and corrective actions established.

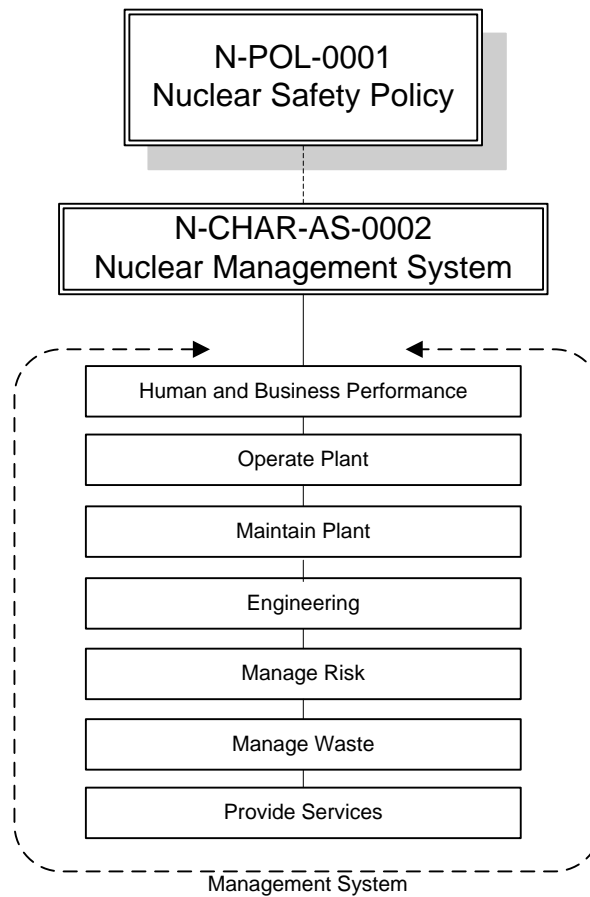


Figure 2 - Nuclear Management System

The Nuclear Management System has evolved over the past licence period, to support the OPG business model. Several programs have transitioned from being nuclear only, to being owned by corporate business units (for example, Items and Services Management, Information Management and Worker Health and Safety). The transition involved careful review and oversight of the changes by the CNO and the Nuclear Executive Committee to ensure that the roles and accountabilities under CSA N286 requirements were understood and captured in the corporate program governance and management systems. Oversight and review of the health and effectiveness of these corporate programs continue to be part of the Nuclear Management System.

For these programs, ownership and accountability for the program resides with the corporate program owner but the CNO remains accountable for the effectiveness of the implementation of these programs for the nuclear management system, and in meeting the requirements of CSA N286-12.

OPG's Nuclear Management System is reviewed through inspections, self-assessments, benchmarking, and independent audits. In 2015, OPG performed an assessment and also in 2015 an external review was performed of the overall OPG program in support of nuclear operations. Where opportunities for improvements were identified, action plans were developed and implementation is on-going.

2.1.2 Organization

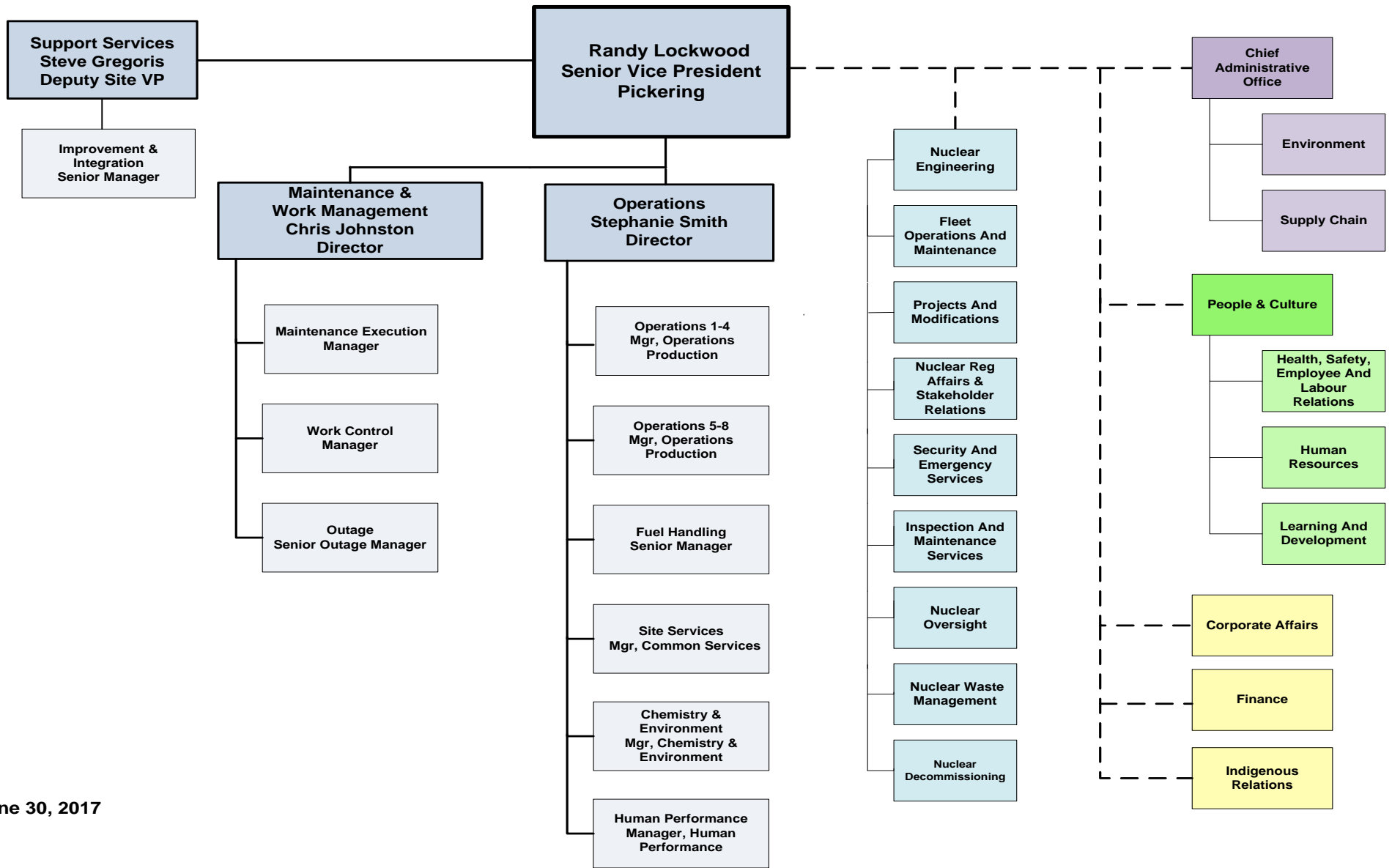
Nuclear standard, N-STD-AS-0020, *Nuclear Management Systems Organizations*, describes the organization and responsibilities of OPG in support of its nuclear management system.

The objectives are to maintain a sufficient number of qualified staff to safely operate, maintain, and support the nuclear generating stations, and to maximize the efficiency and effectiveness of its workforce.

The *Organization Design Change* procedure (OPG-PROC-0166) ensures consistent organization design change processes and alignment across OPG, which includes utilizing change management resources, tools and expertise to support the business in making effective organization design changes. The process for managing changes to the organization structure includes gated criteria to evaluate the complexity of the change; minor or material and required communications.

Stakeholder feedback indicates that the procedure has improved organization change consistency and documentation across the organization, as well as enabled the business to meet their operational needs in a more timely manner. The process ensures that the correct steps are being taken, and that records and systems are being updated accordingly.

Figure 3 provides the current Pickering organizational structure. The Pickering organizational chart information is updated each year and submitted to the CNSC (Reference 16 and Reference 17).



June 30, 2017

Figure 3 - Pickering Organizational Chart

2.1.3 Staffing Management

Workforce planning in OPG Nuclear looks at current staff and business plans and makes projections regarding hiring to ensure that sufficient qualified staff are available to operate and maintain the stations. Staff projections for continued operations of Pickering and the end of commercial operations form part of the overall people strategy for OPG.

Recruiting

OPG has a number of internal, external and student recruiting programs that are administered through the Talent Attraction team within the People and Culture organization. Talent Attraction partners work with hiring managers to attract and retain a diverse and high performing workforce.

The sourcing strategies are multi-faceted and include partnerships with educational institutions, apprenticeship programs, use of hiring halls for trades, internal and external job posting and career sites, talent pipelining, direct sourcing, retained/contingent recruitment agencies and succession planning discussions.

On-boarding is a strategic personnel process designed to support new employee integration with the goal to increase the speed to performance, engagement, retention and build a shared corporate culture. OPG has implemented an Onboarding Centre to ensure all new hires are qualified within the shortest amount of time possible, have the required systems in place and ensure new employees fully understand OPG behaviours, values and the importance of safety to OPG.

Knowledge Management

OPG has many well established methods to ensure people have the qualifications, knowledge and skills required to perform competently. The knowledge management program complements these foundational programs by providing tools and techniques to consider and share tacit knowledge.

Given OPG's demographics, employee attrition and the lengthy training and development required for specialized roles, OPG has invested in knowledge management for ongoing operations as well as the delivery of projects and initiatives to ensure that the critical knowledge and expertise of employees is sustained.

Talent and Succession Planning

The OPG talent review and succession planning program is a foundational element of OPG's strategic corporate human resources plan and business model. The talent management strategy includes the retention and knowledge transfer that is used to ensure that necessary talent and skills will be available when needed, and that essential knowledge and abilities will be maintained. Succession planning is one component of this strategy and the objective is to identify and develop future

leadership and to integrate this with the staffing needs to ensure continuity in critical roles.

The OPG succession planning process follows an annual talent review cycle that includes two succession reviews per year. Nuclear Executive Committee members are an integral part of the process.

The Nuclear organization has an additional complementary integrated succession planning process that includes identifying critical positions and determining the priority of each role. The level of management oversight of the succession planning of these critical positions is determined by the priority given to the role.

The OPG talent review and succession planning program is fully integrated into the broader human resources management programs within OPG that include performance measurement, individual development planning, leadership development, skills and capability development, diversity and inclusion, and culture.

2.1.4 Management of Contractors

Pickering NGS is using Engineer, Procure, and Construct (EPC) contractors to perform the majority of the project work at site. Contractors are pre-qualified by OPG supply chain quality services under a process that ensures the contractor has developed and implemented a management system that meets the applicable requirements outlined in the CSA Standard N286-12.

When requesting materials or services from vendors, Pickering NGS clearly specifies in the scope of work document the technical and quality requirements and selects vendors capable of satisfying these requirements.

Contractor performance is continually monitored through a robust score carding process and presented quarterly to OPG senior management. Contractors are scored on their ability to maintain good standing in safety, human performance and cost/schedule adherence.

2.1.5 Safety Culture

The nuclear standard, N-STD-AS-0023 *Nuclear Safety Oversight* summarizes the framework and accountabilities for the program as well as the external and internal processes used for oversight and assessment of nuclear safety. This standard applies to all aspects of nuclear operations, and to all work and other activities undertaken at or in support of the stations. Nuclear safety oversight is conducted in a manner consistent with the *Traits of a Healthy Nuclear Safety Culture*. A variety of oversight forums and processes are used to review, evaluate, and critique the safety culture at Pickering NGS.

In February 2015, Pickering NGS conducted a station wide nuclear safety culture assessment which consisted of both a staff survey followed by an on-site evaluation by an assessment team who conducted document reviews, staff interviews, and

observations. The assessment focused on perceptions, attitudes and behaviours of the organization.

The assessment concluded that Pickering NGS has a healthy nuclear safety culture, respect for nuclear safety is evident in the organization, and that nuclear safety is not compromised by production priorities. Station personnel feel they can challenge any decision if needed, without fear of retaliation. Areas for improvement were documented following the assessment and actions taken to address the findings are tracked. On July 15, 2015 and June 21, 2016 meetings took place with the CNSC to discuss and share the findings and actions taken.

OPG will continue to conduct these station wide assessments periodically as per N-PROC-AS-0077, *Nuclear Safety Culture Assessment*. The next assessment is scheduled for 2018.

OPG has implemented a nuclear safety culture monitoring panel to monitor the process inputs that are indicative of the health of the organization's nuclear safety culture. The panel, made up of the senior plant leadership team, meets quarterly to discuss the 10 nuclear safety culture traits.

2.1.6 Performance Assessment and Improvement

Quality management oversight of the nuclear management system is performed in accordance with the process described in N-PROG-RA-0010, *Independent Assessment*. The objective is to assess whether the station systems, equipment and activities are of the required quality throughout the plant life cycle and whether the established programs are being effectively implemented.

Nuclear Oversight has implemented a 5-year audit plan using a risk based process that identifies when programs are to be audited based on key risk areas, legal and regulatory requirements. The specific scope of the planned audits is determined through a risk assessment performed prior to audit conduct. This ensures that audits have the appropriate scope. An on-site independent assessment group has been established which provides on-going feedback to program owners. Based on the feedback received, the program owners take corrective action as required.

Nuclear Oversight performance itself has also been assessed through independent assessments such as the 2016 Nuclear Industry Evaluation Program (NIEP) evaluation. This team determined that OPG independent assessment functions for nuclear oversight are effective.

Alliances with a number of industry peer groups have enabled the participation of OPG employees on external assessments, creating opportunities for growth and benchmarking. Peers from other utilities have had similar opportunities in OPG.

2.1.7 Operating Experience (OPEX)

The objective of the Operating Experience (OPEX) program is to prevent the reoccurrence of significant internal and external events in accordance with N-PROC-RA-0035, *Operating Experience Process*.

The OPEX process is comprised of three elements: external OPEX, internal OPEX, and the use of OPEX. Combined, these elements meet the objectives by ensuring that lessons learned are reviewed and appropriate actions taken, internal lessons are shared, and lessons learned are incorporated into training and qualifications.

Over the licensing period Pickering made improvements to its OPEX process and tools, use of OPEX and the sharing of internal lessons. The process and tools improvements include revision of the program governance. The updates were made to simplify/clarify requirements, reflect organizational changes, and incorporate suggested improvements from internal/external assessments. Sharing of internal lessons learned with other OPG stations was improved by updating the evaluation process for applicability of significant lessons learned.

2.1.8 Configuration Management

Configuration Management at OPG is governed by the standard N-STD-MP-0027, *Configuration Management*. This program ensures the station physical configuration for all essential Structures, Systems and Components (SSC) match the configuration documents for all states of the plant. In addition, the program ensures configuration information is maintained accurate, consistent and readily accessible along with defining clear scope, responsibilities, authorities and interfaces among organizations.

Change control programs such as the Engineering Change Control (ECC) support configuration management by ensuring design changes, document changes and physical configuration changes that impact design and the licensing basis are tracked to completion and are traceable throughout the life of facility.

2.1.9 Materials Management

Materials management activities are performed in accordance with OPG-PROG-0009, *Items and Service Management*. This program establishes a governing document framework that meets regulatory requirements and ensures effective and efficient planning for, and procurement of, items and services.

The supply chain organization is responsible for providing the necessary services and materials in a timely manner and of the appropriate quality to the Pickering site. Supply Chain confirms all the quality aspects for receipted materials based on designated quality requirements.

Vendor quality is maintained through audits and receiving inspections. OPG has implemented a Counterfeit, Fraudulent and Suspect Items (CFSI) Program which is aligned to industry best practices. All suppliers to OPG are required to have a CFSI

program implemented and this is verified by supplier audits carried out by OPG. Enhanced purchasing clauses and receiving inspections have been in place for several years to prevent CFSI material from being supplied to or received by OPG.

Standardized training on CFSI was developed and implemented to support this program. External reviews and benchmarking has indicated that OPG's CFSI Program is an Industry leading, well established and effectively implemented program.

Supply Chain has seen improvement in the daily operational activities. Since 2013, stock-out related to critical spares has been improved from 17.3% to 8.6% in 2016. Similarly, scope removal due to unavailable parts in Pickering has also improved from 6.1% to 1.1%.

The Whitby warehouse upgrades were completed in 2016 to address the reduction of the warehouse footprint, elimination of the duplication of processes and provision of a modern facility capable of maintaining the integrity of the inventory. By the end of 2016, all inventories were moved to the Whitby facilities.

Improved performance areas include:

- Receiving backlog moved from an average of 8-10 days to 2 days, reducing congestion and moving material into the hands of the station quickly;
- Inventory accuracy is a world class 99.2% at the end of 2016, supporting the improvement in station execution.

2.1.10 Records Management

OPG-PROG-0001, *Information Management* establishes a set of standards and procedures for the management of OPG's information throughout its life-cycle, regardless of media. It includes electronic systems such as e-mail, central storage software, and the internal network to ensure consistent and appropriate use.

Another objective of the program is the advancement of electronic, digital, and mobility solutions that provide tools that effectively and efficiently capture, change, issue, and make content available.

Nuclear Oversight performed an audit of records and documentation in 2016 to ensure that the requirements of the program were met. This performance based audit of the records and documentation program identified that the managed system controls are fully effective.

Some key measures of information management showing that records management meets or exceeds performance targets, are shown in Table 3. (Data shown are for May 2017)

Measure	Performance	Target
Document Turnaround	Within 5 days 98.6% of time	Within 5 days 95% of time
Client Rejection Rate	1.9%	5%
Quality Check Program (Validate accuracy of controlled copies)	99.6%	95%

Table 3 - Records Management Performance

In 2015, a new application called Smart Form was introduced to nuclear facility workers to electronically submit and file their records and documents in Asset Suite/Curator rather than waiting on a Records Centre to manually index and upload images. The tool significantly reduces turnaround time on availability and cuts manual entry of key information (metadata) about the record/document by 50% or more. Average turnaround time has dropped from 30 days to less than 5 days.

Planned Improvements

An initiative for a new records repository is targeted to be in place by the end of 2020. The repository will have improved capture, retrieval, and work flow capabilities, and will expand on storage options to include various other file formats such as encrypted data, software, videos, photographs and AutoCAD.

2.1.11 Business Planning

Business planning is conducted to set strategic direction for the business and establish challenging but attainable operational and financial goals in accordance with N-PROG-AS-0005, *Business Planning*. Performance targets are established as part of the Pickering business planning process and nuclear benchmarking as outlined in N-PROC-AS-0080, *Nuclear Business Planning*.

Performance benchmarking is the process of comparing performance against industry leaders in order to identify areas of improvement and develop improvement plans to achieve targeted performance. A top-down gap-based business planning process was used to establish the 2017-2019 performance targets. A three-year horizon is assessed in detail and is supported by a complementary long term (20 years) outlook based on higher level information to better identify and react to emerging strategic shifts within the nuclear industry.

Pickering aims for continuous improvement in all areas. Where gaps in performance are identified, improvement initiatives are developed to ensure the established targets are met. These initiatives, and their associated milestones, are monitored and discussed at weekly meetings and other station oversight meetings on a routine basis. Plans address how initiatives will be implemented by the various station departments. Once implemented, results are monitored continuously through review

of the station performance metrics, and if performance gaps still exist, initiative plans are revisited or further developed as required.

The Pickering Generation Plan specifies the major outage scope and durations as well as the operational performance targets, such as Forced Loss Rate, established during the business planning process. The generation planning process is designed to incorporate outage scope requirements and changes based on major component life cycle management plans and up-to-date inspection results and unit conditions.

Major Projects

Major Projects are executed to improve plant safety and reliability, and to address regulatory requirements. Project spending is subject to ongoing review and approval by the OPGN Asset Investment Screening Committee (AISC) as directed in N-PROG-AS-0007, *Project Management*.

Major projects represent a significant investment in the continuing operation of Pickering NGS with a budget for total projects of \$231M over the period 2017 - 2019.

The fuel channel life assurance project, the periodic safety review update and component condition assessments show that Pickering can be safely operated until 2024. Future work is expected to include increased critical component inspections and maintenance and safety enhancements from the IIP. This work forms part of the incremental costs that would enable the extension of Pickering operations beyond 2020. The enabling costs have been estimated at approximately \$307M over the period 2016 to 2020.

2.1.12 Business Continuity

The objective of OPG-PROG-0033, *Business Continuity Program* is to establish a managed system for business continuity, and to provide direction related to business and operational continuity, and recovery planning.

The business continuity program ensures that approved response strategies and recovery guidance are in place for critical functions during incidents that threaten business continuity. Approved strategies are intended to protect employee and public health and safety, limit significant impacts to the environment and operational continuity and maintain financial viability.

OPG Nuclear has continuity plans in place for Pickering NGS which were revised in 2015 to reflect an approach which considers many different natural and technological hazards, as well as the pandemic influenza scenario. These plans will continue to be reviewed every other year for updates as required.

OPG has an enterprise-wide Infectious Disease Guideline (IDG) which replaces previous pandemic plans, making them obsolete. The updated hazard continuity plan addresses response to infectious disease.

OPG held an integrated Nuclear Continuity Plan Tabletop Exercise that engaged all Nuclear Continuity Plan procedures in November 2015 and will be testing the new Infectious Disease Guideline (IDG) in September 2017 with an OPG-wide tabletop.

The program document N-PROG-RA-0018, Nuclear Pandemic Plan was made obsolete in June 2017 and CNSC notification was completed as per Reference 18.

2.1.13 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document Number	Document Title
N-POL-0001	Nuclear Safety Policy
N-CHAR-AS-0002	Nuclear Management Systems
N-STD-AS-0020	Nuclear Management Systems Organizations
OPG-PROC-0166	Organization Design Change
N-STD-AS-0023	Nuclear Safety Oversight
N-PROC-AS-0077	Nuclear Safety Culture Assessment
N-PROG-RA-0010	Independent Assessment
N-PROG-AS-0001	Managed Systems
OPG-PROG-0001	Information Management
OPG-PROG-0009	Items and Services Management
OPG-PROG-0010	Health And Safety Management System Program
N-PROC-RA-0097	Self Assessment and Benchmarking
N-PROC-RA-0035	Operating Experience Process
OPG-PROG-0033	Business Continuity Program
N-CORR-00531-18829	Letter "Persons Authorized to Act on Behalf of OPG in Dealings with the CNSC", July 17, 2017 or the most recent version
N-GUID-09100-10000	Guideline for Maintaining Staff in Key Positions When Normal Station Access is Impeded

2.2 Human Performance Management

Pickering NGS has an effective human performance management program that meets or exceeds all applicable regulatory requirements and related objectives. It ensures that sufficient personnel numbers are maintained in all relevant job areas to safely operate the station. Human performance is managed so that all workers are qualified and have the necessary knowledge, skills, procedures, and tools to safely and competently carry out their duties.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and planned improvements over the next licensing period. These discussions also support that:

- nuclear safety will continue to be assured (e.g., Sections 2.2.1, 2.2.5 and 2.2.6),
- staff are qualified and competent to operate the plant, and this will be maintained through the next licence period, including staffing numbers (e.g., Sections 2.2.1 to 2.2.5)

2.2.1 Human Performance Management Program

The objective of the *Human Performance* program, N-PROG-AS-0002 is to continually reduce the frequency and severity of events through the systematic reduction of human error and the management of defenses in pursuit of zero events of consequence. In support of this, the *Pickering Site Human Performance Strategic Plan*, P-PLAN-01900-00005 forms the basis for guiding Pickering Nuclear toward human performance excellence.

The current strategy for Human Performance at Pickering focuses on the topics of 'People' and 'Behaviours'. Training is being delivered to managers to provide a framework for performing field observations and engaging workers and supervisors in developing their leadership skills, knowledge and reinforcement of standards.

Also, a pilot program to reinforce peer-to-peer coaching called *Coach Me*, was completed in 2016. The results of the pilot showed an increase in employees coaching others as well as receiving coaching. The resulting self assessment recommended that the program be rolled-out station wide, which has been completed.

The measures used to evaluate overall health, reliability and robustness of the Human Performance strategic plan are Site Event Free Day Resets (SEFDR) and SEFDR rate.

As seen in Figure 4, Pickering has achieved its best ever performance in regards to SEFDR. In 2016, Pickering had 1 event against a target of 2, and a SEFDR rate of 0.0019 against a target of 0.038. The 2017 target is 2 SEFDR and at the end of the second quarter of 2017 Pickering has 0 SEFDR. The SEFDR rate for Pickering is top quartile for the nuclear industry in the last two years.

The reduction over the past licensing period speaks to the improvements implemented under the human performance strategic plan.

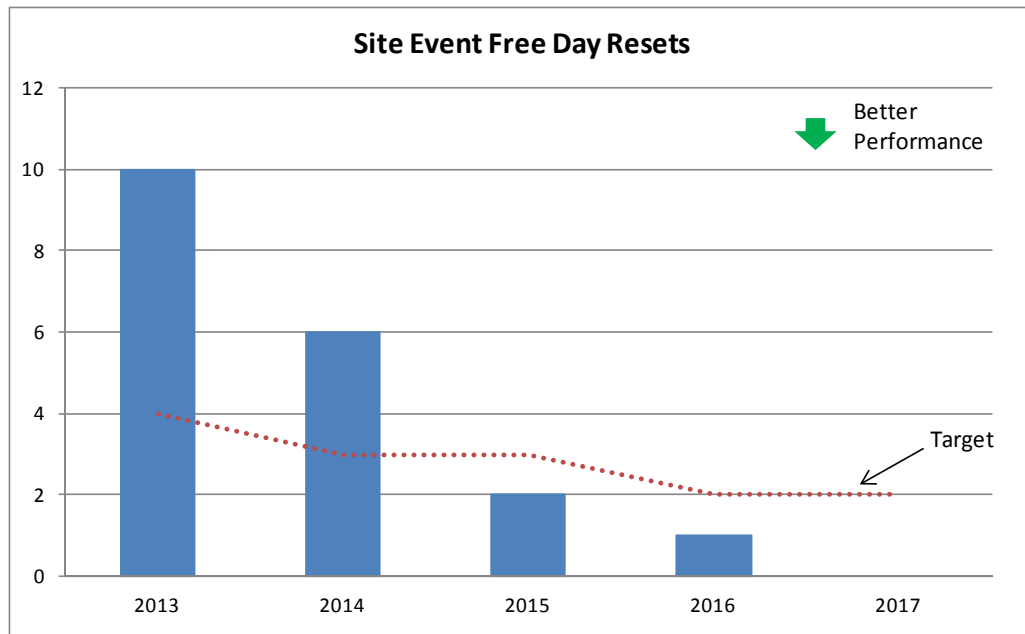


Figure 4 - Pickering Event Free Day Resets

Planned Improvements

An initiative to improve event communication and analysis is being developed in 2017 in order to improve identification of systemic issues. This will facilitate lessons learned from events to prevent event re-occurrence and foster an open reporting culture. This initiative leads to increased ability to develop leading indicators by recognizing adverse trends in low consequence events.

2.2.2 Personnel Training

The training program for regular staff, contractors, temporary personnel and other staff assigned work at OPG is defined by N-PROG-TR-0005, *Training*. The training program provides the structure, processes, and tools for defining, developing, implementing, documenting, assessing, and improving the training required to ensure staff have the appropriate knowledge, skill, and attitudes for safe and efficient plant operation.

The health of training is carefully monitored with a defined program to ensure that there is a Systematic Approach to Training (SAT) foundation for OPG's nuclear training programs upon which it continues to build and improve. Operations, maintenance and engineering departments have a robust continuing training program, and continuing training plans are revised and reissued on a 5-year cycle.

Engineering Training

Significant improvement was made in engineering training, specifically in the initial training program. To enhance the knowledge of the design basis, a one-day classroom course was added to the curriculum. This course has received substantial positive feedback not only from trainees but also from line managers who conduct observations of training.

Engineering training has a very robust continuing training program. An important component of this training program is the Conduct of Engineering Workshops. Every year senior engineering leaders select a new topic and the material is developed and delivered to approximately 1000 OPG engineers. The feedback about this element of continuing training is consistently positive.

Maintenance Training

The maintenance continuing training plan has the flexibility to focus on key performance issues tailored to the individual groups or needs. For example, continuing training topics for 2015 and 2016 were on leak management and valve assembly. Specific workshops were developed on these topics and delivered to 300 maintenance staff at Pickering.

Operations Training

The Operations training plan is a comprehensive and integrated plan that provides an overview of the current status and planned improvements. This plan is aligned and integrated with the fleet plan.

As of the end of 2016, there were 444 qualified Operators for Units 1,4 and 5-8 including 87 Supervising Nuclear Operators and 25 Field Shift Operating Supervisors. There are 88 operators in the initial training program, and all qualified operators participate in the continuing training program.

Leadership Training

In 2015, OPG re-designed and implemented new leadership development programs for First Line Managers (FLM), First Line Manager Assistants (FLMA) and middle level managers based upon international benchmarking and industry best practices. The program is a company-wide program which integrates participants from across the company to bring diverse thoughts, ideas and perspectives, to enhance the learning.

OPG has offered the International Senior Nuclear Plant Manager (ISNPM) program to senior leaders since 1996 with alumni being promoted to positions that include Chief Nuclear Officer, Chief Nuclear Engineer, Site Vice President and similar positions. Senior managers from major contract suppliers have also attended to support the pursuit of nuclear excellence. With the ISNPM program being

recognized worldwide, OPG entered into collaboration with EDF Energy in 2016 and is now also providing the program in England.

Emergency Response Organization Training

In 2016, the Emergency Response Organization Betterment Project was implemented and successfully completed. Achievements include consistent application of the systematic approach to training to all ERO role-related documentation as well as creation or revision of over 200 training documents and trial delivery of selected materials.

2.2.3 Certification

The Pickering Power Reactor Operating Licence (PROL) requires individuals who are appointed to the following positions to have a valid CNSC certification:

- (i) Responsible Health Physicist;
- (ii) Authorized Nuclear Operator;
- (iii) Control Room Shift Supervisor; and
- (iv) Shift Manager.

Table 4 contains the number of Pickering certified staff, as of May 1, 2017.

The initial training programs are in accordance with N-PROC-TR-0008, *Systematic Approach to Training*. As shown in Table 4, there are adequate numbers of individuals for each position that requires CNSC certification. As well, there are on-going training programs preparing trainees to move into these positions.

Training programs are in accordance with CNSC regulatory document RD-204, *Certifications of Persons Working at Nuclear Power Plants*.

Certified Position	Pickering 1 & 4			Pickering 5 to 8		
	# of Certified Staff	# of Trainees	Minimum Required	# of Certified Staff	# of Trainees	Minimum Required
Shift Manager and Control Room Shift Supervisor	15	16	10	19	10	10
Authorized Nuclear Operator	32	20	20	58	18	30
Responsible Health Physicist	4					1

Table 4 - Number of Pickering Certified Staff (May 1, 2017)

Continuing training includes refresher training of knowledge and skills required for the certified position, and update training based on changes to the plant and procedures. Certified Operations staff, on average, complete greater than 200 hours per year of continuing training.

Recent improvements to the initial and continuing training programs have resulted in an increased focus on operator fundamentals, reactivity management and emergency response, including response to beyond design basis events. Full-scope main control room simulators are now being used during the conduct of emergency preparedness drills and exercises in order to achieve more realism in the exercises.

2.2.4 Initial Certification and Requalification

The Initial Certification Examinations are conducted in accordance with the following documents:

N-INS-08920-10002, *Simulator-Based Initial Certification Examinations for Shift Personnel*,

N-INS-08920-10004, *Written and Oral Initial Certification Examinations for Shift Personnel*.

As per CNSC Regulatory Document RD-204, *Certification of Persons Working at Nuclear Power Plants*, the initial certification examinations and requalification tests for the Responsible Health Physicist continue to be administered by CNSC staff.

The initial certification examinations provide assurance that, at the time of their certification, candidates for certified positions have acquired the level of knowledge and skills required to work competently in their assigned position.

Requalification Testing is conducted in accordance with N-INS-08920-10001, *Requalification Testing Of Certified Shift Personnel*. Adherence to this instruction ensures requalification tests are administered in a consistent manner and in accordance with the requirements endorsed by CNSC.

OPG will continue to demonstrate its capability to administer initial examinations and requalification tests for Operations certified staff, and to ensure sufficient numbers of certified staff are available for the safe and reliable operation of the Pickering station. This includes having sufficient trained and qualified staff available to deliver the examination and testing programs throughout Pickering's continued operation.

2.2.5 Minimum Shift Complement (Work Organization and Job Design)

Pickering Minimum Shift Complement (MSC) is the minimum number of qualified workers who must be present at all times to ensure the safe operation of the Pickering facility, to respond to all station emergencies that may arise, and to ensure adequate emergency response capability for the most resource intensive conditions.

Minimum staff requirements and associated qualifications are identified in Pickering instruction P-INS-09100-00003, *Pickering Minimum Shift Complement*, and are in compliance with CNSC guidelines G-323, *Ensuring the Presence of Sufficient*

Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement and G-278, Human Factors Verification and Validation Plans.

Pickering instruction P-INS-09260-00008, *Duty Crew Minimum Complement Assurance*, details the MSC assurance program which is in place to ensure compliance and to maintain historical data.

During the current license period, Pickering NGS completed an assessment for the impact the stock keeper role has on the MSC while responding to the credited design basis events. The assessment concluded that there is no requirement for specialized equipment for which a stock keeper has specialist knowledge or skill that cannot be transferred to Operations, or other workgroup. Therefore the stock keeper role was removed from Pickering MSC with actions to ensure any required tools remained readily available to Operations staff.

In response to the Fukushima lessons learned, OPG completed an assessment of the Emergency Response Team complement and capabilities to respond to beyond design basis events. Based on this assessment, initiatives such as installation of Emergency Mitigating Equipment (EME) and the establishment of Severe Accident Management Guidance (SAMG) were implemented. During the aforementioned assessment, the requirements for Minimum Shift Complement at Pickering NGS were deemed adequate.

2.2.6 Fitness for Duty

N-PROC-HR-0002, *Limits of Hours of Work* identifies the expectations and the process for monitoring and controlling hours worked. This procedure documents the regulatory limits pertaining to hours of work and shift assignments in order to control the effects of fatigue of OPG staff in support of safe reactor operation.

Under this governance, supervisors are required to ensure that their employees are aware of their prescribed limit and are also responsible for monitoring their employees' hours of work. The process requires that employees are aware of their time limitations, track work hours and promptly notify the first line manager in advance of a potential violation.

Information on the limits of hours of work is provided in the *Nuclear Operations & Maintenance Handbook*. This handbook is a small carry-around guide of expectations and information written with the operations and maintenance staff in mind. The handbook describes the steps to be taken for the unlikely situation in which someone is found unfit for duty, and also has the limits for hours of work.

For certified and security staff, regulatory documents RD-204 and RD-363 also outline specific fitness for duty requirements.

The Continuous Behaviour Observation Program (CBOP) is designed to develop a supervisor's ability to recognize and respond to behaviours that may indicate a risk to the security, safety, or health of employees, facilities and the public. All OPG supervisors must complete this training during initial training and complete refresher training every 36 months. The CBOP process is to be followed if a worker reports to work and is suspected to be unfit for duty. Steps to deal with Unfit for Duty situations are covered in the CBOP training and outlined in the operations and maintenance handbook, which is updated yearly.

OPG Security monitors all personnel entering the protected area for indications of being unfit for duty or under the influence of intoxicants; if they suspect a worker is unfit they deny access to the facility. OPG is using periodic canine drug monitoring at the security monitors as an additional barrier to ensure the fitness for duty of all staff entering the protected area.

2.2.7 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
N-PROG-AS-0002	Human Performance
N-STD-AS-0002	Procedure usage and Adherence
N-STD-OP-0002	Communications
N-STD-OP-0004	Self-Check
N-STD-OP-0012	Conservative Decision Making
N-INS-09030-10004	Observation and Coaching
N-STD-RA-0014	Second Party Verification
N-PROC-OP-0005	Pre-Job Briefing and Post-Job Debriefing
N-PROC-HR-0002	Limits of Hours of Work
N-CMT-62808-00001	Continuous Behaviour Observation Program (CBOP) – Participants Materials – Workbook Components
N-TQD-601-00001	Leadership and management Training and Qualification Description
P-INS-09100-00003	Pickering Minimum Shift Complement
P-INS-09260-00008	Duty Crew Minimum Complement Assurance
N-INS-03490-10003	Minimum Shift Complement Resources, Qualifications and Procedures Required for Responding to Resource Limiting Events
N-PROG-TR-0005	Training
N-PROC-TR-0008	Systematic Approach to Training
N-LIST-08920-10001	Trained Performance Areas
N-INS-08920-10004	Written and Oral Initial certification examination for Shift Personnel
N-INS-08920-10002	Simulator-Based Initial Certification Examinations for Shift Personnel
N-INS-08920-10001	Requalification Testing of Certified Shift Personnel
N-MAN-08131-10000-CN-031	Responsible Health Physicist
N-MAN-08131-10000-CN-007	Shift Manager, Pickering Nuclear
N-MAN-08131-10000-CN-010	Authorized Nuclear Operator
N-MAN-08131-10000-CN-028	Control Room Shift Supervisor, Pickering Nuclear

2.3 Operating Performance

Pickering NGS has an effective Operations Program which meets or exceeds all applicable regulatory requirements and related objectives. The program ensures that plant operation is safe and secure, with adequate regard for health, safety, security, radiation and environmental protection, and international obligations.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and planned improvements over the next licensing period. These discussions also support that:

- Nuclear safety will be assured such that plant personnel and the public are protected (e.g., Sections 2.3.2, 2.3.3, 2.3.5, and 2.3.9).
- The plant is reliable and programs will continue to improve reliability during the next licence period (e.g., Section 2.3.7).
- Transparency continues to be maintained through the internal corrective action program and external reporting to regulatory agencies (i.e., Sections 2.3.10 and 2.3.11 respectively).

2.3.1 Operations

The *Nuclear Operations* Program, N-PROG-OP-0001, implements a series of standards and procedures to ensure that the plant is operated safely and reliably. This program establishes safe, uniform, and efficient operating practices and processes within nuclear facilities that provide nuclear professionals the ability to ensure facilities are operated in such a manner that the reactor operating licence, Operating Policies and Principles (OP&P), and other applicable regulations and standards are followed. It also supports the alignment, prioritization and resolution of operational problems, keeping reactor safety as an overriding priority.

Plant Operational Focus is the behaviour of an organization that is necessary to achieve high levels of operational safety and reliability. Plant Operational Focus at Pickering is used to ensure Operations leaders are providing input and oversight to work management processes. This allows operations leadership to ensure risks to plant operation due to equipment deficiencies and degradation are appropriately mitigated.

Improvements in these areas have helped drive operator advocacy and are showing a reduction in operator challenges and equipment unavailability.

As well, plant operational focus has driven improvements in housekeeping, storage of transient material, the preservation of seismic routes and plant material condition.

2.3.2 Plant Status Control

Plant Status Control forms part of the managed process to operate the plant safely and within the approved design basis.

N-STD-OP-0024, *Nuclear Safety Configuration Management* defines expectations for the identification and control of systems and equipment to ensure the availability of systems needed for nuclear safety. It defines operational requirements that are used to ensure that controls are in effect when station equipment is placed or maintained in a specific position or state, for nuclear safety reasons.

As a performance metric of plant status control, a misposition is declared when a component is found in a position off its baseline position without documented approval, or a component is incorrectly operated, or the incorrect component is operated. There is an immediate follow-up to misposition events to gain an understanding of the organizational and individual drivers that contributed to the event and to establish compensatory actions to prevent reoccurrence. The human performance lessons learned process is then used to share the underlying contributors to the event to prevent other occurrences. The Plant Status Control Committee was established as an oversight body, to review and categorize all misposition occurrences, identify trends and review corrective action plans to ensure that adequate corrective actions are taken to prevent recurrences.

The results are a reduction in the number of department resets due to misposition events and fewer and less significant misposition events.

Figure 5 shows a reduction in significant misposition events which are categorized as Level 1 or 2. Level 3 misposition events are not significant themselves but are tracked for trending purposes, and as a leading indicator to help inform activities to improve plant status control.

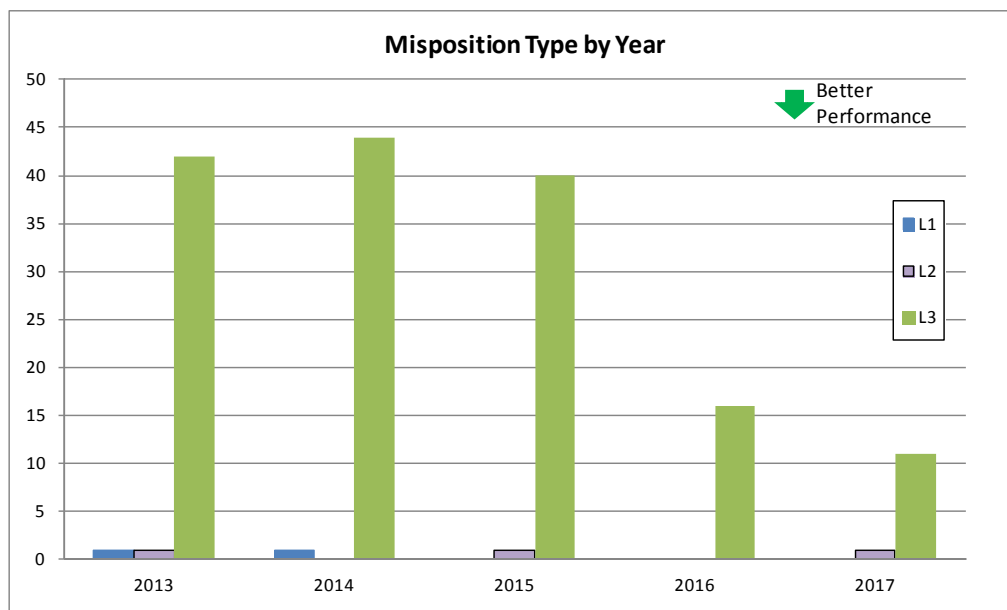


Figure 5 - Misposition Type by Year

2.3.3 Work Protection

The *Work Protection* program, N-PROG-MA-0015 describes the management processes, corporate governance, and roles and responsibilities to ensure worker safety where work on equipment requires isolation and de-energization. Worker safety is achieved through the effective application of work protection standards and procedures which ensure physical and administrative barriers are established between the energy source and the worker.

Operations provides oversight to the work protection program as follows:

- Nuclear Work Protection Review Board (NWPRB) - this group provides oversight of work protection performance at the nuclear or fleet level.
- Local Work Protection Review Board (LWPRB) – this group provides oversight of the Work Protection Performance at the site level.
- Site Work Protection Working Group (SWPWG) – this group is made up of individuals who execute work protection and provides oversight of work protection performance at the worker level.
- All 3 groups work to review events, identify trends, develop actions to improve performance and ensure that operating experience is used to inform improvement strategies.

Planned Improvements

Planned improvements include the development and use of model work protection permits and establishing an annual work protection oral review board to assess knowledge and identify gaps that require corrective actions.

2.3.4 Operating Procedures

Quality procedures are essential for maintaining safe and reliable operation. There is a dedicated group that ensures procedures are maintained current and technically correct.

A Technical Procedural Action Request (TPAR) is an approved request to change a technical procedure such as an operating procedure. High priority has been placed on completing these changes and reducing backlog.

Pickering has been successful in reducing both the number of temporary operating instructions and the backlog of operationally significant procedure change requests.

2.3.5 Reactivity Management

Reactivity Management practices are established through N-STD-OP-0009, such that reactivity of the reactor core is always respected and controlled. Reactivity management is the systematic control of activities that ensure core reactivity and

stored nuclear fuel are monitored and controlled consistent with fuel design and operating limits. It is a key factor in maintaining barriers to fuel damage and fission product release.

Reactivity Management applies to all plant operations and maintenance activities with potential to impact on core reactivity and as such, must be performed in a safe, controlled, conservative manner, following approved procedures.

A reactivity management plan is produced weekly that integrates the timing of fuelling windows for adequate core reactivity with both unit and fuel handling maintenance. It is a forward-looking plan that ensures maintenance activities are scheduled appropriately for unit conditions and fuelling machine availability and staffing.

All reactivity management events and conditions are systematically reviewed, indexed and their significance quantified. The performance measure, Reactivity Management Index (RMI) is utilized in order to identify deficiencies and communicate overall program effectiveness. RMI is consistent with industry standards. Where deficiencies are identified, corrective actions are established and tracked for effectiveness. Pre-cursor, non-consequential events are evaluated as a leading indicator in order to prevent events. Additionally, significant reactivity management operating experience is reviewed and lessons learned implemented at the station.

2.3.6 Response to Transients

Unit transients are minimized by ensuring required corrective and preventive maintenance is performed, to ensure equipment reliability and redundancy is maintained, such that operation of the station is challenged as infrequently as possible by unanticipated equipment failures. In addition, station maintenance and operations activities are conducted in a manner such that the likelihood of unanticipated impact on station operation is minimized. In the event that a unit transient does occur, staff are trained and qualified to respond to transient conditions and ensure the equipment or the unit is placed in the appropriate safe state.

Response to Transients, N-STD-OP-0017, defines the response protocols for a unit transient. In addition, this standard requires, for all unit transients, that a robust multi-disciplinary post transient review is held shortly after unit conditions are stabilized.

The intent of the post transient review is to confirm the direct cause of the event is understood, verify major process system responses are as expected, ensure the unit is placed in the appropriate end state and document any corrective actions and lessons learned. The review also provides an opportunity to assess crew response for any improvements for personnel involved and adequacy of response procedures. Lessons learned from the review are shared with the entire operations team as well as the Training department to address any training requirements.

2.3.7 Outage Management Performance

Outage management is performed in accordance with OPG procedures for *Planned Outage Management*, N-PROC-MA-0013 and *Forced Outage Management*, N-PROC-MA-0049. The overall objective of outage management is to perform event free inspections, maintenance and modifications in a shutdown state, such that plant safety and reliability are maintained at the desired levels during normal operation. During the current licence term, Pickering NGS outages have been managed in a safe and effective manner.

Planned Improvements

Pickering has an outage performance improvement plan which includes a study for a 30-month outage scheduling cycle for Pickering to improve outage performance and maximize reliability, fitness for service and operational stability. The expected benefits of the potential 30-month outage cycle would include dose reduction, improved training windows, improved resource balancing because of reduced outage overlap, improved human performance, more outage preparation time and fewer outage days.

Additionally, the outage performance improvement plan includes a focus on risk mitigation and contingency planning to support execution of planned outage work. Accurately identifying and assessing risk ensures that business planning accounts for required contingencies, and key work required for plant reliability is completed within the outage window.

2.3.8 Heat Sink Management

Heat sinks are governed by a Heat Sink Management standard, N-STD-OP-0025 and define nuclear safety principles and requirements for the management of reactor heat sinks.

This standard is applicable to all planned reactor states and plant configurations in a low-power operating condition. The standard specifies requirements for the selection of heat sinks including the required diversity such that heat sinks are physically and electrically independent. It also specifies requirements for the monitoring of heat sinks and expectations following heat sink failures.

For planned outages, heat sinks are specified in advance to account for the planned equipment outages. The available equipment is reviewed against checklists as required by the operating manuals.

For forced outages, heat sinks are initially governed by abnormal operating procedures or emergency operating procedures. Once the unit is stable, a formal heat sink is declared using the same process as that for a planned outage.

In the event of a heat sink failure due to a Beyond Design Basis Event, heat sink restoration would be supported by Emergency Mitigating Equipment Guidelines (EMEG) and/or Severe Accident Management Guidelines (SAMG).

2.3.9 Safe Operating Envelope

OPG nuclear standard N-STD-MP-0016, *Safe Operating Envelope* (SOE) defines the processes, organizational responsibilities and key program elements to ensure that the SOE is defined and documented in a correct, complete and consistent manner and reflected in the station operating documentation.

The SOE specifies the information required to ensure plant operation is in conformance with the licensing basis. The safe operating limits, conditions and surveillance requirements as well as their bases as defined by the current safety analyses are documented in station and system specific documents, Operational Safety Requirements (OSRs).

The limits and conditions defined in the OSRs, including any surveillance requirements, are specified in the applicable operations and maintenance procedures and tests, to ensure the plant is operated within the SOE.

2.3.10 Corrective Action Program

The Corrective Action Program (CAP) objectives as described in N-PROG-RA-0003, *Corrective Action*, are to ensure deficiencies, non-conformances, and weaknesses that adversely impact, or may adversely impact plant operations, personnel, nuclear safety, the environment or equipment and component reliability, are promptly identified and corrected or dispositioned. The program has two elements: identification of adverse conditions and resolution of adverse conditions.

Pickering Nuclear has a healthy SCR reporting culture; over 13,000 SCRs are generated annually. These SCRs cover a variety of adverse conditions that are promptly reviewed by supervisors to assign dispositions based on resolution category and significance.

The site managerial team reviews all of the dispositions in order to ensure the appropriate disposition is assigned to each SCR. Approximately 95% of the SCRs generated at Pickering are by themselves not significant and are dispositioned for trend analysis or closed to a previous evaluation. This distribution of the SCR population is closely aligned with industry best practices based on benchmarking with nuclear utilities.

Root cause and apparent cause investigations are conducted for significant events to improve plant reliability and human performance at Pickering Nuclear.

Reporting and Trending analysis is conducted to identify trends in performance at a lower level before they become a more significant issue. The trending includes aspects from cognitive analysis, data analysis and industry experience.

Reporting is quarterly through SCR trending and performance improvement reports. Identified adverse trends are addressed by initiating an SCR and corrected as required through the corrective action program.

2.3.11 Regulatory Reporting

Procedure N-PROC-RA-0020, *Preliminary Event Notifications* identifies the notification requirements for reporting to facility and off-site organizations, management, and external officials and agencies, after a reportable event has occurred.

Procedure N-PROC-RA-0005, *Written Reporting to Regulatory Agencies* identifies the processes and requirements for written event reports to regulatory agencies and scheduled reporting to the CNSC.

Pickering NGS has been submitting routine scheduled reports in a timely fashion throughout the licence period that are required to assess plant performance and for compliance monitoring, in accordance with REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

2.3.12 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
N-PROG-OP-0001	Nuclear Operations
N-STD-OP-0012	Conservative Decision-Making
N-STD-OP-0036	Operational Decision Making
N-STD-OP-0024	Nuclear Safety Configuration Management
N-STD-OP-0011	Operations Performance Monitoring
N-STD-MP-0019	Beyond Design Basis Accident Management
N-STD-OP-0025	Heat Sink Management
N-STD-OP-0017	Response to Transients
N-STD-MP-0016	Safe Operating Envelope
N-STD-OP-0009	Reactivity Management
N-STD-OP-0021	Control of Fuelling Operations
NA44-OPP-03600	Pickering NGS-A Operating Policies and Principles
NA44-OSR-08131.02-00001	Pickering NGS A Shutdown Systems
NA44-OSR-08131.02-00002	Pickering A Operational Safety Requirements: Negative Pressure Containment
NA44-OSR-08131.02-00003	Pickering A Operational Safety Requirements: Fuel and Reactor Physics
NA44-OSR-08131.02-00004	Pickering A Operational Safety Requirements: Emergency Coolant Injection System
NA44-OSR-08131.02-00005	Pickering A Operational Safety Requirements: Boiler Emergency Cooling System
NA44-OSR-08131.02-00006	Pickering A Operational Safety Requirements: Emergency Boiler Water Supply System
NA44-OSR-08131.02-00007	Pickering A Operational Safety Requirements: Feedwater System
NA44-OSR-08131.02-00008	Pickering A Operational Safety Requirements: Service Water Systems
NA44-OSR-08131.02-00009	Pickering A Operational Safety Requirements: Powerhouse Emergency Venting System

Document	Title
NA44-OSR-08131.02-00010	Pickering A Operational Safety Requirements: Main Steam Supply System
NA44-OSR-08131.02-00011	Pickering A Operational Safety Requirements: Shutdown Cooling System
NA44-OSR-08131.02-00012	Pickering A Operational Safety Requirements: Moderator System
NA44-OSR-08131.02-00013	Pickering A Operational Safety Requirements: Heat Transport System
NA44-OSR-08131.02-00014	Pickering A Operational Safety Requirements: Reactor Regulating System
NA44-OSR-08131.02-00015	Pickering A Operational Safety Requirements: Electrical Power System
NA44-OSR-08131.02-00016	Pickering Nuclear 1-4: Annulus Gas System
NA44-OSR-08131.02-00017	Pickering NGS-A Operational Safety Requirements: Fuel Handling System and Irradiated Fuel Bays
NA44-OSR-08131.02-00018	Pickering NGS-A Critical Safety Parameter Monitoring Instrumentation
NA44-OSR-08131.02-00019	Pickering NGS- A Operational Safety Requirements: Shield Cooling System
NA44-OSR-08131.02-00021	Pickering NGS-A Operational Safety Requirements: Interstation Transfer Bus (ISTB)
NA44-OSR-08131.02-00022	Pickering Nuclear 1-4 Operational Safety Requirements: Powerhouse Environmental Protection System
NK30-OPP-03600	Pickering NGS-B Operating Policies and Principles
NK30-OSR-08131.02-00001	Pickering B Operational Safety Requirements: Emergency Coolant Injection System
NK30-OSR-08131.02-00002	Pickering B Operational Safety Requirements: Fuel and Reactor Physics
NK30-OSR-08131.02-00003	Pickering B Operational Safety Requirements: Negative Pressure Containment
NK30-OSR-08131.02-00004	Pickering B Operational Safety Requirements: Shutdown Systems
NK30-OSR-08131.02-00005	Pickering B Operational Safety Requirements: Boiler Emergency Cooling System
NK30-OSR-08131.02-00006	Pickering B Operational Safety Requirements: Feedwater System
NK30-OSR-08131.02-00007	Pickering B Operational Safety Requirements: Emergency Water Supply System
NK30-OSR-08131.02-00008	Pickering B Operational Safety Requirements: Service Water Systems
NK30-OSR-08131.02-00009	Pickering B Operational Safety Requirements: Main Steam Supply System
NK30-OSR-08131.02-00010	Pickering B Operational Safety Requirements: Moderator System
NK30-OSR-08131.02-00011	Pickering B Operational Safety Requirements: Powerhouse Emergency Venting System
NK30-OSR-08131.02-00012	Pickering B Operational Safety Requirements: Shutdown Cooling System
NK30-OSR-08131.02-00013	Pickering B Operational Safety Requirements: Heat Transport System
NK30-OSR-08131.02-00014	Pickering B Operational Safety Requirements: Emergency Power Supply
NK30-OSR-08131.02-00015	Pickering B Operational Safety Requirements: Reactor Regulating System
NK30-OSR-08131.02-00017	Pickering B Operational Safety Requirements: Group 1 Electrical Power System

Document	Title
NK30-OSR-08131.02-00018	Pickering B Operational Safety Requirements: Fuel Handling and Irradiated Fuel Bays
NK30-OSR-08131.02-00019	Pickering NGS Operational Safety Requirements: HPECI Power Supplies
NK30-OSR-08131.02-00020	Pickering B Operational Safety Requirements: Annulus Gas System
NK30-OSR-08131.02-00021	Pickering B Operational Safety Requirements: Critical Safety Parameter Monitoring Instrumentation
NK30-OSR-08131.02-00022	Pickering B Operational Safety Requirements: Shield Cooling System
N-PROG-MP-0014	Reactor Safety Program
N-PROC-RA-0035	Operating Experience Process
N-PROC-RA-0022	Processing Station Condition Records
N-PROC-RA-0003	Corrective Action
N-PROC-RA-0005	Written Reporting to Regulatory Agencies
N-PROC-RA-0020	Preliminary Event Notifications

2.4 Safety Analysis

Pickering NGS has a mature safety analysis program that meets or exceeds all applicable regulatory requirements and related objectives. Safety analysis is updated in an effective manner to maintain the overall safety case and demonstrate the fundamental safety functions to control power, cool the fuel, and contain or limit any accidental releases from the plant.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and planned improvements over the next licensing period. These discussions also support that:

- Nuclear safety will be assured such that the public is protected (e.g., Sections 2.4.1 to 2.4.8)

2.4.1 Reactor Safety Program

The OPG *Reactor Safety Program*, N-PROG-MP-0014 defines the organizational responsibilities and key program elements for the management of issues related to nuclear safety analysis and operational safety requirements.

The program, standards, and implementing procedures govern the management of issues related to the safety analysis basis, which includes analyses and assessments which ensure that Pickering design and performance remain within the licensing basis.

2.4.2 Deterministic Safety Analysis

The deterministic safety analyses documented in the Pickering Safety Reports, demonstrate compliance with licensing limits and derived acceptance criteria.

NA44-SR-01320-00001	Pickering A Safety Report
NA44-SR-01320-00002	Pickering Nuclear 1-4 Safety Report Part 3: Accident Analysis
NA44-REP-00531.7-10001	Pickering A Analysis of Record
NK30-SR-01320-00002	Pickering B Safety Report - Part 2
NK30-SR-01320-00003	Pickering Nuclear 5-8 Safety Report Part 3: Accident Analysis
NK30-REP-00531.7-00001	Pickering B Analysis of Record

Table 5 - Document Numbers for Pickering Safety Analysis

The analyses listed in Table 5 are used to identify limits on process parameters and safety system requirements, and serve as a basis to establish the safe operating envelope for the station.

The Analysis of Record is the set of documents that establishes the current reactor safety licensing basis. It consists of the latest revision of the safety report and all analyses that update or supersede analyses contained in the latest revision of the safety report.

The safety reports are periodically updated and submitted to the CNSC in accordance with regulatory requirements.

The deterministic safety analysis will be updated in compliance to REGDOC-2.4.1, *Deterministic Safety Analysis* by including an appendix for common mode events into the safety reports by the end of 2017. For Pickering, the REGDOC-2.4.1 implementation plan is to be revised for 2018-2021 and will focus on aspects for which safety margins need to be confirmed. OPG will consider the Darlington experience during implementation of REGDOC-2.4.1 when determining the analysis upgrades for Pickering and include this in the revised implementation plan which OPG plans to submit to the CNSC before the end of 2017.

2.4.3 Heat Transport System Aging

The Heat Transport System (HTS) Aging Management activities were initiated in 2000 to evaluate the impact of HTS component aging on safety margins. The objective is to provide an integrated assessment on the cumulative effects of the identified aging mechanisms, and to develop effective safety margin management strategies based on the results of the assessments.

During the 2013-2015 period, OPG completed the deterministic safety analyses for the Slow Loss Of Regulation (SLOR), Loss of Flow (LOF), and Small Break Loss of Coolant Accident (SBLOCA) for future aged conditions for all Pickering units.

Progress reports on OPG Heat Transport System Aging Safety Analysis will continue to be submitted to the CNSC annually. The most recent progress report was submitted in February 2017. (Reference 19)

Pickering NGS has adequate provisions in place by which the effects of aging are managed to ensure that safety analysis margins are being maintained through to the end of commercial operation.

2.4.4 Risk and Reliability Program

The *Risk and Reliability Program*, N-PROG-RA-0016, establishes a framework for the development and use of Probabilistic Safety Assessment (PSA) as a means to manage radiological risks and to contribute to safe reactor operation. The PSA is used to assess the magnitude and frequency of radiological risks to the public, and operational reliability monitoring and reporting ensures that systems important to safety are monitored and managed.

Program elements have been developed to meet the intent of CNSC regulatory requirements in regulatory document RD/GD-98, *Reliability Programs for Nuclear Power Plants*.

Under the Risk and Reliability Program, actual station specific component failure data are collected and added to generic industry component failure data to obtain component failure rates. This component failure rate information is updated in models to derive an annual result for system Predicted Future Unavailability (PFU) of the Systems Important to Safety (SIS). This information is reported in the *Annual Risk and Reliability Report* which allows OPG to assess the performance of the SIS against their PFU targets, as well as to identify and take corrective actions in case the PFU results do not meet the targets.

The risk assessment models are also used operationally to assess the nuclear safety risk associated with taking station equipment out of service for maintenance during normal operation or during planned maintenance outages. This tool provides insight into the risk of plant configurations, enabling the application of alternate layers of defense, where required. Based on these assessments, changes to scheduled activities are made to reduce the risk level, if required.

2.4.5 Probabilistic Safety Assessment

Probabilistic Safety Assessment (PSA) is a tool used to help demonstrate that the design and operation of a nuclear power plant poses an acceptably low level of risk to the public. The main benefits of PSA include the identification of risk insights that can be used to improve the safety of plant design and operation. The results of the PSAs are compared with OPG's safety goals as documented in N-PROG-RA-0016, *Risk and Reliability Program*.

Hazard analysis is conducted as an initial step to probabilistic safety assessments. This involves the assessment and screening of various types of hazards: internal and external hazards, naturally occurring and human-induced.

Based on the hazard screening process, PSAs are developed for internal events, internal floods, internal fires, seismic events, and high winds. All other hazards identified were screened out and dispositioned to be of very low risk.

Pickering PSAs

The purpose of a PSA is to establish whether the design and operation of the plant poses an acceptable level of risk to the public and to identify the major sources of risk. The overall conclusion of the Pickering A and the Pickering B PSA is that the public risk from Pickering NGS operation is low.

In 2014 OPG updated selected elements of the Pickering A and B PSAs to include the Fukushima Action Plan (FAP) items, namely the Phase 1 Emergency Mitigating Equipment (EME) and other enhancements. These FAP updated PSAs were submitted to the CNSC in 2014 and showed that the EME reduces the Pickering NGS risk.

For each of the Pickering NGS PSAs (Pickering A and B, Level 1 and Level 2 PSAs for internal and external events, at power and outage), the OPG safety goals were met. Where the PSA results were found to be below the OPG safety goals but above the more stringent administrative safety goals, a risk improvement plan (or action plan) was prepared and submitted to CNSC detailing physical and analytical improvements to further reduce the plant risk where practicable. An annual update to this risk improvement plan has been provided to the CNSC since 2014.

As per regulatory requirements, the PSAs for Pickering are being updated on a periodic basis to reflect changes in the station. The updated PSA for Pickering NGS B will be completed and submitted to the CNSC by the end of 2017, and the PSA for Pickering NGS A will be updated and submitted by the end of 2018; these updates will be compliant with CNSC regulatory standard S-294. In accordance with the implementation plan for REGDOC-2.4.2, the additional new PSA requirements in this regulatory document will be addressed by the end of 2020.

Whole-Site Risk

During the previous Pickering relicensing hearing, the topic of “whole-site” risk was raised (given that the current PSAs and safety goals are per-unit based). Whole-site risk refers to the characterization of the overall risk of the site due to: multiple reactor units, other on-site sources of radioactivity (such as the irradiated fuel bays), internal and external hazards, and other reactor operating modes (besides full power and outage states).

The key issues associated with this topic include: a lack of international consensus on the methodology, the appropriateness of risk aggregation, and the acceptance criteria for a site-based risk assessment. For instance, a multi-unit PSA risk result is generally not equal to the per-unit risk value multiplied by the number of units on site.

In response to this issue at the time, OPG committed to perform a whole-site risk assessment for Pickering by the end of 2017 and submitted to the CNSC a concept-level report on whole-site PSA methodology, COG-13-9034 *Development of a Whole-Site PSA Methodology*, in collaboration with the CANDU Owners Group (COG). This COG report was made publically available on OPG’s external website.

In addition, OPG supported a COG-hosted international workshop (January 2014) and participated in a CNSC-hosted international workshop (November 2014) on topics related to whole-site PSA.

Since then, a COG joint project was launched to further develop the concepts in the COG paper and to complete a Pickering whole-site risk assessment. The work has progressed in collaboration with the industry and updates have been provided to the CNSC. In addition, OPG has actively participated in and monitored international developments in the area of whole-site risk. The Pickering whole-site risk assessment will be submitted to CNSC by the end of 2017, to further substantiate that the risk of the whole Pickering site is low.

2.4.6 Severe Accident Management

OPG's *Beyond Design Basis Accident Management program* has been implemented through N-STD-MP-0019. Severe accident management provides an additional layer of defence in depth to mitigate the consequences of accidents that fall beyond the scope of events considered in the plant design basis and is supported in its execution by the Emergency Response Organization.

Severe accident analysis has been conducted to support Level 2 PSA, as part of regulatory document, S-294 compliance, and in response to the Fukushima Action Items. Extensive analysis was carried out to identify beyond design basis events with the potential (albeit highly unlikely) to result in significant core damage and large offsite releases of radioactive material (severe accidents). This work included habitability studies to evaluate the impact of such events on the ability of station personnel to carry out actions as part of the emergency response.

The program ensures the safety of the public, environment, plant personnel and the station during a Beyond Design Basis Accident (BDBA) by identifying and implementing operational strategies to terminate the event progression and mitigate the consequences in order to ensure that fuel damage is precluded or limited. Operational strategies include maintaining the containment envelope to limit radiological release and achieving a stable plant configuration as soon as possible.

BDBA operational strategies are referred to as Emergency Mitigating Equipment Guidelines (EMEGs) and Severe Accident Management Guidelines (SAMGs).

EMEGs have a primary focus on fuel cooling, and are used to mitigate accident progression when design basis equipment is unable to provide adequate core cooling. The intent of EMEG use is to prevent a BDBA sequence from progressing to a severe accident.

SAMGs have a focus on both containment integrity and fuel cooling and their use is initiated if an event has progressed to the severe accident stage. The goals of SAMGs are to terminate progression of core damage by restoring cooling, and to maintain containment integrity and minimize radioactive releases.

2.4.7 Criticality Safety

The objective of criticality safety focuses on the prevention of the criticality of fuel outside the core, for either new or irradiated fuel.

The Pickering reactors use natural uranium fuel which cannot achieve a criticality event without a heavy water moderator. New fuel is stored in such a manner that the new fuel cannot be made critical.

Irradiated natural uranium fuel is stored under light water and cannot be made critical in any configuration; therefore no criticality risk exists in the irradiated fuel bays.

2.4.8 Management of Safety Issues

The Safety and Licensing (S&L) Research and Development (R&D) program addresses issues related to the safety design basis and safe operating envelope of existing nuclear plants, in collaboration with the CANDU Owner's Group (COG). There is a strong focus on supporting the resolution of outstanding generic S&L issues and safety margin improvement initiatives. The program takes into consideration both Canadian and international operating experiences in identifying and selecting R&D work to be performed. In part, this work also supports safety assessments for new plant designs and refurbishments and assists in maintaining the core capabilities, scientific expertise, and the infrastructure necessary for an ongoing nuclear safety R&D program.

Pickering-specific safety analysis issues are also addressed via the OPG Reactor Safety Program as well as the Risk and Reliability Program (for PSA issues).

The COG Industry Standard Toolset Program is a consolidation of the maintenance and support, development and qualification activities of the computer codes used for the design, safety analysis and operational support of CANDU reactors.

The COG R&D program overview report and operational plans are submitted to the CNSC as part of annual reporting requirements in accordance with REGDOC-3.1.1. This submission provides a summary of the work completed in the previous year and the on-going R&D activities that are being performed under the COG R&D and IST program. As well, COG-CNSC R&D seminars are held bi-annually.

2.4.9 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document Number	Document Title
N-PROG-MP-0014	Reactor Safety Program
N-PROG-RA-0016	Risk and Reliability Program
N-STD-MP-0019	Beyond Design Basis Accident Management
N-PROC-MP-0086	Safety Analysis Basis and Safety Report Updates

Document Number	Document Title
N-STD-RA-0034	Preparation, Maintenance and Application of Probabilistic Risk Assessment
NA44-SR-01320-00001	Pickering A Safety Report
NA44-SR-01320-00002	Pickering Nuclear 1-4 Safety Report Part 3: Accident Analysis
NA44-REP-00531.7-10001	Pickering A Analysis of Record
NK30-SR-01320-00002	Pickering B Safety Report - Part 2
NK30-SR-01320-00003	Pickering Nuclear 5-8 Safety Report Part 3: Accident Analysis
NK30-REP-00531.7-00001	Pickering B Analysis of Record
N-PROG-MP-0006	Software
NA44-GUID-03611-00010	Pickering NGS A Probabilistic Risk Assessment Guide – Level 1 At-Power
NA44-GUID-03611-00011	Pickering A Probabilistic Risk Assessment (PRA) Guide – Level 2 (At-Power)
NA44-GUID-03611-00012	Pickering 014 Probabilistic Risk Assessment Guide – Level 1 Outage for Internal Events
NA44-GUID-03611-00013	Pickering NGS A Probabilistic Risk Assessment Guide – Fire
NA44-GUID-03611-00014	Pickering NGS Probabilistic Risk Assessment (PRA) Guide – Internal Flood
NA44-GUID-03611-00015	Pickering NGS A Probabilistic Risk Assessment Guide – Seismic
N-CORR-00531-06350	Pickering NGS A - Outage Probabilistic Risk Assessment (PRA) for Seismic Events
N-CORR-00531-06351	Pickering NGS A - Outage Probabilistic Risk assessment (PRA) for High Winds
N-CORR-00531-06432	Pickering NGS A – Outage Probabilistic Risk Assessment (PRA) for Internal Floods
N-CORR-00531-06433	Pickering NGS A – Outage Probabilistic Risk Assessment (PRA) for Internal Fires
N-CORR-00531-06439	Pickering NGS A – Level 2 At-Power Probabilistic Risk assessment (PRA) for Internal Floods
NA44-REP-03611-00011	Hazards Screening Analysis- Pickering A
NA44-REP-03611-00012	Pickering NGS A Level 1 At-Power Internal Events Risk Assessment (PARA-L1P)
NA44-REP-03611-00013	Pickering NGS A Level 2 At-Power Internal Events Risk Assessment (PARA-L2P)
NA44-REP-03611-00014	Pickering NGS A Level – 1 Outage Internal Events Risk Assessment (PARA-L1O)
NA44-REP-03611-00021	Pickering NGS A Internal Flood Probabilistic Risk Assessment (PARA Flood)
NA44-REP-03611-00022	Pickering NGS A PRA – Based Seismic Margin Assessment (PARA Seismic)
NA44-REP-03611-00023	Pickering NGS A Level 1 High Wind Probabilistic Risk Assessment
NA44-REP-03611-00038	Pickering NGS A Probabilistic Risk Assessment (PRA) – Internal Fire Report
N-GUID-03611-10001 Volume 1	OPG Probabilistic Risk Assessment (PRA) Guide-Level 1 (At Power)
N-GUID-03611-10001 Volume 2	OPG Probabilistic Risk Assessment (PRA) Guide Volume 2 – Level 2 (At Power)
N-GUID-03611-10001 Volume 4	OPG Outage Probabilistic Risk Assessment (PRA) Guide-Level 1
N-GUID-03611-10001 Volume 5	OPG Probabilistic Risk Assessment (PRA) Guide-Fire
N-GUID-03611-10001 Volume 6	OPG Probabilistic Risk Assessment (PRA) Guide-Internal Flood
N-GUID-03611-10001 Volume 7	OPG Probabilistic Risk Assessment (PRA) Guide-Seismic

Document Number	Document Title
N-GUID-03611-10001 Volume 8	OPG Probabilistic Safety Assessment (PSA) Guide-External Hazard Screening
N-GUID-03611-10001 Volume 9	OPG Probabilistic Risk Assessment (PRA) Guide-Internal Hazards Screening
N-GUID-03611-10001 Volume. 10	OPG Probabilistic Risk Assessment Guide – High Wind Hazard
NK30-REP-03611-00006	Pickering NGS B Level 1 At-Power Internal Events Risk Assessment
NK30-REP-03611-00008	Hazards Screening Analysis – Pickering B
NK30-REP-03611-00009	Pickering NGS B Level 1 Outage Internal Events Risk Assessment
NK30-REP-03611-00010	Pickering NGS B At-Power Level 2 Probabilistic Risk Assessment (PRA) for Internal Initiating Events
NK30-REP-03611-00011	Probabilistic Risk Assessment Level 2 Outage Report – Pickering B
NK30-REP-03611-00012	Pickering NGS B Probabilistic Risk Assessment – Internal Fire Final Report
NK30-REP-03611-00013	Pickering NGS B (PNGS - B) PRA Based Seismic Margin Assessment (SMA)
NK30-REP-03611-00014	Pickering NGS B Internal Flood Probabilistic Risk Assessment (PBRA Flood)
NK30-REP-03611-00020	Pickering NGS B High Wind Probabilistic Risk Assessment
N-CORR-00531-04548	Submission of OPG Probabilistic Risk Assessment (PRA) Computer Codes
N-CORR-00531-04858	Submission of OPG Accident Sequence Quantification (ASQ) Tool
N-CORR-00531-05159	Submission of OPG Sensitivity and Uncertainty MAAP4-CANDU Post-Processing and Input Generation and Analysis Scripts
N-CORR-00531-05596	Submission of MAAP4-CANDU Version 4.0.7C for CNSC Acceptance in Accordance with S-294
N-CORR-00531-05492	Acceptance of Software Packages Used in OPG's Probabilistic Risk Assessments
N-CORR-00531-06093	Submission of MAAP4-CANDU Version 4.0.7D for CNSC Acceptance in Accordance with S-294
N-CORR-00531-05491	External Hazards Screening Methodology – Outage Unit
P-CORR-00531-03780	Pickering A and B – Internal and External Hazards Screening Analysis- Single and Coincidental Outage Unit
N-CORR-00531-05928	Pickering NGS B – Methodology for a Reduced Scope At-Power Level 2 Probabilistic Risk Assessment (PRA) for Seismic Events
N-CORR-00531-05961	Pickering NGS B – Outage Probabilistic Risk Assessment (PRA) for Internal Fires
N-CORR-00531-05962	Pickering NGS 'B' – Outage Probabilistic Risk Assessment (PRA) for High Winds
N-CORR-00531-05959	Pickering NGS 'B' – Methodology for a Reduced Scope Level 2 Outage Probabilistic Risk Assessment (PRA) for Internal Events
N-CORR-00531-05960	Pickering NGS 'B' – Outage Probabilistic Risk Assessments (PRA) for Internal Floods
N-CORR-00531-05927	Pickering NGS 'B' – Level 2 At-Power Probabilistic Risk Assessment (PRA) for Internal Floods
N-CORR-00531-05930	Pickering NGS 'B' – Outage Probabilistic Risk Assessment (PRA) for Seismic Events
N-CORR-00531-05997	Pickering NGS B – Level 2 At-Power Probabilistic Risk Assessment (PRA) for High Winds

2.5 Physical Design

Pickering NGS has an effective program to maintain its design basis that meets all applicable regulatory requirements and related objectives. The structures, systems, and components at Pickering remain available, reliable, effective, and consistent with design, analysis, and quality control measures.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and ongoing activities over the next licensing period. These discussions also support that:

- Systems, structures and components at the plant are fit to continue commercial operation and programs will ensure fitness-for-service during the next licence period (e.g., Sections 2.5.4 to 2.5.6).
- OPG continues to invest in Pickering to support the assurance of fitness for service through procurement and fuel inspections (e.g., Sections 2.5.3 and 2.5.4).
- Nuclear safety is assured by maintaining the plant's pressure boundary and ensuring key mitigating equipment is qualified (e.g., Sections 2.5.5 and 2.5.6).

2.5.1 Conduct of Engineering and Design Management

The *Conduct of Engineering* program, as defined in N-PROG-MP-0007, defines the programs and processes to ensure that engineering is performed consistently across OPG Nuclear.

The *Design Management* program, as defined in N-PROG-MP-0009, sets the overall requirement for execution and control of activities that provide design support and documentation for the nuclear facility.

These programs provide assurance that all design activities and their resulting documentation are controlled in a manner consistent with the plant's licensing basis. The program defines the minimum set of documentation that identifies and describes the design basis, design outputs and design processes.

2.5.2 Engineering Change Control

Design changes are performed in accordance with OPG's program N-PROG-MP-0001, *Engineering Change Control*. The Engineering Change Control (ECC) program ensures design changes to each OPG Nuclear facility (including systems, structures, or components; software; and engineered tooling) are planned, designed, installed, commissioned and placed into or removed from service such that the facility configuration is managed in accordance with the design and licensing bases, and remains within the safe operating envelope.

The health of the design and ECC programs is monitored using the ECC site index. The index incorporates metrics associated with quality of design ECC packages, ECC process compliance, and the timely updating of records and closeout of modifications. Pickering performance in the ECC site index was generally strong during the current licence term.

Timeliness of Engineering Change (EC) close out activities has generally improved over the licensing period, including completion of significant efforts to eliminate the backlog of records that needed updating to reflect installation of past modifications, and to reduce the number of temporary modifications installed in the Pickering facility and bring that number in line with industry best practices. Reduction of the backlog of open EC's was completed in 2016 and remains low.

2.5.3 Procurement Engineering

The Procurement Engineering (PE) process involves a technical review of items and services in order to establish purchasing and acceptance requirements. The procurement process ensures that items and services meet the design intent and also supports plant operations in resolving technical issues related to purchases.

The process is applicable to individual items, generic classes, and services. The procurement requirements include technical and quality requirements, acceptance criteria and acceptance methods, and are established in order to assure that properties and attributes of importance are imparted to the item being purchased.

2.5.4 Fuel

The primary objectives of the *Fuel* program, N-PROG-MA-0016 are to establish a formal and systematic process for ensuring the safe use of fuel in OPG's nuclear reactors.

This program specifies the requirements for monitoring, integrating and assessing fuel-related information and details the documentation requirements for issues identified by this program. It requires regular cross-discipline reviews to ensure the safe operation of the plant and to facilitate efforts to operate with zero fuel defects.

The program also incorporates the reporting requirements associated with demonstrating fuel compliance within the fuel design basis.

Radioiodine levels have remained below station shutdown limits at Pickering NGS during the licensing period. In addition, improvements have been made to the fuel defect management process.

Post-discharge fuel inspections and post-irradiation hot cell examinations of samples of the fuel discharged in the last five years of operation indicate that the fuel condition remains within the design basis compliance envelope for wear and deformation.

Mitigation measures for eliminating the black deposits which were observed on the fuel in Unit 1 from 2011 - 2015 have been successful. As a result, the number and size of deposits recorded and the total coverage continue to decline. Pickering will continue to monitor the fuel for any changes and report as required.

2.5.5 Pressure Boundary Program

The objective of the *Pressure Boundary Program*, N-PROG-MP-0004 is to manage the processes that control the quality of pressure boundary activities at OPG. The program establishes the infrastructure and defines the activities necessary to maintain a sustainable managed process that allows OPGN to perform activities associated with repairs, replacements, modifications and alterations to pressure retaining items, components and systems, including installation of new systems.

The Pressure Boundary program is a mature program that is compliant with the mandated codes and standards. Pickering NGS has implemented CSA N285.0-2008 with Update No. 2 by revising the *Pressure Boundary Program Manual*, along with associated procedures to comply with the standard.

After a successful assessment in 2017 by TSSA (Technical Standards and Safety Authority) demonstrating pressure boundary processes to be in compliance with the applicable codes and standards, Certificates of Authorization (C of A) for pressure boundary activities were renewed for three years, until April 15, 2020.

2.5.6 Environmental Qualification

The *Environmental Qualification* (EQ) program is defined in document N-PROG-RA-0006, and is compliant with standard CSA N290.13-05.

The objective of the program is to ensure that all required systems, equipment, components, protective barriers, and structures are qualified to perform their safety functions under the environmental conditions defined by the Pickering design-basis accidents.

The program includes the procedures and processes to systematically identify the equipment to be environmentally qualified, the environmental conditions to be used for qualification and the required documentation.

EQ is an on-going program ensuring that aging is managed, obsolescence is taken into account and that qualification configurations are maintained.

2.5.7 Software

The objective of the *Software* program, N-PROG-MP-0006, is to identify the processes and overall requirements for software that supports safe and efficient plant operation. This program applies to software classified as Real-Time Process Computing (RTPC) and Scientific, Engineering and Safety Analysis (SESA) Software

or Software Engineering Tools in OPGN. Software is classified in order to determine the set of applicable standards and procedures for its custom development, maintenance, acquisition, qualification, use and retirement. For each classification the detailed requirements are tailored to the significance of the software.

For the development of RTPC systems within OPGN, N-PROC-MP-0099, *Development of Real-Time Process Computing Systems* provides a systematic and uniform process for development. This procedure defines requirements on the development of RTPC systems.

The SESA portion of the software governance manages the analytical tools credited to support the design or maintenance of safety related systems with particular emphasis on the requirements of standard CSA N286.7. Software classified as SESA is extended to apply to all analytical software used within OPGN whose failure or misuse can lead to a safety (conventional, radiological or environmental), licensing or reliability impact on the facility.

2.5.8 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
N-PROG-MP-0007	Conduct of Engineering
N-PROG-MP-0001	Engineering Change Control
N-STD-MP-0027	Configuration Management
N-PROG-MP-0009	Design Management
N-PROG-MA-0016	Fuel
N-PROG-MP-0004	Pressure Boundary Program
N-PROC-MP-0040	System and Item Classification
N-PROC-MP-0082	Design Registration
N-PROG-MP-0006	Software
N-MAN-01913.11-10000	Pressure Boundary Program Manual
N-CORR-00531-06752	Authorized Inspection Agency service Agreement
N-INS-08173-10050	Procurement from Licensed Canadian Nuclear utilities
N-LIST-00531-10003	Index to OPG Pressure Boundary Program Elements
N-PROG-RA-0006	Environmental Qualification

2.6 Fitness for Service

Pickering NGS has an effective fitness for service program that meets or exceeds all applicable regulatory requirements and related objectives. The physical condition of structures, systems and components at Pickering remain available, reliable, effective and consistent with design, analysis and quality control measures.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, ongoing activities and planned improvements over the next licensing period. These discussions also support that:

- Equipment reliability is maintained and programs will continue to improve reliability during the next licence period (e.g. Sections 2.6.1, 2.6.3, 2.6.5, 2.6.7, and 2.6.8).
- Systems, structures and components at the plant are fit to continue commercial operation and inspection programs will ensure fitness-for-service during the next licence period (Sections 2.6.2 to 2.6.4).
- OPG continues to invest in Pickering to support the improvement of equipment reliability and assurance of fitness for service (e.g. Sections 2.6.4, 2.6.5, and 2.6.8).
- Nuclear safety is assured through periodic inspection, testing, and maintenance of plant systems, structures, and components (Sections 2.6.4, 2.6.5, and 2.6.7)

2.6.1 Equipment Reliability

The objective of the *Equipment Reliability Program*, N-PROG-MA-0026, is to improve station equipment reliability and reduce forced loss rate by ensuring high levels of reliable performance of components important to nuclear safety and production.

The equipment reliability process represents the integration and coordination of a broad range of equipment reliability activities into one program for plant personnel to evaluate important station equipment, develop and implement long-term equipment health plans, monitor equipment performance and condition, and make continuing adjustments to preventive maintenance tasks and frequencies based on equipment operating experience. This process includes surveillance and testing, Life Cycle Management (LCM) planning, and equipment performance and condition monitoring.

Pickering has performed benchmarking against other plants through participation in the Equipment Reliability Working Group (ERWG) of the CANDU Owners Group (COG). COG has established the Equipment Reliability Index (ERI) which the industry uses to assess the health of a plant's reliability program and performance and enables benchmarking against other plants. This index provides an aggregate assessment of equipment reliability and the supporting programs. See Figure 6 for the ERI data.

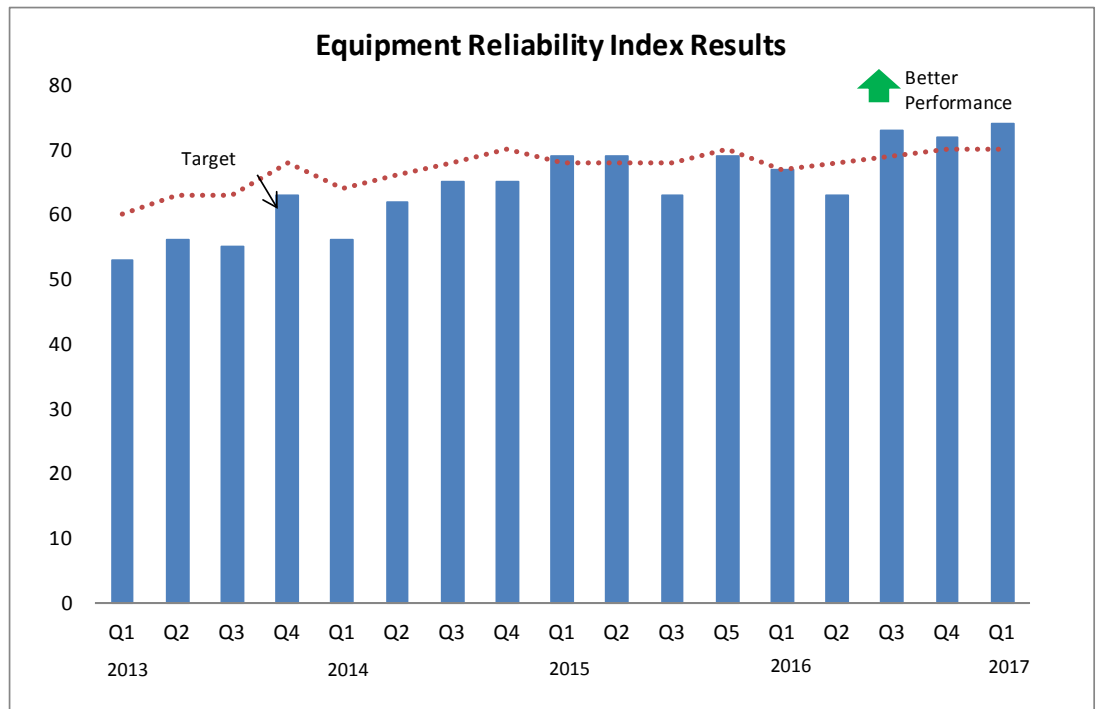


Figure 6 - Equipment Reliability Index (ERI)

The ERI score is derived from 17 key weighted sub-indicators which add up to a maximum score of 100. Pickering's ERI score has significantly improved over the course of the current licence period. This improvement is the result of various equipment reliability initiatives. At the end of 2016, the ERI was 72 versus a target of 70, and in June 2017 the ERI is 74 against a 2017 target of 72.

An increased ERI score is reflected in a reduction in Forced Loss Rate (FLR), a measure of the amount of gross unplanned production losses in a period of time. In 2015 and 2016, Pickering achieved its two best FLR values ever, 2.89% and 4.08% respectively.

2.6.2 Major Components

The *Major Components Program* is described in program document N-PROG-MA-0025. It establishes an integrated set of processes and activities to demonstrate fitness for service of Fuel Channels, Feeders, Steam Generators and Reactor Components and Structures, and develops long term life cycle management strategies for continued operation.

This program ensures that these four major components will perform safely and reliably until the end of commercial operations, maintaining design and licensing bases and operational safety requirements while optimizing production and cost-effectiveness.

Fuel Channels

The fuel channel life cycle management program facilitates the safe operation of the fuel channels to the Pickering specified targeted operating life, and is constructed based on many years of inspection, monitoring, and mitigation of known degradation mechanisms. With the implementation of the Fuel Channel Life Cycle Management Plan (LCMP), N-PLAN-01060-10002, OPG will continue to demonstrate that these degradation mechanisms are understood, and confirm that component condition remains acceptable via monitoring and inspection.

OPG's planned research and development activities continue to support demonstration of understanding of key degradation mechanisms, material properties and component fitness for service. Research and development findings, as well as inspection results and industry operating experience are incorporated into the fuel channel program to maintain adequate margins on fitness for service for the station operational life. Enhancements and improvements in engineering assessments have provided margin and incorporation of new models from the applicable standards.

Steam Generators

The goal of the steam generator life cycle management program is to maintain steam generator performance and reliability for operation until the end of commercial operation through the implementation of the LCMP, N-PLAN-33110-10009.

Steam Generators are closely monitored by an inspection program to manage active and plausible degradation mechanisms. The inspection results demonstrate that life-limiting degradation mechanisms are being monitored and mitigated. There were no boiler tube leaks detected in the current licensing period. This is due to sound inspection and maintenance strategies, which complies with standard CSA N285.4 Clause 14 requirements.

Through the inspection program, a new degradation mechanism was discovered in the steam generators on Pickering Unit 4. Based on strong technical rigor, detailed analysis, and conservative decision making, the degradation is under control and mitigating actions have been implemented.

Feeders

The goal of the feeder piping system life cycle management program is to maintain the integrity of the feeder piping system until the end of commercial operation through the implementation of LCMP, N-PLAN-01060-10001.

The Pickering feeder piping system's continuing fitness for service is demonstrated by inspection and assessment activities. Advanced stress analysis methodologies have been used to demonstrate that the required minimum wall thickness can be safely reduced in order to minimize or eliminate feeder replacement resulting from flow accelerated corrosion. Feeder fretting and contact with other components will continue to be closely monitored with visual inspections and with the incorporation of operating experience.

The COG Feeder Joint Integrity Project has produced feeder fitness for service guidelines, which are used in addition to ASME codes, as acceptance criteria for feeder degradation assessments. A feeder replacement schedule is developed from the most recent feeder thinning inspections and assessments of remaining life based on minimum required wall thickness, to demonstrate fitness for continued service. Feeder replacements will continue to be assessed for Pickering out to end of commercial operation.

Reactor Components and Structures

The Reactor Components and Structures LCMP, N-PLAN-01060-10003, is intended to establish the strategy or identify necessary actions to ensure that the effects of aging on reactor components and structures are appropriately managed for the plant operating life. The plan is updated annually and assessments are incorporated into the life cycle management strategies.

Reactor component and structures inspections and assessments continue to demonstrate fitness for service of these components. OPG expects that continued inspections and monitoring will effectively manage the degradation mechanisms to the end of commercial operation.

2.6.3 Aging Management

The *Integrated Aging Management (IAM)* Program, documented in N-PROG-MP-0008 ensures that the condition of Structures Systems and Components (SSC) and critical station equipment is understood and that required activities are in place to assure the health of the SSC's, through plant aging.

Integrated aging management is implemented with the following programs:

N-PROG-MA-0025, *Major Components* develops long-term life cycle management strategies that support continued fitness for service for major components.

The life cycle plans are established by a comprehensive Condition Assessment (CA) process. Condition assessments supplement the ongoing engineering surveillance activities in place to monitor and optimize system performance. These CA's focus on the aging mechanisms, current condition and recommended actions required to maintain the health of the component in order to reach Pickering NGS end of commercial operation.

N-PROG-MA-0026, *Equipment Reliability* establishes the process for Equipment Reliability (ER) for critical components. The ER Program and its implementing procedures ensure that critical components meet their defined or desired level of reliability for the lifespan of the station.

N-PROG-MA-0017, *Component and Equipment Surveillance* defines the requirements for the surveillance of a select set of components including inspection, maintenance, certification, and testing. Heat exchangers, check valves and power operated valves are examples of the defined component programs. Pipe wall thickness, pressure relief valves and buried piping are examples of equipment undergoing inspection and testing programs.

2.6.4 Periodic Inspection and Testing

The objective of the periodic inspection program and the in-service inspection program is to ensure pressure boundary integrity, fitness for service, and aging management of the nuclear plant systems and components in Pickering.

The program provides assurance that the likelihood of a failure that could endanger health and safety is being maintained low.

The programs are documented in specific periodic inspection program plans and associated inspection schedules and they are administered under nuclear and station governing documents.

The periodic inspection program for standard CSA N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components*, consists of approximately 300-600 inspection items for each of the six operating units. Each scheduled item is normally inspected once within each 10-year cycle. Inspected components include: piping and vessel welds, pumps, valves, pipe and component supports, heat exchangers, and mechanical couplings.

The periodic inspection program for standard CSA N285.5, *Periodic Inspection of CANDU Nuclear Power Plant Containment Components*, consists of approximately 100 inspection items for Unit 0 and 200-600 inspection items for each of the six operating units. Each item is normally inspected once within each 10-year cycle. Inspected components include: containment penetration seal welds, pipe supports, piping/ducting, valves, containment dampers and other components.

Baseline inaugural inspections are performed for newly installed equipment and components that are inspected under either the CSA N285.4 or CSA N285.5 program. These inspections are used to establish the condition of the SSC at the time it was placed into service. This ensures that when the standard inspections are performed on 10-year cycles there will be at least one previous result for each SSC, thus always allowing for comparative analysis between inspection results.

Inspections/testing of Vacuum Building (VB) and Pressure Relief Duct (PRD) containment structures were last performed during the 2010 Vacuum Building Outage under CSA N287.7, *In-Service Examination and Testing Requirement for Concrete Containment Structures for CANDU Nuclear Power Plants*. Inspection activities involved concrete components, vacuum building joint sealant, vacuum building roof seal and pressure relief duct joint seals. Pickering NGS will continue to meet regulatory requirements for VB and PRD inspections.

Structural Integrity

The station's principal structures consist of eight reactor buildings, two main control rooms (one for Pickering Units 1-4 and one for Pickering Units 5-8), two reactor auxiliary bays, two powerhouses (including the turbine hall and turbine auxiliary bay, the Vacuum Building (VB) with its associated Pressure Relief Duct (PRD), a service wing, an administration building, two irradiated fuel bays, an auxiliary irradiated fuel bay, a heavy water upgrading building, two screenhouses, a water treatment

building, a high pressure Emergency Coolant Injection (ECI) pumphouse, and an ECI water storage tank. The administration and service buildings, heavy water upgrading building, VB and ECI structures serve the entire unit station.

Pickering NGS follows the CSA standard N285.5, *Periodic Inspection of CANDU Nuclear Power Plant Containment Components* and CSA standard N287.7, *In-service Examination and Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants*, for reactor building integrity.

The reactor building undergoes inspection for integrity during every planned unit outage. These inspections are covered under the Periodic Inspection Plan (PIP) which is overseen by the Components Engineering group. A reactor building pressure test is performed every 6 years to check for reactor building leak tightness.

The Units 1-4 underwater concrete structure and the Units 5-8 underwater concrete structure were inspected during the station vacuum building outage in 2010, to confirm their structural integrity and operational adequacy. The topic of the condition of the underwater concrete structures was discussed at the previous Pickering licence renewal hearings, and the matter continues to be managed as part of OPG's aging management program and is being considered via the PSR process in support of continued operations.

2.6.5 Non-destructive Examination

Non-destructive Examination (NDE) has a direct bearing on the safe and reliable operation of nuclear facilities and is performed in accordance with applicable codes and standards. NDE is governed by I-STD-AS-0003, *Non-Destructive Examination*, which ensures that NDE is conducted in a planned and controlled manner using approved procedures and qualified personnel.

Inspection and Maintenance Services (IMS), a division of Ontario Power Generation Nuclear (OPGN), provides inspection, specialized maintenance, project management, and technical services to nuclear and non-nuclear facilities in accordance with program document I-PROG-AS-0001, *Conduct of Inspection and Maintenance Services*.

2.6.6 Chemistry Control

The objective of the *Chemistry* program, N-PROG-OP-0004, is to specify processes, requirements, and staff accountabilities to ensure effective control of plant chemistry, including provision of analytical services. The chemistry program covers activities associated with overall objectives of controlling plant chemistry in order to ensure safe plant operation and to protect the long term life of SSC's.

The Chemistry Performance Index (CPI) compares the concentration of selected impurities and corrosion products to corresponding limiting values, with focus on secondary system chemistry. The limiting values are periodically reviewed against industry best practices to ensure they continue to represent challenging targets. The measure is reported as a twenty-four month rolling average.

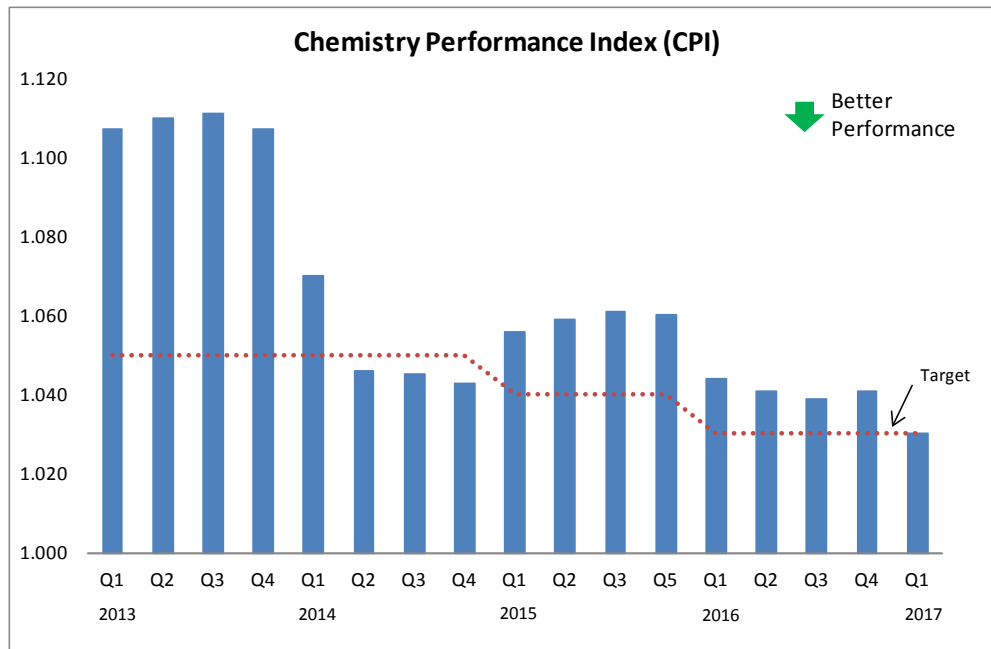


Figure 7 - Chemistry Performance Index (CPI)

As shown in Figure 7, the trend indicates improving performance. This is a reflection of combined efforts to improve the water treatment plant performance, as well as to improve start-up chemistry and outage practices, and to eliminate condenser cooling water ingress.

2.6.7 Maintenance

Program document N-PROG-MA-0004, *Conduct of Maintenance* is designed to ensure plant equipment is maintained to maximize safety and reliability through effective implementation and control of maintenance activities.

The Maintenance programs are organized to align closely with the Engineering, Work Management, Operations and Supply Chain organizations to support equipment fitness for service requirements.

The intent of the maintenance program is to ensure that safety systems remain available and that equipment failures are minimized. This is accomplished through corrective and preventive maintenance activities as well as routine inspections of system components to ensure they continue to operate as expected. N-PROG-MA-0019, *Production Work Management Program*, details the requirements for identifying, prioritizing, planning, scheduling and executing work in support of the operation, maintenance and modification of the plant.

Maintenance is a key component in equipment reliability. The Maintenance Department is focusing on improving maintenance technical skills, maintenance fundamentals and craftsmanship in order to assure the quality of the maintenance at Pickering.

2.6.8 FH Reliability

A primary focus of the Pickering NGS Fuel Handling (FH) group is to improve FH equipment reliability (ER). In 2014/2015 an Equipment Reliability Index (ERI) metric was developed specifically for FH in conjunction with the COG peer team to track ER improvement. Pickering NGS is taking the lead on various changes to the FH ERI metric indicators in order to improve its ability to accurately reflect ER condition in the station, and to aid as a predictor and tool for driving ER improvements. FH ERI has trended upwards since 2015.

Pickering NGS FH developed a reliability plan in 2012/2013 based on key performance indicators in specific equipment areas. From 2014 onwards, annual self assessments have been performed to analyze the overall effectiveness of the ER strategy. This plan has been modified over the years to best reflect the station's current needs.

The primary lagging indicator for FH ER is Forced Loss Rate due to FH equipment issues. FLR related to FH equipment was approximately 1.54% in 2016, with year to date for 2017 showing improvement from the 2016 value.

Some examples of recently completed reliability initiatives include the 014 Fuelling Machine (FM) 90 degree rotation modification, which eliminated obsolescence and reliability concerns; the D₂O and head oil supply filter element upgrades, and the FM cable catenary replacements. Progress continues on repairing the Irradiated Fuel Bay 'B' (IFB-B) liner leakage.

Planned Improvements

One of the major reliability focus areas for 2017/2018 is the upgrade to the FM ram seals, which is a joint project between OPG, COG and New Brunswick Power - Point Lepreau. This seal redesign is expected to mitigate the primary failure modes of the current seals, decrease failure rates, and extend the life of the ram seals.

2.6.9 Maintenance Backlog

Pickering Nuclear endeavours to ensure that work is prioritized, planned and executed in a manner that focuses on maintaining personnel and nuclear safety, increases plant equipment reliability and reduces the station Forced Loss Rate.

Part of the prioritization of this work is in identifying components important to safety and reliability and to ensure that where those components can no longer reliably perform their function, that the repair is executed with priority. These components receive coding per N-PROC-MA-0008 as either Corrective Critical (CC) or Corrective Non-Critical (CN), depending on component risk ranking.

It is a priority to ensure that CC and CN backlog is maintained low, which in turn allows important preventive maintenance programs to be executed and maintain system designed redundancy.

As shown in the Figure 8, the volume of corrective maintenance backlog work orders continues to steadily decrease since 2014.

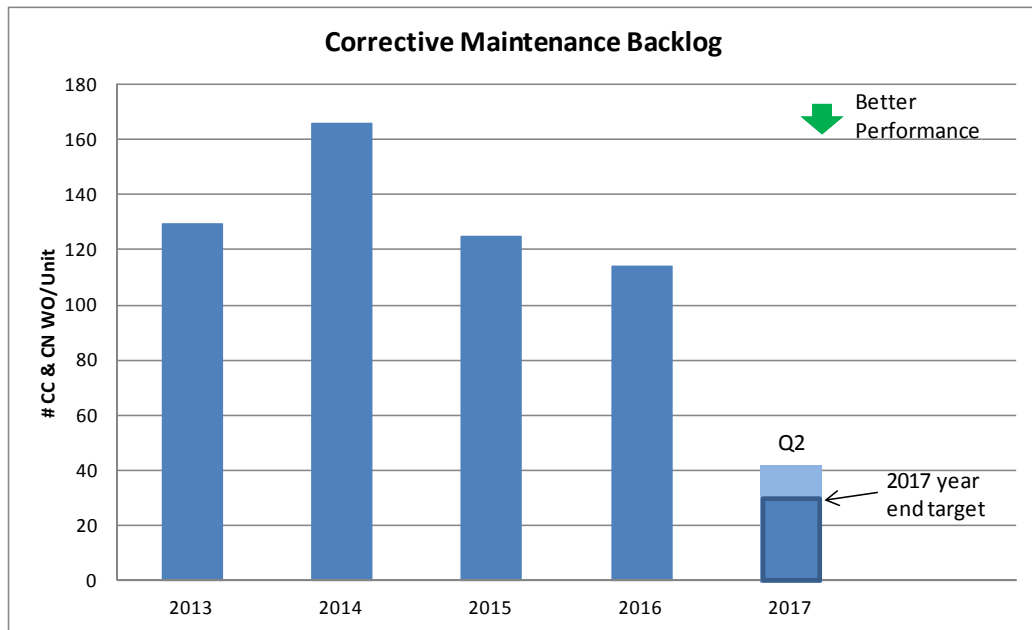


Figure 8 - Maintenance Backlog

2.6.10 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
N-PROG-MA-0004	Conduct of Maintenance
N-PROG-MA-0017	Component and Equipment Surveillance
N-PROG-MA-0019	Production Work Management
N-PROG-MP-0008	Integrated Aging management
N-PROC-MP-0060	Aging Management Process
N-PROC-MA-0013	Planned Outage Management
N-PROC-MA-0049	Forced Outage Management
N-PROG-MA-0026	Equipment Reliability
N-PROG-RA-0016	Risk and Reliability Program
N-STD-RA-0033	Reliability and Monitoring of Systems Important to Safety
NA44-REP-03611-00004	Pickering A Systems Important to Safety
NK30-REP-03611-00024	Pickering B Systems Important to Safety
P-INS-03611-00001	Pickering Reliability Instruction
P-LIST-06937-00001	Pickering A and B List of Safety Related Systems
N-PROG-OP-0004	Chemistry
N-PROG-MA-0025	Major Components
N-PLAN-01060-10001	Feeders Life Cycle Management Plan
N-PLAN-01060-10007	Feeders Life Cycle management Plan: Technical Basis Document
NA44-PIP-33126-00002	Pickering Nuclear Unit 1 Fuel Channel Feeder Pipes Periodic Inspection Program Plan
NA44-PIP-33126-00001	Pickering Nuclear Unit 4 Fuel channel Feeder Pipes Periodic Inspection Program Plan

Document	Title
NK30-PIP-33126-00001	Pickering Nuclear Unit 5 Fuel channel Feeder Pipes Periodic Inspection Program Plan
NK30-PIP-33126-00002	Pickering Nuclear Unit 6 Fuel channel Feeder Pipes Periodic Inspection Program Plan
NK30-PIP-33126-00003	Pickering Nuclear Unit 7 Fuel channel Feeder Pipes Periodic Inspection Program Plan
NK30-PIP-33126-00004	Pickering Nuclear Unit 8 Fuel channel Feeder Pipes Periodic Inspection Program Plan
COG-JP-4107-V06	Fitness-for-Service Guidelines for Feeders in CANDU Reactors
N-PLAN-33110-10009	Steam Generators Life Cycle Management Plan
NA44-PLAN-33110-10003	Picketing Units 1 and 4 Steam Generator life Cycle Management Plan (Excluding Sheet Sections 001 to 007)
NA44-PLAN-33110-10003 Sheet Sections 001 to 007	Pickering Units 1 and 4 Steam Generator Life Cycle Management Plan- Pickering Units 1 and 4 Steam Generators In-Service Inspection Plan
NK30-PLAN-33110-10008	Pickering Units 5 – 8 Steam Generator Life Cycle Management Plan (excluding Sheet Sections 001 to 007)
NK30-PLAN-33110-10008 Sheet Section 006	Pickering Units 5-8-In-Service Inspection Plan
COG Report 07-4089	Fitness-For-Service Guidelines for Steam Generator and Pre-heater Tubes
N-PLAN-01060-10002	Fuel Channels Life Cycle Management Plan
N-REP-31100-10041	Acceptance Criteria and Evaluation Procedures for Material Surveillance Pressure Tube
N-REP-31100-10055	Report on technical basis for Fuel Channel Aging and Life Cycle Management Strategy and Plan
NA44-PIP-31100-00001	Pickering Nuclear 1-4, Unit 1 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NA44-PIP-31100-00004	Pickering Nuclear 1-4, Unit 4 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NK30-PIP-31100-00001	Pickering Nuclear 5-8, Unit 5 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NK30-PIP-31100-00002	Pickering Nuclear 5-8, Unit 6 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NK30-PIP-31100-00003	Pickering Nuclear 5-8, Unit 7 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NK30-PIP-31100-00004	Pickering Nuclear 5-8, Unit 8 Fuel Channel Pressure Tubes Periodic Inspection Program Plan
NA44-CORR-00531-06621	Letter, G Jager to T.E. Schaubel, "Notification of Correction of Pickering "A" Fuel Channel Periodic Inspection Program Plans, Attachment 1" December 23, 2010
N-REP-31100-10055	Report on Technical Basis for Fuel Channels Life Cycle Management Plan
N-PLAN-01060-10003	Reactor Components and Structures Life Cycle Management Plan
N-PLAN-01060-10008	Reactor Components and Structures Life Cycle Management Plan: Technical Basis Document
NA44-PIP-03641.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Plan for Unit 1
NA44-PIP-03641.2-00007	Pickering Nuclear Generating Station A Periodic Inspection Plan for Unit 4
NK30-PIP-03641.2-00001	Pickering Nuclear Generating Station B Periodic Inspection Plan for Unit 5
NK30-PIP-03641.2-00002	Pickering Nuclear Generating Station B Periodic Inspection Plan for Unit 6

Document	Title
NK30-PIP-03641.2-00003	Pickering Nuclear Generating Station B Periodic Inspection Plan for Unit 7
NK30-PIP-03641.2-00004	Pickering Nuclear Generating Station B Periodic Inspection Plan for Unit 8
N-PLAN-01060-10004	Aging Management Plan for Containment Structures
NA44-PLAN-34220-00002	Life Cycle and Aging Management Program Plan for Fibreglass-Reinforced Plastic Components in the Pickering NGS Vacuum Building
NA44-PIP-03642.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Program for Containment Components
P-PIP-03642.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Program For Unit 0 Containment Components
NK30-PIP-03642.2-00001	Pickering Nuclear Generating Station B Periodic Inspection Program for Containment Components
NA44-PIP-03643.2-00001	Pickering Nuclear GSA – Reactor Building Periodic Inspection Program
NK30-PIP-03643.2-00001	Pickering Nuclear GSB – Reactor Building Periodic Inspection Program
NA44-PIP-03643.2-00002	Pickering Nuclear GS – PRD & VB Periodic Inspection Program
NA44-PIP-03643.2-00003	Pickering Nuclear GS – Vacuum Building Post Tensioning Rods Periodic Inspection Program
NA44-REP-34200-00017	Pickering NGS “A” Reactor Building and Pressure Relief Duct In-Service Leakage Rate Test Requirements in Accordance with CSA N287.7-08
NA44-REP-25100-00009	Pickering NGS Vacuum Building In-Service Leakage Rate Test Requirements in accordance with CSA N287.7-08
N-PROC-MA-0066	Administrative Requirements for In-Service Examination and testing for Concrete Containment Structures

2.7 Radiation Protection

Pickering NGS has an effective radiation protection program that meets or exceeds all applicable regulatory requirements and related objectives. The health and safety of persons is protected through the implementation of this program, which ensures that radiation doses are kept below regulatory dose limits and are optimized and maintained as low as reasonably achievable (ALARA).

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and planned improvements. These discussions also support that:

- Radiological impacts of plant operation to workers and the public will continue to be of acceptably low risk and adequately mitigated (e.g., Sections 2.7.1 to 2.7.3)

2.7.1 Radiation Protection Program

The Radiation Protection (RP) program is described in program document N-PROG-RA-0013, *Radiation Protection*. The objective of the RP Program at Pickering is to control occupational and public exposure to radiation.

For the purposes of controlling doses to workers, this program has four implementing objectives:

- Keeping individual doses below regulatory limits.
- Avoiding unplanned exposures.
- Keeping individual risk from lifetime radiation exposure to an acceptable level.
- Keeping collective doses As Low As Reasonably Achievable (ALARA), social and economic factors taken into account.

In terms of protecting the public, the RP program prevents the uncontrolled release of contamination or radioactive materials from the site by controls and monitoring of people and materials. The RP program includes a set of action levels to provide an alert before a regulatory dose limit is reached.

2.7.2 Application of ALARA

The *Radiation Protection* program, N-PROG-RA-0013, implements a series of standards and procedures for the conduct of activities within the nuclear station and with radioactive materials intended to keep radiation exposure to workers - As Low as Reasonably Achievable (ALARA).

The Pickering ALARA strategy identifies initiatives, actions and programs that support achieving these objectives. The strategy applies to all units at Pickering, whether operating, in outage or in safe storage. Equally, the strategy applies to all staff, contractors and visitors at Pickering. The strategy is updated annually to reflect the results of benchmarking, corrective action plans and industry best practices. Management of collective dose is implemented in N-STD-RA-0018, *Controlling Exposure as Low as Reasonably Achievable*.

Collective dose performance targets for Pickering are established annually by OPG. Annual targets take into account planned maintenance outage scope, past performance, and anticipated dose savings from planned initiatives and application of ALARA techniques. As work is planned in more detail, collective dose projections are reviewed and actions taken to ensure dose is ALARA. Actual performance against targets is reviewed and corrective actions taken where expectations are not met. Refer to Figure 9 for a historical summary of results over the current licence term.

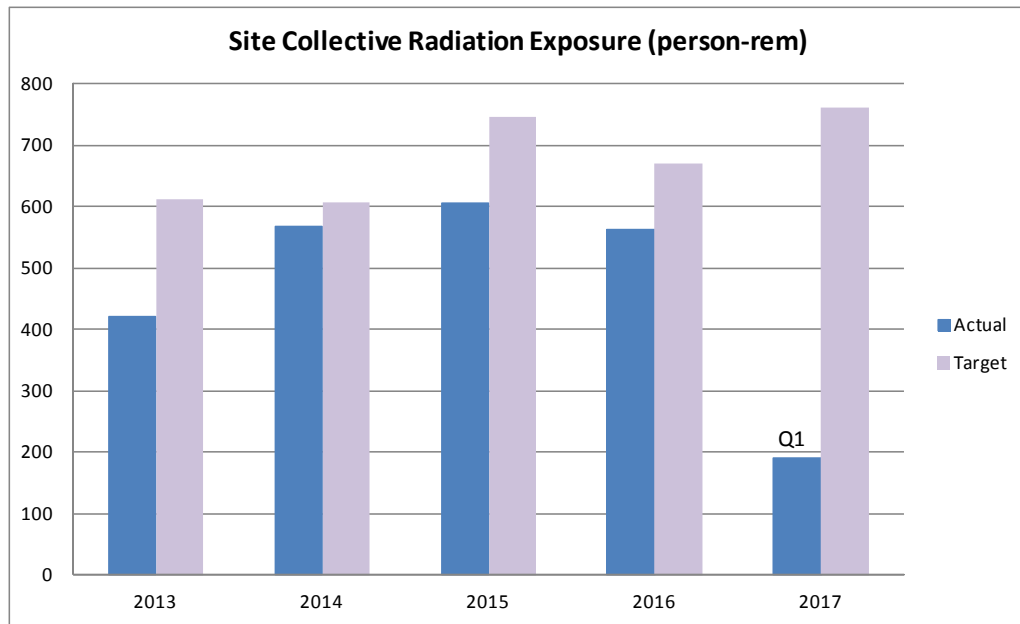


Figure 9 - Site Collective Radiation Exposure

Pickering has been successful with actual Collective Radiation Exposure (CRE) better than the targets, which was achieved through the implementation of increased line accountability for dose and improvements driven through lessons learned and OPEX. This is evidenced by continued dose performance improvement during major outage evolutions such as feeder inspections, fuel channel reconfigure, single fuel channel replacement, jigsaw installation and removal, and boiler primary side inspections.

Pickering ALARA strategy initiatives that contributed to improved dose performance include improved shielding and fine mesh heat transport filters to reduce dose rates from system equipment.

2.7.3 Worker Dose Control

Worker exposures are planned and managed to ensure doses are kept well below regulatory limits and to ensure unplanned exposures are avoided. Individual worker doses, including those for contractors and visitors, are managed to exposure control levels that are below administrative dose limits, which are in turn below the regulatory limits. This ensures individual risk from lifetime radiation exposure is kept to an acceptable level.

The worker dose control program at Pickering is managed through the assessment of hazards and maintaining knowledge of conditions in order to plan radioactive work using best practices.

During the current licence period from 2013 to date, there were no worker doses at Pickering which exceeded regulatory or OPG administrative dose limits.

Since 2013, there has been continued strong performance in the precursor indicators related to worker dose control such as the number of Electronic Personal Dosimeter (EPD) dose alarms and precursor-level tritium uptakes (see Figure 10 and Figure 11). These precursor indicators are the tracking of low level events used to identify and correct behaviours, or improve radiation work plans, thus preventing more significant events from occurring.

This level of performance is attributed to improved line accountability, planning tritium exposure, and focus on preventing alarms.

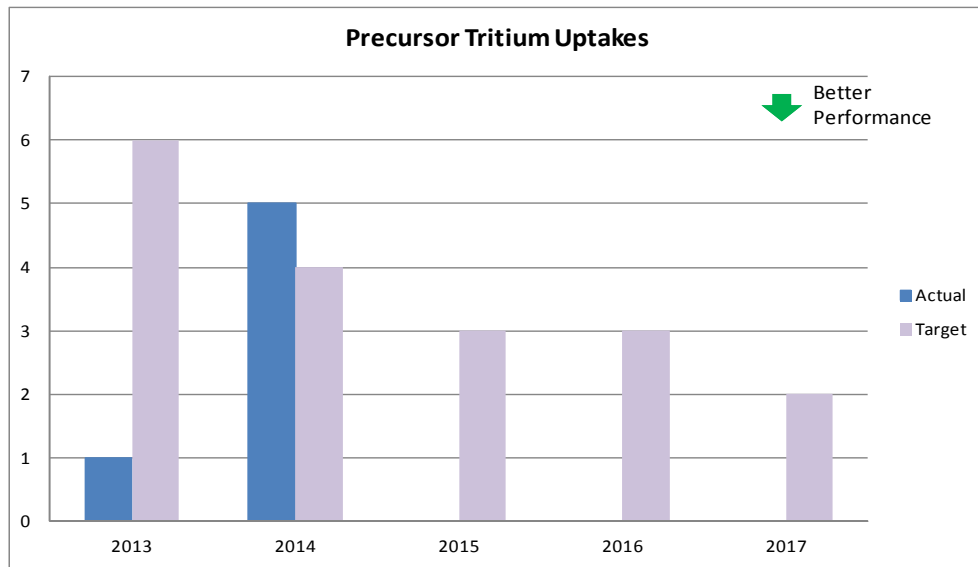


Figure 10 - Precursor Tritium Uptakes

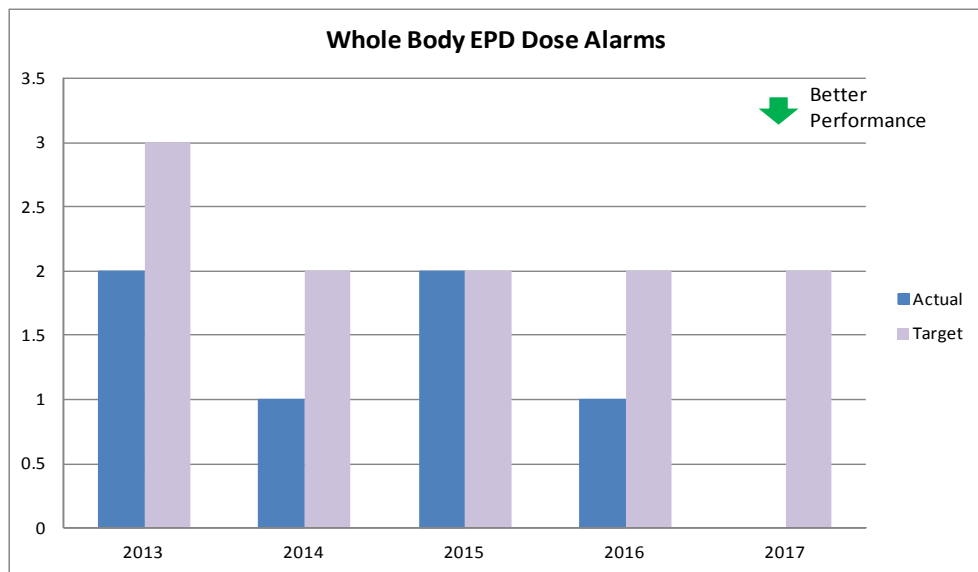


Figure 11 - Whole Body EPD Dose Alarms

A recent enhancement has been the implementation of individual dose goals for work executed in the field. These dose goals provide a platform for workers and supervisors to set challenging targets for their work each day (that are below the limits of their radiation exposure permit) and use comparison of their actual dose vs. target as an opportunity to identify and implement dose improvement initiatives.

Pickering's effective use of technology has been recognized as industry leading. Significant improvements have been made in the use of teledosimetry, remote on-line hazard monitoring and digital hazard display boards. Continuous monitoring of hazard levels and remote monitoring of worker dose reduce the risk of workers working in changing hazard conditions and ensure dose is kept ALARA.

2.7.4 Radiological Hazard Control

Radiological hazard surveys are performed using approved instruments on both a routine basis and prior to performance of radioactive work. Remote instrumentation is used to provide real-time hazard information to staff. Robotic equipment is used by Operations staff to reduce exposure during on-power entries, and allow for searches in areas previously inaccessible. In one case, robotic equipment was used to remove and contain active debris from a steam generator drain line with a high dose rate. The work was executed event free and within the dose target established for the job. This remote instrumentation and use of robotics has reduced exposure to staff.

Contamination control ensures that contamination is prevented from leaving the radiological controlled area, and the spread of contamination within this area is minimized.

The protected area (inside the inner security fence) of the station is divided into zones to facilitate contamination control. Boundaries of the zones are well marked and changes to the boundaries are approved by the Responsible Health Physicist. Workers moving through the radiological zones monitor themselves and material as required when crossing zone boundaries (depending on the direction of travel) and at other designated monitoring points. Loose surface contamination is not tolerated within the radiological zones except within established contamination control areas. Whole Body Contamination Monitor alarm setpoints have been reduced on exit and interzonal personnel contamination monitors. The lowered detection limit allows for continued improvements in detecting and monitoring for contamination.

Certain areas of the station are subject to high radiation fields as a result of normal reactor operation, irradiated fuel transfer, equipment operation or exposure of calibration sources. Accidental entry to these areas is prevented through the use of locked access points. When work is required in these areas, workers use procedures and physical controls to ensure the access hazards are not present or, if present, are strictly controlled.

2.7.5 Occupational Radiation Protection Action Levels

Section 6 of the *Radiation Protection Regulations* specifies requirements related to action levels and the timeline for notification when an action level has been reached. These action levels are precautionary levels, below the actual regulatory limits.

As required by the *General Nuclear Safety and Control Regulations*, the action levels for Pickering NGS are documented in N-REP-03420-10001, *Occupational Radiation Protection Action Levels for Power Reactor Operating Licences*.

2.7.6 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
N-PROG-RA-0013	Radiation Protection
N-STD-RA-0018	Controlling Exposure As Low As Reasonable Achievable
OPG-PROC-0132	Respiratory Protection
N-REP-03420-10001	Occupational Radiation Protection Action Levels for Power Reactor Operating Licences
N-PROC-RA-0019	Dose Limits and Exposure Control

2.8 Conventional Health and Safety

Pickering NGS has an effective Conventional health and safety program that meets or exceeds all applicable regulatory requirements and related objectives. Conventional health and safety work practices and conditions at the station result in a high degree of personnel safety.

The following describes the objectives, key results from the current licensing period, and planned improvements in this area. These discussions also support that:

- Worker safety is taken seriously at Pickering NGS and plant personnel are protected from conventional hazards such that the associated risk is low.

2.8.1 Conventional Health and Safety Program

The foundation of OPG's Health and Safety Management System is the *Employee Health and Safety Policy*, OPG-POL-0001, which describes the approach and commitments to conventional health and safety for the organization, and the requirements and accountabilities of all employees. OPG is committed to preventing

workplace injuries and to continuously improve employee health and safety performance.

OPG's *Health and Safety Management System Program*, OPG-PROG-0010 puts the Health and Safety Policy into action. The Health and Safety Management System program and supporting governing documents establish process requirements that protect employees by ensuring they are working safely in a healthy and injury-free workplace. It also outlines the responsibilities of various levels in the organization to ensure activities are performed to meet the requirements of OPG's Health and Safety Policy.

During the current licensing period, Pickering NGS has demonstrated strong safety performance throughout its operations.

In 2014, Pickering NGS reached 11 million hours without a lost time accident with an All Injury Rate of 0.22 which represented the best performance achieved for the station.

In November 2016, OPG received the Canadian Electricity Association President's Gold Award of Excellence for Employee Safety in recognition of the company-wide All Injury Rate and Accident Severity Rate performance for 2013, 2014 and 2015.

All Injury Rate

As shown in Figure 12, Pickering NGS All Injury Rate performance was better than target from 2013 through 2015. For 2016, an executive leadership decision was made to challenge the organization's All Injury Rate targets and accelerate the drive towards zero injuries. While the new target has been challenging to the organization, it has driven a sharper focus on low level safety events and injury prevention. The current rate for 2017 is zero.

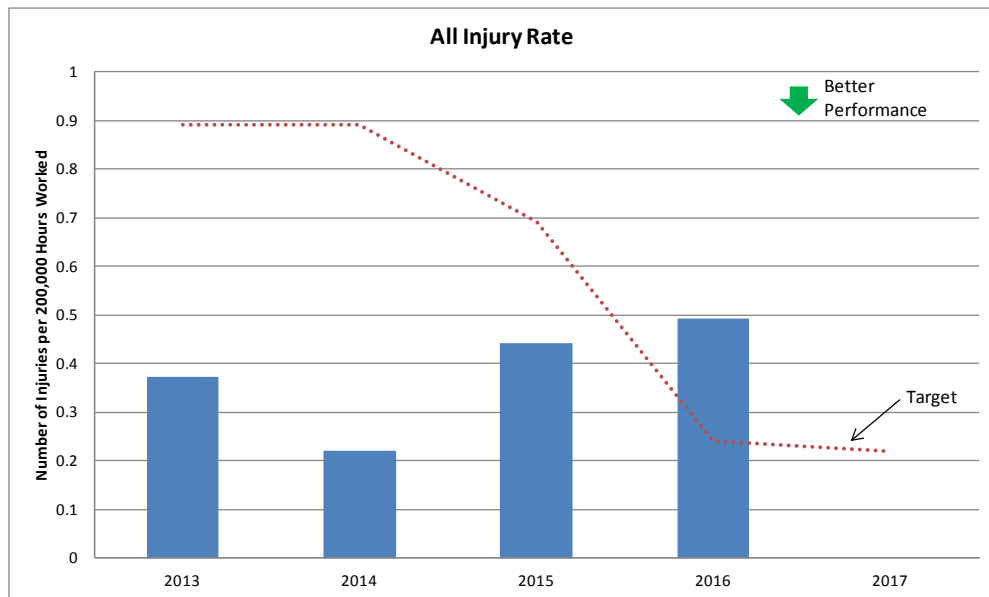


Figure 12 - Pickering All Injury Rate vs. Target

Accident Severity Rate

Pickering's Accident Severity Rate performance over the current licensing period was very good overall. However, in 2016, a slip and fall injury in a change room resulted in 120 days of lost time, which dramatically impacted Pickering's Accident Severity Rate. The incident was reviewed and lessons learned were reinforced.

Safety Enhancements

A number of health and safety enhancements have been made to the program, equipment and systems at Pickering NGS, during the current licensing period.

OPG has implemented an "iCare" safety culture initiative aimed at elevating worker safety culture where employees are self-motivated to work safely. Following established rules and procedures forms the foundation for the OPG health and safety programs, however, following rules is not enough to achieve the goal of zero injuries. OPG introduced the concept of "iCare Enough to Act for Safety" because all employees must care enough to act to protect themselves and each other. OPG cares that all employees get home safely to their families at the end of each day.

Some further safety enhancement initiatives include:

- Implementation of a Total Health initiative aimed at fostering a stronger employee health culture with a focus on enhanced support and mental health training. This initiative supports employees and their families in their efforts to achieve an optimal level of health and functioning, primarily through health education, health promotion, disease and injury prevention, and crisis intervention. Some examples include implementation of a mental health training program for people leaders, mental health stigma awareness campaign, access to confidential personal health assessments, and Employee Family Assistance Program resource awareness.
- Focused campaigns aimed at heightening and improving situational awareness in order to improve employee ability to recognize hazards by anticipating them, looking out for changing conditions in the work environment and taking action. This includes injury prevention for non-routine activities and even routine activities such as walking.

2.8.2 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
OPG-POL-0001	Employee Health and Safety Policy
OPG-PROG-0010	Health and Safety Management system Program
N-PROG-MA-0015	Work Protection

Document	Title
OPG-PROC-0132	Respiratory Protection
N-PROG-RA-0012	Fire Protection
P-LIST-71400-00001	Application of CSA N293-07 to Structures, and Components for Pickering Nuclear

2.9 Environmental Protection

Pickering NGS has an effective environmental protection program that meets or exceeds all applicable regulatory requirements and related objectives. All reasonable precautions are taken to ensure that adequate provisions for the protection of the environment are maintained.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and planned improvements over the next licensing period. These discussions also support that:

- Impacts of plant operation to the environment and the public will continue to be of low risk and adequately mitigated (e.g., Sections 2.9.1, 2.9.3, and 2.9.7).
- Transparency and appropriate public consultations have been upheld and will continue (e.g., Section 2.9.1 regarding community engagement and Section 2.9.3 regarding external posting of effluent monitoring results).
- OPG continues to invest in Pickering to support environmental protection (e.g., Sections 2.9.4 and 2.9.7).

2.9.1 Environmental Policy

OPG's *Environmental Policy*, OPG-POL-0021, provides direction related to environmental performance and environmental management. This policy is approved by the OPG Board of Directors. It ensures that:

- OPG establishes an environmental management system registered to the ISO 14001 Environmental Management System standard;
- Adverse effects on the environment are prevented and mitigated with a long-term objective of continuous improvement in OPG's environmental management system and its environmental performance; and
- The Pickering site is managed in a manner that strives to maintain, or enhance where it makes business sense, significant natural areas and associated species of concern. This is achieved through the work with community partners to support regional ecosystems and biodiversity through science-based habitat

stewardship and by taking reasonable steps to manage any residual impact to these areas and species.

2.9.2 Environmental Management System (ISO 14001)

The OPG *Environmental Management* program, as documented in N-PROG-OP-0006, maintains an environmental management program consistent with the International Organization for Standardization (ISO) 14001 *Environmental Management System*.

OPG's environmental management program requires assessment of environmental risks associated with station activities, and to ensure that these activities are conducted such that any adverse impact on the natural environment is As Low as Reasonably Achievable (ALARA). This program includes OPG's approach to ensure compliance with applicable statutory and regulatory requirements.

The Environmental Management System (EMS) provides the structure and processes to ensure implementation and follow-up on management programs needed to deliver the environmental policy are achieved. As part of OPG's EMS, environmental performance targets and environmental compliance are reviewed annually to ensure that opportunities for continuous improvement are identified and implemented.

Annual internal environmental compliance audits are conducted, including components of the ISO 14001 EMS. Adverse conditions or opportunities for improvements are addressed following OPG's corrective action program.

2.9.3 Protecting the Public

Assessment and Monitoring

The monitoring program at Pickering is designed in accordance with CSA N288.5-11, *Effluent Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*. This monitoring program ensures that releases are ALARA and are within regulatory limits.

OPG provides the results of the Effluent Monitoring Program to the CNSC annually, and these results are also available to the public on the OPG website at www.opg.com.

OPG began publishing quarterly environmental emissions data reports on OPG's external web-site in 2014, in response to questions asked in the 2013 Pickering licence renewal hearings. The reports include data related to radiological emissions to air and water, waste management facility monitoring results, and spills to the environment that are reportable to a regulatory authority.

Radiological Emissions to Water

During the current licence period, there were no Derived Release Limit (DRL) or action level exceedances for Tritium, Beta/Gamma, Carbon-14 or Alpha emissions to water on an annual basis. See Figure 13 for a historical summary. The DRL's were revised in 2013 which changed the historical values; therefore data are included as a percentage of the DRL before and after the revision.

Also from Figure 13, elevated waterborne Carbon-14 is a reflection of a larger amount of Spent Resin Storage Tank (SRST) water being sent and processed by Common Services (CS). This varies from year to year. CS received SRST water in January 2015 and in January/February 2016 for discharge via active liquid waste, which accounts for the higher Carbon-14 concentrations and corresponding loadings. Waterborne Carbon-14 still remains well below 1% of the DRL.

There was one reported monthly action level exceedance on Pickering 5-8 for Beta/Gamma to water in February 2016 from a routine sample. The elevated beta activity was detected in the reactor building service water from entrained lake sediment.

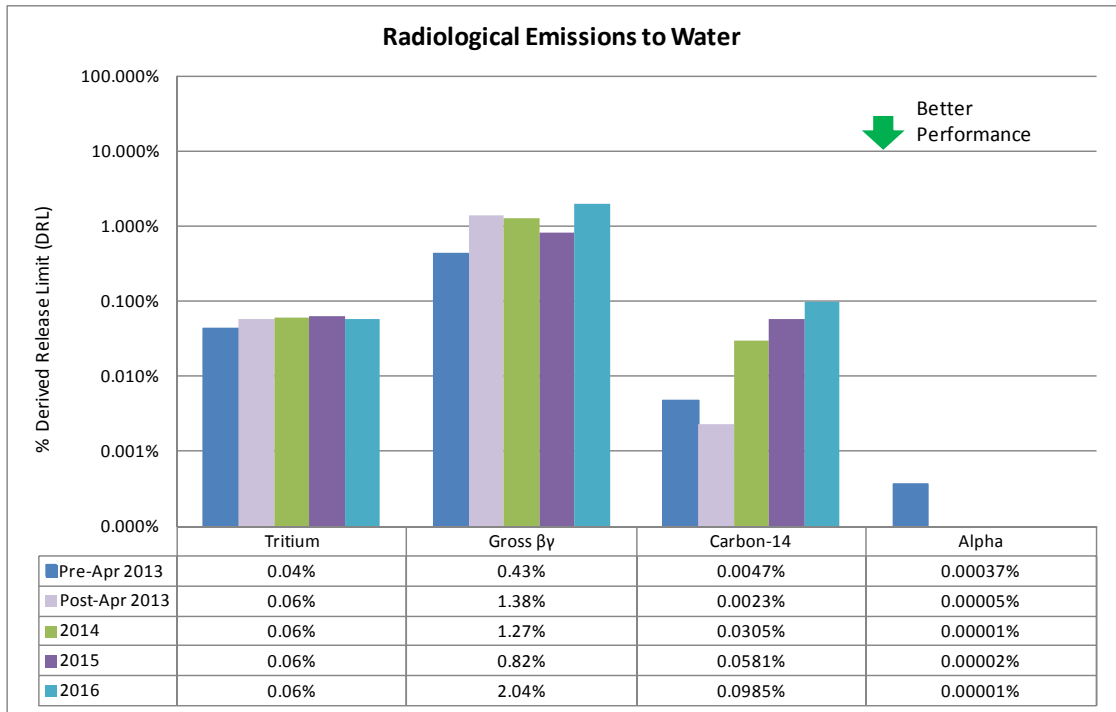


Figure 13 - Radiological Emissions to Water

Radiological Emissions to Air

During the current licensing period, Pickering Nuclear has not exceeded the Derived Release Limit (DRL) or the Action Level for any radiological emission to air on an annual basis. Details of the emissions can be found in Figure 14 - Radiological Airborne Emissions; as shown, emissions have been well below the licence limit.

Increased 2016 tritium emission values can be attributed mainly to an increase in airborne tritium releases which were as a result of tritiated water in the 056 fuel transfer conveyor tunnel, and overall dryer reliability. Actions were completed to reduce tritium emissions back to baseline values through the installation of portable dryers. A dedicated investigation team has determined the root cause of the tritiated water in the 056 fuel transfer conveyor tunnel was the construction joint seals in the floor of the Unit 5 moderator room. All of the identified degradations at the construction joints were repaired and additional sealant was applied. Post-maintenance testing confirmed the successful completion of the repairs.

A dryer reliability team is in place to improve vapour recovery equipment reliability and operating performance, to help further reduce tritium emissions.

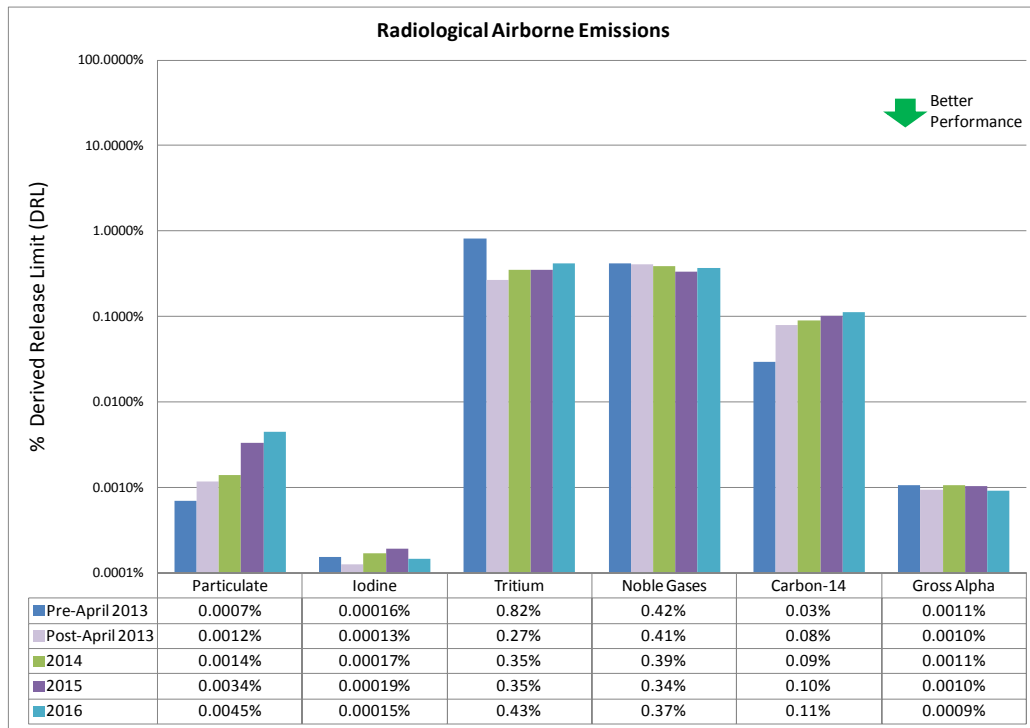


Figure 14 - Radiological Airborne Emissions

Conventional Emissions

Standby Generators and Emergency Power Generators are standby safety support systems designed to provide electrical power to critical nuclear systems in the event of a loss of normal supplies. As with any standby safety support system, routine testing is a regulatory requirement to confirm availability. Routine and non-routine testing of these generators results in the release of small quantities of carbon dioxide (CO₂), nitrogen oxides (NO_x), and sulphur dioxide (SO₂).

Pickering Nuclear uses some Ozone Depleting Substances (ODS) such as HydroChloroFluoroCarbons (HCFCs) and ChloroFluoroCarbons (CFCs), in water coolers, air conditioning systems and refrigerators. In accordance with continuous improvement efforts ODS emissions have been decreasing due to the installation of high efficiency purge units on the larger chillers in conjunction with post maintenance helium leak checks. In addition, Pickering 5-8 has installed and now operates R-123 containing chillers, replacing older R-11 (CFC) units. ODS emissions remain low, but variable.

The National Pollutant Release Inventory (NPRI) is an Environment Canada initiative, which provides public access to information regarding releases of specific chemicals from industrial sources. Pickering Nuclear's NPRI report includes hydrazine, nitrogen oxides (NO_x), particulate matter, and sulphuric acid.

The Ministry of the Environment and Climate Change (MOECC) regulates the use of the following chemicals which are used at Pickering NGS:

- Sodium hypochlorite is used to control zebra/quagga mussel infestation in piping systems at the station. Sodium hypochlorite is neutralized before release to the environment.
- Sodium hydroxide is used at the Water Treatment Plant (WTP). Sodium hydroxide is neutralized before release to the environment.
- Sodium metabisulphite is used to neutralize residual chlorine generated from sodium hypochlorite used to control zebra/quagga mussel infestation in piping systems at the station. Sodium metabisulphite is neutralized before release to the environment.
- Sulphuric acid is used at the WTP for regeneration of resin and neutralization. Sulphuric acid is neutralized before release to the environment.
- Ammonia and Morpholine are used as pH control.
- Hydrazine is used as an oxygen scavenger.

Pickering Nuclear controls and monitors certain waterborne discharge streams under the Municipal Industrial Strategy for Abatement (MISA) regulations, O. Reg. 215/95. The monitored discharge streams are the water treatment plant, radioactive liquid waste management system, and the inactive drainage system. Pickering Nuclear issues MISA quarterly reports to the Ministry of the Environment and Climate Change (MOECC).

All effluent streams that are monitored under O. Reg. 215/95 were discharged to the environment via approved pathways and were in compliance during the current licence period.

Groundwater Monitoring Program

The Pickering Nuclear groundwater monitoring program was established to confirm the predominant on-site groundwater flow characteristics of the Pickering Nuclear site. Monitoring is designed to detect changes to on-site groundwater quality to ensure timely detection of any inadvertent releases of nuclear and hazardous substances to groundwater. The overall objective of the program is to ensure no adverse off-site impacts from contaminants in groundwater.

In 2016, groundwater samples from 140 sampling points were collected. Collected samples were mainly analyzed for tritium, but several locations were also analyzed for petroleum hydrocarbons (PHCs), benzene, toluene, ethylbenzene, xylenes (collectively referred to as "BTEX"), and volatile organic compounds (VOCs).

Sampling points included monitoring wells, foundation drains, sumps, catch basins, and ground tubes. Based on the collected data, tritium concentrations at site-perimeter locations of Pickering Nuclear remain low and indicate that there were no adverse off-site trends. Tritium concentrations in groundwater at the Unit 1 Reactor Building area have declined substantially since 2012 as a result of corrective actions completed to mitigate the source of tritium from the foundation drainage sump.

As part of Pickering's annual groundwater monitoring program, data are collected from the site-perimeter monitoring wells and analysed statistically to identify any trends. The term "low" is descriptive and used in a qualitative fashion because there is no tritium in groundwater limits. In addition, a previous study indicated that the upper limit of expected tritium concentrations from atmospheric deposition for areas within the immediate influence of the station is 3.7×10^4 Bq/L. The concentrations at the site-perimeter locations are significantly lower than this value, as would be expected.

A source of tritium in the Unit 5 to 8 Reactor Building (RB) areas was attributed to historic releases from the RB foundation drainage sumps due to the failure of non-return valves. Pickering NGS has preventive maintenance scheduled to clean or replace the Unit 5 to 8 non-return valves.

In 2016, elevated tritium concentrations in the groundwater were identified in the vicinity of the Unit 5 and 6 RBs and a comprehensive investigation was initiated which determined the source to be the Unit 5 moderator room floor slab construction joint seals, as discussed previously. The increase in tritium concentration is due to leakage from the Unit 5 moderator sump through the floor slab joints and repairs have been completed.

Based on the groundwater migration pathway, tritium in groundwater identified in the vicinity of U5 and U6 reactor building is migrating northwards to the Inactive Drain (IAD) sumps. The combined discharge from the IAD sumps is sampled each shift and sample results are within the normal range. The monitoring of Unit 5 to 8 RB foundation drains and the RB foundation drainage sumps will continue in this area.

In this licence period (2013 - 2016) elevated tritium concentrations in groundwater were observed at the Pickering 5-8 Irradiated Fuel Bay area, with a maximum tritium concentration of 3.96×10^6 Bq/L in 2013 with a downward trend at the end of 2016. In 2013, OPG had initiated a project to repair the Pickering 5-8 Irradiated Fuel Bay liner and its collection sumps, which is expected to reduce the potential for the bay water to negatively impact site groundwater quality. The liner repair tooling has been

fabricated, tested and delivered and field repair as well as sump repair is expected to be completed by the end of 2017. Surveillance will continue to track the movement of tritium in groundwater in this area. It should be noted that this level of tritium in groundwater has no adverse environmental impact.

2.9.4 Spill Management Program

Pickering NGS has extensive programs to ensure the risk of spills to the environment is effectively assessed and managed.

Any spill that causes or is likely to cause an adverse effect must be reported to the Ontario Ministry of the Environment and Climate Change (MOECC). Within OPG, reportable spills to the MOECC have been classified as Category A (major), Category B (moderate) and Category C (minor) depending on criteria such as environmental impact and quantity of substance released.

From 2013-2017, there were no Category A or Category B spills and 12 Category C spills at Pickering Nuclear. The Category C spills are listed below. The number of Category C spills has been declining at Pickering Nuclear since 2004; this improvement is attributed to improved environmental awareness and to more stringent spill control practices.

- | | | |
|------|-----|---|
| 2013 | 1) | 4 L of ethylene glycol from an air conditioning unit |
| | 2) | 50 L of sodium hypochlorite solution from an underground pipe |
| | 3) | 536 L of generator seal oil from a heat exchanger |
| 2014 | 4) | 30 L of hydraulic fluid from a pump |
| | 5) | 200 L of sewage – overflow |
| | 6) | 19 L of FRF (fire resistant fluid) from the turbine governor system |
| | 7) | 10 L of oil from a transformer temporary dike |
| | 8) | 100 L of sewage from a leak in a line |
| 2015 | 9) | 100 L of sewage – overflow |
| | 10) | 50 L of sewage – overflow |
| 2016 | 11) | 8 L of oil from a compressor |
| 2017 | 12) | 50 L of lube oil – spilled on the floor |

The following spill mitigation initiatives have been completed driven by OPG's adherence to continuous improvement:

- Replaced all 4 sodium bisulphite solution storage tanks with one double walled stainless steel tank on Pickering 058. (Completed November 2016)
- All of the Pickering 058 seal oil drain lines to the local water tundish have been cut and capped in order to remove any flow path from the seal oil heat exchangers to the environment. (Completed December 2014)
- Installation of underflow weir system to the existing spill containment surrounding the Main Output Transformers located on all 4 units of Pickering Units 058. (Completed December 2016).
- Upgraded spill containment in the new Water Treatment Plant Chemical Addition Area. (Completed April 2014)

Planned Improvements

- A permanent concrete dike will be installed around the overflow tank associated with the Emergency Coolant Injection system, which will reduce the risk of spills to the environment. The scheduled project completion date is December 2017.
- The 012 sewage sump pumps are being replaced with more robust grinder style pumps for improved availability. An additional level switch will also be installed to prevent sump overflows. The scheduled project completion date is September 2017.

2.9.5 Environmental Monitoring Program

OPG maintains an Environmental Monitoring Program (EMP) in the vicinity of Pickering Nuclear in accordance with operating licence requirements. The EMP complies with the standard CSA N288.4-10, *Environmental Monitoring Programs at Class I Nuclear Facilities and Uranium Mines and Mills*. The program scope encompasses protection of both the public and the environment from nuclear substances, hazardous substances, and physical stressors resulting from the operation of Pickering Nuclear, including on-site waste management facilities.

Results of the Pickering Nuclear EMP are reported annually and made available on www.opg.com.

Additionally, environmental sampling and analyses for the EMPs support the calculation of annual dose to the public resulting from operation of Pickering Nuclear. The EMP routinely measures radionuclides in environmental media such as air, water, and food products. Radioactivity in the environment is measured near Pickering as well as at provincial background locations. Measured data are used together with station emissions data to determine the dose received by members of

the public, known as potential critical groups. The highest estimated potential critical group dose establishes the official public dose for the site.

During the current licensing period the dose to the public has always been less than 0.2 % of the annual legal limit of 1000 μSv . The public dose for 2016 was 1.5 μSv and was assigned to the “Urban Resident (Adult)” group, as shown in Figure 15.

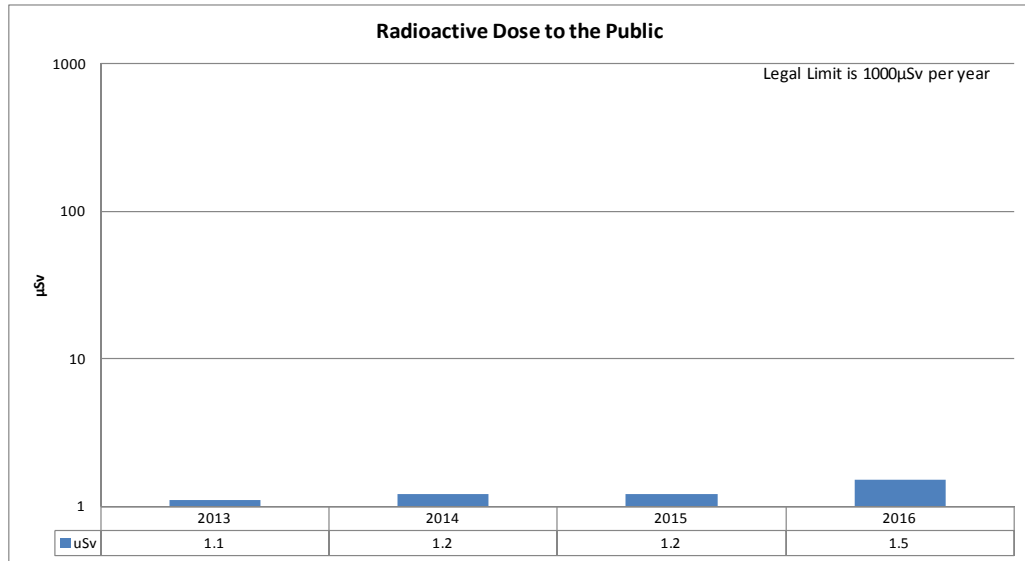


Figure 15 - Radioactive Dose to the Public

As shown in Figure 16, the radiation dose to the public resulting from the operation of the Pickering Nuclear Generating Station is a very small fraction of the estimated annual average natural background radiation dose around the station.

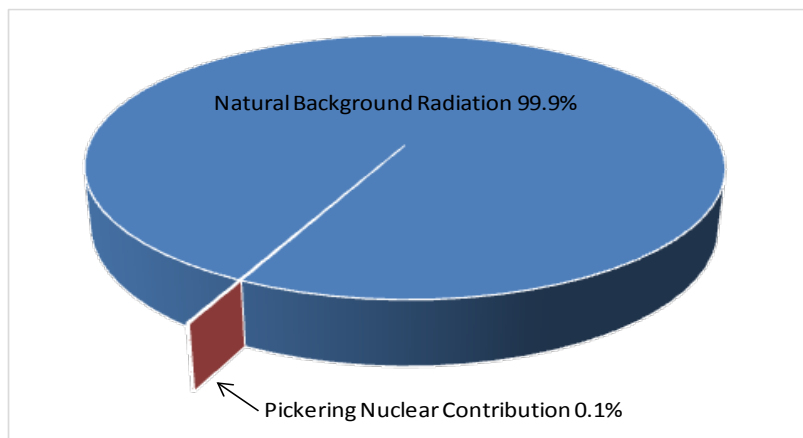


Figure 16 - Radioactive Dose Relative to Natural Background Radiation

2.9.6 Regulatory Compliance

Pickering operates under numerous environmental regulations governing plant operations. The primary regulators from an environmental perspective are the CNSC and the Ontario Ministry of Environment and Climate Change (MOECC).

During the period 2013 to 2017 there were no major infractions of environmental regulations.

Pickering Nuclear had a total of 23 other infractions over the period of 2013 – 2017 year to date (~5 year period), decreasing to only 1 infraction in 2016 and none to-date in 2017. Table 6 contains the details of these infractions.

During the period of 2013 to 2017 Pickering Nuclear had ten occurrences of exceeding the Environmental Compliance Approval (ECA) delta temperature limit. The number of events has declined each year starting in 2015, this improvement is attributed to equipment improvements and improved awareness.

	Infraction
2013	Station discharge ΔT exceeded C of A Limits (four infractions)
	Unapproved discharge to Pickering Sewer per the Durham Sewage By-Law
	Waste storage timeline exceeded
2014	Unapproved discharge to Pickering Sewer per the Durham Sewage By-Law
	Station discharge ΔT exceeded C of A Limit (five infractions)
	Upgrades to Water Treatment Plant without ECA amendment
	Exceeded allowable annual un-monitoring limit for C14 (2 infractions)
2015	Station discharge ΔT exceeded C of A Limit
	MISA Report data missing
	Contravention of both Ontario Endangered Species Act and Migratory Bird Convention Act
	Fish impingement event
	ECA Semi-Annual sample missed
	Public complaint of Noise or Odour
	Waste non-compliance due to refrigerant storage timeline
2016	CNSC Monthly Action Limit exceeded for beta gamma activity
2017	No infractions to date

Table 6 - Environmental Infractions for the Period 2013-2017

2.9.7 Fish Impingement and Entrainment

Impingement and entrainment of fish within the Pickering Nuclear Generating Station occurs from the use of lake water for condenser cooling water. A Fish Diversion System (FDS) as shown in Figure 17, is used to mitigate impingement and has been demonstrated to reduce fish losses by more than 80%.

Typically the FDS is installed in the spring, around April, and removed at the end of November each year before significant lake ice build up. During the deployment of the FDS, there is ongoing maintenance to remove algae and zebra mussels as well as complete minor repairs to the net.

A new net was installed in the FDS for the 2017 season. OPG continues to ensure fish impingement is maintained at levels consistent with CNSC targets.



Figure 17 - Fish Diversion System

During the off season, the net is inspected and repaired as necessary at its storage facility and made ready for the following year's deployment.

Monitoring of fish impinged is conducted weekly throughout the year. Fish from the screen house are collected in bins and specially trained staff identify the fish species, count them and measure representative samples of fish. The estimated biomass of impinged fish is reported annually to the CNSC. The annual reports demonstrate that the CNSC impingement target reduction has been achieved.

The FDS is not designed to prevent entrainment. Entrainment occurs when very small fish eggs and early life stages (less than 4.7mm) pass through the travelling screens and are subsequently carried through the condenser cooling water system.

OPG has proposed three offsetting measures to counterbalance losses such that a net benefit in fisheries productivity is achieved. Two of the offsetting measures are habitat creation projects; the first is in the Big Island Wetland located in the Bay of Quinte and has already been created, and the second is to be constructed in the Simcoe Point Wetland near the outlet of Duffins Creek. The third offset is associated

with OPG's stocking contribution for the Lake Ontario Atlantic Salmon Program. OPG is the lead sponsor from 2016 to 2020.

The reduction of impingement and entrainment continues to be verified through a monitoring program.

2.9.8 Thermal Plume

In 2017, OPG evaluated the lake water temperature from the thermal plume at Pickering NGS and reference sites from 2009-2010, 2010-2011 and 2011-2012 using a revised impact assessment model to predict hatch date and survival of Round Whitefish embryos. The estimated survival loss at the plume stations compared to the reference stations, were all below the survival loss of 10%, the threshold for no-effect level for round whitefish embryo survival. The average water temperature during the spawning and egg incubation period for all plume stations and each individual station in 2009-2010, 2010-2011 and 2011-2012 were below the threshold effect level of 6°C in each year. Therefore, the thermal plume from Pickering NGS is not having an adverse effect on Round Whitefish embryo survival.

2.9.9 Environmental Risk Assessment

OPG has completed an updated Environmental Risk Assessment (ERA) for Pickering Nuclear (PN), focused on the years 2011 to 2015. The assessment meets the requirements of Canadian Standards Association (CSA) N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills*. The ERA includes a Human Health Risk Assessment (HHRA), and an Ecological Risk Assessment (EcoRA), for radiological and non-radiological contaminants and physical stressors. The ERA evaluated the risk to relevant human and ecological receptors from exposure to contaminants and physical stressors related to Pickering and its activities; and as warranted, recommended further monitoring or assessment based on the results of the ERA. The ERA report P-REP-07701-00001, *Environmental Risk Assessment for Pickering Nuclear* was submitted to the CNSC (Reference 15).

Human Health Risk Assessment (HHRA)

Predicted exposures to PN emission sources were evaluated on the basis of potential toxicological effects from non-carcinogenic Contaminants of Potential Concern (COPCs), cancer risk from carcinogens, and radiation exposure from radionuclides. Human receptors evaluated include off-site members of the public, specifically those critical groups used for dose calculations in the annual OPG EMP reports within approximately 20 km of the PN site. Measured and modeled concentrations of COPCs were evaluated against screening benchmarks that are protective of human health. Radiological stressors were carried forward to Tier 2 because of the public interest in these emissions.

Non-radiological HHRA: The complete exposure pathways assessed in the non-radiological HHRA included inhalation (hydrazine) for all six human receptor groups; water ingestion (hydrazine and morpholine) for the Urban Resident, Correctional Institution, and Industrial/Commercial Worker; and game fish ingestion (hydrazine and morpholine) for the Sport Fisher.

- No increased risk to human receptors is expected from exposure to morpholine.
- No risks to the urban resident, correctional institution resident and industrial/commercial worker are expected due to exposure to modeled hydrazine in drinking water at the Ajax Water Supply Plant.
- No risks to the sport fisher are expected from fish ingestion based on mean modeled hydrazine in fish tissue.
- The estimated risks to all human receptors from inhalation of hydrazine are below the cancer risk target.

Radiological HHRA: The annual dose to the critical group (the urban resident adult) during this five-year period ranged from 0.9 to 1.2 μSv , approximately 0.1% of the regulatory public dose limit of 1 mSv/a. The sport fisher may receive a maximum dose up to 0.14 $\mu\text{Sv/a}$ from exposure to the Pickering Waste Management Facility (PWMF) (Phase I and Phase II) at full capacity; a small fraction of the regulatory public dose limit. Since the critical groups that receive the highest dose from Pickering are protected, other receptor groups near Pickering NGS are also protected.

Ecological Risk Assessment (EcoRA)

The assessment for the EcoRA focused on the near shore Lake Ontario (generally in the area surrounding the Pickering NGS outfalls), the Pickering site, and Frenchman's Bay. Valued Ecosystem Components (VECs) were selected for dose and risk analysis because they are known to exist on-site, and/or are representative of major taxonomic/ecological groups, major pathways of exposure, or have a special importance or value. Protection of VECs implies that other species in the same VEC category are also protected. Threatened and endangered species identified within the PN Terrestrial Site Study Area during the 2011 to 2015 time period, including the Barn Swallow, Least Bittern, Butternut, and American Eel, were assigned a representative species already selected for the EcoRA.

Non-radiological EcoRA: The potential for ecological effects was assessed by comparing exposure levels to toxicological benchmarks, and characterized quantitatively in terms of Hazard Quotients (HQ). A HQ greater than 1 indicates a need to more closely assess the risk to the concerned VEC whereas a HQ less than 1 indicates little likelihood of an adverse effect.

Maximum measured concentrations of COPCs did not exceed their respective benchmarks for the ecological receptors evaluated near the PN outfall, with the exception of measured maximum copper surface water concentrations near the PN outfall that exceeded fish and benthic invertebrate benchmarks. However, mean copper concentrations in water were acceptable. Since fish are mobile, exposure to the mean concentration is more likely. Overall, the risk to fish at the

outfall is low, and fish are not expected to experience any significant adverse effects due to non-radiological releases from PN operations.

Regarding the results of the ecological risk assessment to ecological receptors at Frenchman's Bay, the EcoRA evaluated the contribution from PN to the overall risk, and concluded that PN operations contribute a small proportion of the overall risk to aquatic receptors at Frenchman's Bay. The percent contribution from PN ranges from 0.3% to 22% of the total risk for all contaminants of potential concern.

The soil sampling program focused on areas of previously identified contamination and emphasized areas identified as potential habitat. Soils that exceed benchmark concentrations are associated with past industrial activities on site, rather than deposition from ongoing sources. HQs were not exceeded for mammals or birds exposed to average concentrations in soil, therefore, adverse effects are not expected. Although HQs were exceeded for earthworms and terrestrial plants in areas of past industrial activity, the earthworm community and terrestrial plant populations on the site as a whole, would not be significantly affected. Species at risk were also assessed and confirmed to not be at risk from PN operations.

Radiological EcoRA

At the outfall there were no exceedances of the radiation dose benchmarks for aquatic biota including fish, benthic invertebrates, and Ring-billed Gull. There were no exceedances of the radiation dose benchmarks for any aquatic receptors at Frenchman's Bay, and no exceedances of the radiation dose benchmark for terrestrial biota on the PN site. Similarly there were no radiation dose levels that approached the radiation benchmark for terrestrial biota associated with the Pickering Waste Management Facility.

Overall, these studies confirm the PN site is continuing to operate in a manner that is protective of human and ecological receptors residing in the surrounding area.

2.9.10 Predictive Effects Assessment

OPG undertook a Predictive Effects Assessment (PEA) to evaluate the potential for adverse effects to human health and the environment from the activities associated with transitioning the station from end of commercial operation to a Safe Storage with Surveillance state. The PEA encompasses both the Stabilization Phase and the Safe Storage with Surveillance Phase. The PEA report, P-REP-07701-00002, *Predictive Effects Assessment for Pickering Nuclear Safe Storage* was submitted to the CNSC (Reference 15).

Overall, the change from power generation to the Stabilization and Safe Storage with Surveillance Phases will result in reductions in emissions from the Pickering NGS. Noise, atmospheric emission, waterborne emissions and thermal discharges will all be reduced as Pickering moves from the current operational condition to a safe storage state.

Human Health Risk Assessment (HHRA)

The human health risk assessment evaluated potential radiological impacts to receptors that include: farm and dairy farm use; urban residents; area industrial/commercial occupants; a potential future industrial/commercial worker at the current Engineering Services Buildings (i.e., a new tenant); and a sport fisher (i.e., a person assumed to be fishing south of the Pickering Nuclear Generating Station). The exposure duration, exposure factors and calculations are the same as those used in the Pickering Nuclear Environmental Risk Assessment. The dose was updated based on conservative assumptions and the modelled surface water and airborne concentrations. All other exposures were considered to be bounded by the Pickering Nuclear Environmental Risk Assessment. The maximum predicted dose was estimated to be 0.002 mSv/a to a future industrial/commercial worker (i.e., a new tenant of the Engineering Services Buildings).

The public dose estimates for the human receptors for the Safe Storage with Surveillance Phase are approximately 0.2% of the regulatory public dose limit of 1 mSv/a and approximately 0.15% of the dose from Canadian background radiation. Since the dose estimates are a small fraction of the public dose limit and natural background exposure, no discernible health effects are anticipated due to exposure of potential groups to radioactive releases from Pickering Nuclear during the Safe Storage with Surveillance Phase.

Ecological Risk Assessment (EcoRA)

For the EcoRA, exposure points at receptor locations were estimated based on the Tier 1 assessment. The receptor locations of interest were the Pickering Nuclear outfall (nearshore Lake Ontario), forebay, and Frenchman's Bay. Receptors, exposure, dose and risk estimation calculations were based on the work completed in the Pickering Nuclear Environmental Risk Assessment.

Given the reduced flows into the station and assumed removal of the Fish Diversion System, the potential forebay habitat was evaluated based on the Safe Storage with Surveillance Phase assumptions. Potential impacts within the forebay were assessed for exposure to tritium, carbon-14 and cobalt-60 for radionuclides. There were no potential adverse effects identified.

Thermal effects were also evaluated as part of the Predictive Effects Assessment. In general, the lake near the discharge will be returned to a thermal condition that is more normal for the nearshore zone of Lake Ontario.

Entrainment and impingement effects were evaluated as part of the Predictive Effects Assessment. Impingement and Entrainment cease to be a concern at the low flow rates anticipated during the Safe Storage with Surveillance Phase, once the condenser cooling water pumps are not required.

No interactions were identified that are predicted to pose an unacceptable risk to humans or the environment during the Stabilization and Safe Storage with Surveillance activities proposed. Therefore, no new mitigation is required based on the conclusions of the Predictive Effects Assessment. During both the Stabilization and Safe Storage with Surveillance Phases, OPG's environmental programs will be

maintained, and updated as needed. Emission control measures and discharge limits are specified within specific permits. These permits and in-design mitigation measures will remain in place until such a time that it can be demonstrated, in discussion with the regulator as applicable, that they are no longer required.

Planning the work to define the safe storage end states of the station systems is ongoing, and waterborne emissions and cooling water flows in the Safe Storage with Surveillance Phase will be reviewed as final configurations are determined. If the surface water assumptions and the environmental interactions are substantially different than those indicated in the PEA, a reassessment of the environmental risk would be carried out and mitigation identified as required. The outcome of the review will be documented in a future Environmental Risk Assessment.

The PEA concludes that there are no predicted potential adverse effects from the Stabilization and Safe Storage with Surveillance activities proposed.

2.9.11 Biodiversity and Wildlife Habitat Council

Pickering Nuclear has a Biodiversity and Natural Areas Management Program to protect, maintain and enhance the natural environment, species and wildlife habitat on, and in the vicinity of, the Pickering Nuclear site.

On-site biodiversity initiatives include enhancement of wildlife corridors across the site, protection of species of concern like peregrine falcons (see Figure 18) and enhancement and protection of the ecological value of the Frenchman's Bay and Duffins Creek watersheds, and associated natural areas on and adjacent to the site.

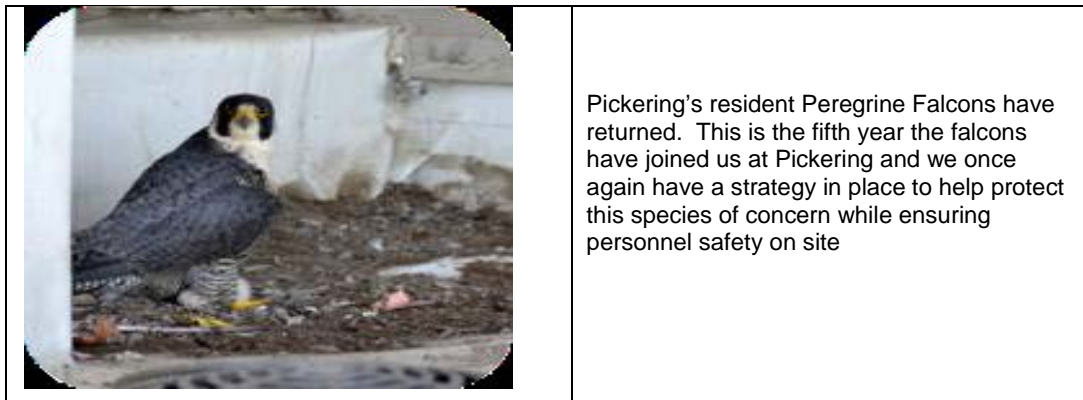


Figure 18 - Biodiversity

Program activities have focused on habitat enhancement. In the past three years, approximately 2000 trees and shrubs have been planted on Pickering OPG property by volunteers from the community and OPG staff.

Pickering Nuclear continues to enhance habitat off site through the ongoing partnership with Environmental Stewardship Pickering (ESP). Projects have included the creation of a wildflower garden at a local school, tree planting events and the creation of habitat structures for birds and pollinators. ESP also hosts

educational workshops for community members on gardening, habitat creation and environmental stewardship.

OPG submits applications for Wildlife Habitat Council certification of select sites. The Wildlife Habitat Council is an international non-profit, non-lobby group that promotes and independently certifies habitat conservation and management on corporate lands through partnerships and education.

In January 2017, Wildlife Habitat Council advised OPG that the 2014-2016 Nuclear Biodiversity Program at Pickering and Darlington Nuclear Generating Stations application successfully received Wildlife Habitat Council's new "Conservation Certification" for 2017-2019.

2.9.12 Fisheries Act Authorization

Pickering Nuclear has submitted an application for authorization from the Department of Fisheries and Oceans (DFO) under section 35 (2)(b) of the *Fisheries Act*.

Key activities to complete the application for an authorization included a quantitative assessment of residual impact from fish loss, offsets for the residual impacts, and Aboriginal engagement. The *Fisheries Act* allows offset to include habitat improvements, stocking of fish and limited funding for research.

It is expected that the authorization will be in effect prior to the 2018 Pickering NGS licensing hearings.

2.9.13 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document Number	Document Title
OPG-POL-0021	Environmental Policy
N-PROG-OP-0006	Environmental Management
OPG-PROC-0126	Hazardous Material Management
N-PROC-OP-0044	Contaminated Lands and Groundwater Management
N-PROC-OP-0025	Management of the Environmental Monitoring Programs
N-STD-OP-0031	Monitoring of Nuclear and Hazardous Substances in Effluents
N-PROC-OP-0037	Environmental Approvals
P-REP-08965-0633695	Pickering NGS Hazardous Substances
NA44-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Generating Station A
NK30-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Generating Station B
P-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Sewage Effluent
4922-5S7NFH	Dual Phase Extraction System Operation
4881- 5MHQ9F	Comprehensive Certificate of Approval (Industrial Sewage)
4881- 5MHQ9F	Station Temperature Limits Notice 5 (Industrial Sewage)

Document Number	Document Title
2460-A2NHF2	PNGS-A-Permit to Take Water
2731-8ULK95	PNGS-B Permit to Take Water
A390407	Closure of West Landfill Site (Waste Disposal)
0947-A7NM85	New Water Treatment Plant Operation
4766-A3YMB9	Pickering Site Operation Comprehensive certificated of Approval (AIR)
5683-6XAMAB	Auxiliary Power System (Industrial Sewage)
7719-5TXL94	Dual Phase Extraction System Operation
8-3056-94-006	Performance Testing of Air Filtering and Monitoring Equipment

2.10 Emergency Management and Fire Protection

Pickering NGS has an effective emergency preparedness and fire protection program that meets or exceeds all applicable regulatory requirements and related objectives. Emergency preparedness measures and fire protection response capabilities are in place at Pickering NGS to prevent and mitigate the effects of nuclear and hazardous substances releases, both onsite and offsite, and fire hazards in order to protect workers, the public and the environment.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and planned improvements over the next licensing period. These discussions also support that:

- Nuclear safety will be assured such that plant personnel, the public and the environment are protected (Sections 2.10.1 and 2.10.2)
- Staff are qualified and competent to respond to nuclear and fire events at the plant, and this will be maintained through the next licence period, including staffing numbers (e.g., see Section 2.10.1 regarding Staffing, Training and Resources).
- OPG continues to invest in Pickering to support nuclear safety (e.g., via drills and exercises as described in Section 2.10.2)
- Transparency and appropriate public consultations have been upheld and will continue (e.g., via public alerting provisions and public awareness campaigns for KI pill distribution, as described in Section 2.10.2)

2.10.1 Fire Protection and Conventional Emergency Preparedness and Response

The OPG *Fire Protection* program, N-PROG-RA-0012, describes the fire protection organization and interfacing organization and processes, and their accountabilities within the fire program. The objective is to ensure that all reasonable measures are taken to prevent fires, and to promptly detect and suppress any fires that may occur at the nuclear plant.

The overall program is based on CSA N293, *Fire Protection for CANDU Nuclear Power Plants* and industry best practices.

Staffing, Training and Resources:

The Pickering Fire Protection section at Pickering NGS incorporates positions for Shift Emergency Response Managers (SERM) and Emergency Response Maintainers (ERM), who are trained to respond to emergencies that may occur on-site.

The Pickering Fire Protection section is supported by the Fire Protection Programs department. Fire Protection Program staff play a key role in standardizing emergency response procedures, equipment, and training.

Fire Protection Training has made substantial enhancements to field training simulators at Wesleyville Fire and Rescue Academy owned and operated by OPG.

Fire Protection Training has also implemented the first delivery of 2016 International Fire Service Training Association Standards in 2017. In addition, training has implemented the *Blue Card Incident Command Certification* which is an industry standard for incident command, as well as implementing the NFPA1407 Rapid Intervention/Fire Fighter Survival program.

The continuing training program at OPG requires ERMs to participate in annual continuing training and practice sessions where response skills are demonstrated and assessed. These skills require the ability to respond safely and effectively to physically demanding scenarios. ERT drills documenting team and individual performance are also evaluated annually and have demonstrated the capability of the ERT to respond effectively to realistic scenarios at the station and at the Wesleyville live fire training facility.

Integrated Response Capability:

On an annual basis, OPG reviews its Memorandum of Understanding with the City of Pickering. The memorandum defines the mutual responsibilities, provides for a high level of mutual aid between the parties, and provides a strong foundation for continued productive and integrated working relationships between Pickering Fire Services (PFS) and OPG. Equally important, it provides the local community with access to additional resources from OPG to deal with major incidents and improved training for emergency response staff.

Fire protection staff periodically meets with PFS firefighters to discuss fire safety and response at the Pickering site. PFS continues to participate in fire drills, exercises and training evolutions and site orientations with OPG staff to maintain an effective integrated response capability.

PFS officers and Pickering Nuclear Fire Protection staff participate annually in the Incident Command training at Wesleyville. Also, joint live fire training takes place at Wesleyville on an annual basis with PFS and the Emergency Response teams to maintain an effective integrated response.

Planned Improvements

OPG is partnering in the Durham Regional NextGen public safety radio system and is installing radio system infrastructure at the site. This will allow seamless integration and interoperable communications with Pickering Fire Service responders using their own radios in the plant, and is expected to be completed by the end of 2017.

Fire Safety Assessments

In 2017 an updated Pickering NGS A Fire Safe Shutdown Analysis (NA44-REP-71400-00023) and Pickering NGS A Fire Hazards Assessment (NA44-REP-71400-10003) were completed and submitted to the CNSC as per Reference 20.

An updated Pickering NGS B Fire Safe Shutdown Analysis (NK30-REP-71400-00001) and Pickering NGS B Fire Hazards Assessment (NK30-REP-71400-10002) were completed and submitted to the CNSC as per Reference 21 .

2.10.2 Nuclear Emergency Preparedness Program

The Nuclear Emergency Preparedness program is documented in OPG's *Consolidated Nuclear Emergency Plan (CNEP)*, N-PROG-RA-0001. This plan describes concepts, structures, roles and processes to implement and maintain an effective OPG response in the unlikely event of a nuclear emergency that could endanger onsite staff, the public, or the environment. The CNEP provides a framework for interaction with external authorities and defines OPG commitments under the *Provincial Nuclear Emergency Response Plan (PNERP)*.

The objective of the OPG Nuclear Emergency Preparedness program is to ensure OPG has adequate provisions for the preparedness and response capability that would mitigate the effects of accidental releases of radioactive material.

In order to respond effectively to an emergency, Pickering NGS practices the response capability of staff through simulated emergencies, and maintains plans and procedures to ensure that this capability is sustained.

A summary of performance is provided in Table 7 - Emergency Response Performance Indicators.

The Radiological Emergencies Performance index is an indication of the accuracy and timeliness of the station's initial notification under the PNERP.

The ERO Drill participation index provides information on how many of the ERO staff scheduled to participate in a drill complete this during the year.

The Emergency Response Resources Completion index considers the ratio of completed to scheduled work and presents an indication of the operational readiness of emergency facilities.

Performance Indicator	2013	2014	2015	2016
Radiological Emergencies Performance Index (% - 100 max)	99.2%	96.9%	92.6%	100%
ERO Drill Participation Index (% - 100 max)	100%	100%	100%	100%
Emergency Response Resources Completion Index (% - 100 max)	100%	100%	100%	100%

Table 7 - Emergency Response Performance Indicators

A new emergency accounting system was installed within Pickering’s protected area, which includes emergency accounting readers at each assembly area. When assembling during a station emergency, employees account by scanning their entry card at an emergency accounting reader in their designated assembly area. This change aligns with industry best practices, and more importantly, by providing a more accurate and timely accounting process, it also enhances the safety of staff.

Formalized self-assessments are conducted to identify additional program improvement opportunities. A systematic review and assessment process has been implemented to ensure operational readiness of the emergency preparedness program to support safe and reliable operation of Pickering units.

Drills and Exercises

In order to demonstrate OPG’s emergency response capability, Pickering maintains an extensive drill and exercise program. This program validates emergency plans and procedures, and provides the emergency response organization with the opportunity to improve and sustain their emergency response capability.

In the unlikely event of an emergency at the station, OPG would perform the appropriate notifications to the Province, CNSC, and local municipalities in accordance with established procedures. Pickering NGS takes actions to control and mitigate the emergency on-site and minimize off-site effects. The Province under the PNERP takes actions to notify and protect the public, including recommending protective actions such as sheltering, potassium iodide ingestion, or evacuation. The local municipalities support provincial directions, which may include such activities as guiding members of the public should an evacuation be required. OPG and a range of other organizations are integrated to ensure effective emergency measures are in place.

In May 2014 OPG executed the “Exercise Unified Response” in order to test and demonstrate the effective integration of emergency response; see Figure 19. This exercise assessed the preparedness of OPG and government agencies at federal, provincial, and municipal levels to respond to a simulated severe nuclear event with off-site releases at the Darlington station. This exercise involved over 2000 participants and 54 agencies over three days. The exercise was very successful and demonstrated the integration of nuclear response plans at all levels of government. Although the incident station in Exercise Unified Response was Darlington, a majority of the participants would fulfil a similar role in the unlikely event of a Pickering emergency.

In November 2015, Pickering conducted a station emergency exercise involving a multi-unit severe accident. The initiating events for this exercise were conducted from the Pickering Simulators, with field actions performed as permitted by exercise design. The scope of this exercise was developed to demonstrate OPG's response capability to an event which progressed into a multi-unit severe accident requiring deployment of the Emergency Mitigating Equipment; see Figure 20.

OPG has scheduled a multi-agency interoperability exercise 'Exercise Unified Control' for December 6-7, 2017, focused on Pickering NGS. This full-scale integrated exercise is designed to test the capacity of onsite and off-site agencies to respond to a significant emergency at the Pickering site. The exercise is being planned to include participation of emergency response agencies of the Province of Ontario, Durham Region, the City of Toronto, the CNSC and other federal agencies. Lessons learned from this unified exercise will be available early in 2018 and will help participating agencies to continue to improve respective emergency plans.



Figure 19 - Exercise Unified Response Montage



Figure 20 - Pickering Emergency Mitigation Equipment

Public Alerting

In the unlikely event of an emergency where the Province initiates protective actions under the PNERP, the need to shelter, evacuate or take other actions is communicated to the public as follows:

- *Sirens*: Mounted on poles, sirens emit a single tone alarm that can be heard outdoors. These sirens are located within 3 kilometres of the Pickering site.
- *Radio, Television, Social Media*: Local radio and television stations, and social media, will broadcast information on public health, safety, and welfare. Instructions on what to do in the event of a nuclear emergency will be provided.
- *Telephone Dialing System*: An automated telephone dialing system will deliver a recorded emergency message through landline home phones to a large population in a short time.

In addition, OPG has partnered with Durham Region, the Office of the Fire Marshall and Emergency Management (OFMEM), Bell Canada and the Weather Network to pilot a Wireless Public Alerting System (WPAS) project in Durham Region. Wireless Public Alerting is a system that broadcasts messages through wireless (cell phone) technology; see Figure 21, for example. This technology is used successfully in other jurisdictions outside of Canada, such as the United States, and significantly helps to make the receiving of public alerts more accessible. As part of the pilot project, approximately 80 people in Durham Region, including OPG employees, were equipped with WPAS-enabled phones. Over the course of several months, they received test messages to validate the functionality and effectiveness of the program.

This is an important step for Canada in its emergency preparedness and response, and OPG is proud to be a partner in the pilot program. The Canadian Radio-television and Telecommunications Commission (CRTC) has issued a regulatory policy (CRTC 2017-91) to direct wireless service providers to implement wireless public alerting capability on their networks by April 6, 2018.



Figure 21 - Sample Wireless Public Alerting Service

Evacuation Time Estimate

An updated Evacuation Time Estimate (ETE) was completed for Pickering and issued in 2016. This update is based on current census data, and future population growth projections on a per-decade estimation. Industry-accepted methodology was used for this study. The ETE study takes into consideration the time required to evacuate schools, hospitals and other residential institutions, and was completed with support from the Province, local municipalities, police and transit organizations.

The estimate provides off-site emergency planners with projections on how long it may take for sectors and the primary zone to evacuate if required. Variables such as time of day, day of week, road restrictions, special event assemblies and weather were assessed as to how those factors may impact the evacuation duration.

The study determined that the conservative value for the evacuation time estimate was 8 hours. This value is expected to be used by off-site emergency planners and response organizations, in alignment with the provincial strategy, when considering the need to implement access control or to commence an evacuation.

Off-Site Support

OPG provides Monitoring and Decontamination Unit capability and readiness at Emergency Worker and Reception Centres.

OPG participated in the Reception Centre Exercises in 2012 (Durham College) and 2013 (Fleming College), as well as Emergency Worker Centre Exercises in 2014 at the Orono Arena in Clarington and in 2016 at Iroquois Park in Whitby. This effort is in addition to the routine work of OPG's Emergency Response and Fire Protection staff to work with key members of the Ajax-Pickering hospital staff to review and familiarize each other with procedures and training relevant to radiological emergency situations.

To ensure emergency plans continue to support a timely and safe evacuation in the event of a nuclear emergency, OPG monitors and engages with the Province, Region of Durham, and the City of Pickering regarding land use policies and activities in associated emergency planning zones to ensure no adverse impact on implementation of nuclear emergency plans.

Equipment Important to Emergency Response

A program to manage Equipment Important to Emergency Response (EITER) has been implemented to align with industry best practices. This program identifies equipment that is required in an emergency response and its back-up equipment,

and ensures contingency actions if equipment is out of service if no acceptable back-up is available.

The EITER program is ensured through N-PROC-RA-0133 *Management of Equipment Important to Emergency Response*. EITER includes systems, structures, and components, as well as essential tools and equipment, necessary to implement the emergency *Consolidated Nuclear Emergency Plan*.

The Pickering station-specific EITER equipment and facilities and necessary actions are identified in a Pickering instruction. Corporate and OPG off-site facilities and equipment which may be required to support Pickering are identified in a corporate instruction.

The EITER program ensures that OPG has the capability to implement the emergency plan through the readiness and availability of the EITER equipment, facilities, or through enacting compensatory measures or use of designated alternate facilities where the primary means may be unavailable. The EITER requirements are integrated into the work management for planned maintenance activities.

Potassium Iodide (KI) Pills

In response to requirements in CNSC regulatory document REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*, the pre-distribution of an iodine thyroid blocking agent or potassium iodide pills was expanded to the population residing in the primary zone.

Ingestion of Potassium Iodide (KI) is one protective action that may be directed by authorities in the unlikely event of a nuclear emergency. Historically, the off-site response plan protocol for KI pill pre-distribution has been to provide them free of charge through local pharmacies. In addition, KI pills have been available in schools, child care centres, health care facilities, municipal services, and reception centers designated in nuclear emergency plans.

OPG developed a communication campaign that began in January 2015 with focus groups established in the primary zone. The campaign included a two-part communications strategy for pre-distribution and distribution, based on the results obtained from the focus groups. The pre-distribution campaign was a focused education campaign that raised public awareness of KI distribution. The distribution campaign utilized product packaging to improve the public's understanding of when and how to use the KI pills, and to reinforce the safety of OPG's nuclear facilities. KI pills were distributed in October 2015.

Branding for the distribution campaign was specifically designed; helping to ensure the packages would be easily recognized and not discarded. The KI packages included user instructions and information printed on the front. As part of the overall campaign, a website was created to provide an online site for people within 50 km of Pickering NGS to order KI pills and provide information.

KI pill fact sheets were distributed to operators at local and provincial health help lines and local physicians in order to assist in answering questions from the public. The public within 50 km can continue to order KI pills through the website.

Website FAQs are translated into the 9 most common languages spoken within 10 km (based on census data). New households and businesses are identified three times a year by Canada Post and sent information packages including KI pills. On-going public awareness campaigns by the local health department and OPG remind residents of pill availability and other preparedness information.

Planned Improvements

The provincial Office of the Fire Marshall and Emergency Management (OFMEM) are working to update the PNERP which was last revised in 2009. The review and update of the PNERP began in 2015 and is being revised to incorporate lessons learned from past nuclear exercises and adopt aspects of International Atomic Energy Agency (IAEA) guidance. The Province is conducting a public consultation process with the objective of obtaining a Cabinet approved PNERP by year end 2017 and an approved OFMEM Pickering implementing plan by March 2018. OPG has reviewed and provided comments during the public review period, and will enhance its emergency plans to align with any PNERP requirements once issued.

A new public education campaign is planned for 2017 building on the successful previous campaign designed to provide guidance on what to expect in the unlikely event of a nuclear emergency and how to prepare prior to an emergency.

2.10.3 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
N-PROG-RA-0001	Consolidated Nuclear Emergency Plan
N-STD-AS-0010	Nuclear Crisis Communications Standard
N-PROC-RA-0045	Emergency Preparedness Drills and Exercises
N-PROG-RA-0012	Fire Protection

2.11 Waste management

Pickering NGS has an effective waste management program that meets or exceeds all applicable regulatory requirements and related objectives. Pickering's facility and waste stream-specific waste management program is fully developed, implemented and audited to control and minimize the volume of nuclear waste generated by the licensed activity.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and planned improvements over the next licensing period. These discussions also support that:

- Nuclear safety will be assured such that plant personnel, the public and the environment are protected during the various phases of activities in the next licensing period
- Impacts of plant operation to the public, workers, and the environment during these different phases will be of low risk and adequately mitigated

2.11.1 Waste Minimization, Segregation and Characterization

Procedure, *Waste Management*, N-PROC-OP-0043, provides an overview of waste processes and responsibilities and ensures that all waste at Pickering NGS is processed in accordance with federal, provincial and municipal regulations.

The objective of the procedure, *Segregation and Handling of Radioactive Waste*, N-PROC-RA-0017, is to ensure that radiological waste is properly handled, segregated and characterized.

Waste is generated at Pickering as a result of daily operations and maintenance activities and during planned and unplanned outages. Waste is characterized as either radiological or conventional depending on the radiological zone of its origin and from radiological surveys and analysis, in order to ensure that waste is safely disposed.

Low Level Radioactive Waste (LLRW)

Radioactive waste is collected from designated areas throughout the station. Waste handlers separate the solid waste into conventional and radiological and hazardous waste streams. Designated waste handlers process the waste to prepare and stage for shipment and final disposal.

In order to reduce radioactive waste generated in the Pickering NGS, OPG has reduced the amount of plastic, wood and cardboard by de-packaging materials and equipment before entering the station, thus reducing the risk of contaminating items that eventually become low level radioactive waste.

Monthly tracking of performance allows the operations and maintenance organization to assess where waste reduction strategies can be focused.

Site wide communications on waste reduction expectations will continue to improve behaviours and performance in waste reduction initiatives. Work groups are held accountable for waste reduction strategies and implement them in daily activities as well as for outage planning activities.

Conventional Solid Waste

Conventional waste is generated through maintenance activities in the Zone 2, unzoned and the public domain areas. This waste is confirmed to be free of contamination and is either processed to a waste transfer station and then onto a landfill or to a recycler for processing.

Conventional solid waste is also minimized to reduce the impact that it can have on the environment. This reduction includes implementation of the 3R's (Reuse, Reduce and Recycle). Recyclable material collected and processed at Pickering includes wood, cans, cardboard, paper, paper towels, newspaper, plastic, asphalt, concrete, compost, metal and glass.

The proportion of recycling diversion is dependent on the specific annual work as different activities generate varying forms of waste, not all of which are recyclable. Consequently the changing relative proportion between recyclable and non recyclable waste results in varying recycling diversion percentages each year.

Nevertheless, Pickering has improved in recycling methods over the years with introduction of organic waste segregation and blue box recycling, including single stream recycling, allowing all of general office recyclables to go into a single bin, simplifying the process for the users. Waste that cannot be recycled is sent to landfill.

Hazardous/Chemical Waste

Pickering NGS continues to meet federal and provincial requirements in processing and disposing of hazardous and chemical wastes.

Typical hazardous waste generated at Pickering includes chemicals and liquids such as cleaning agents, grease, oil, waste fuels, acids as well as batteries and PCBs. The liquid and chemical wastes are collected as a result of operations activities from equipment /system use or maintenance.

The volume of chemical drums on site is tracked and reported monthly with associated targets to ensure that the backlog is maintained at a low manageable level and that the waste is disposed as required by Ontario Regulation 347 requirements. These tracked drum volumes also support and impact the Environmental Index performance measure.

Environment Canada completed a site inspection of Pickering's PCB Waste Management Program in August 2015. The enforcement officers found no non-compliances and were satisfied with the program.

2.11.2 Waste Storage and Processing

There are various waste disposal paths depending on the characterization of the waste.

The waste disposal paths include:

- Solid radioactive waste shipped to Western Waste Management Facility for incineration or long term storage (compactable and non-processible);
- Radioactive oil shipped to Western Waste Management Facility for incineration;
- Radioactive liquid chemicals incinerated or solidified and stored at Western Waste Management Facility;
- Non radiological solid conventional waste shipped to public landfill or recycled;
- Non radiological chemicals/liquid industrial waste shipped to hazardous waste receiving company for incineration or disposal in hazardous landfill; and,
- PCBs shipped to Swan Hills Alberta Hazardous Waste Facility and incinerated.

All such waste will continue to be disposed safely.

2.11.3 Interim Dry Storage of Irradiated Fuel

The objective of interim dry storage of irradiated fuel is to provide safe, passive dry storage of irradiated fuel onsite until a permanent storage facility is in operation.

Fuel is moved from wet storage to dry storage in order to ensure sufficient irradiated fuel bay storage area for sustainable operation and eventual shutdown of the Pickering station.

Pickering NGS has been removing fuel from the wet irradiated fuel bays and transferring it as dry fuel to the Pickering Waste Management Facility (PWMF) since 1996. As of December 2016, a total of approximately 855 Dry Storage Containers (DSCs) containing 330,000 bundles of spent fuel have been safely processed and stored in 3 storage buildings onsite. The PWMF is licensed separately by the CNSC and considers the future needs of the Pickering station.

2.11.4 Decommissioning Plans

The objective of the Pickering Preliminary Decommissioning Plan (PDP) is to demonstrate the technical and financial feasibility of decommissioning Pickering NGS. The scope of the PDP includes all of the associated buildings and structures located inside the Pickering Protected Area, not including decommissioning of the Pickering Waste Management Facility. There is a separate PDP for the decommissioning of the Pickering Waste Management Facility, which is licensed separately.

In support of the above objective, the PDP accounts for the removal of all structures on site and of all radioactive and other (conventional) hazardous materials, their disposal at licensed facilities, and eventual restoration of the site to an end state agreed with the Regulators. As per the PDP, upon completion of the decommissioning program, the site will be in a condition that will support an application for a Licence to Abandon.

The decommissioning activities outlined in the PDP are planned in accordance with the requirements of the Canadian Standards Association (CSA) standard N294-09 “Decommissioning of Facilities Containing Nuclear Substances”, CNSC guides G-206 “Financial Guarantees for the Decommissioning of Licensed Activities”, and CNSC G-219 “Decommissioning Planning for Licensed Activities”.

OPG’s management system for decommissioning is defined under its Decommissioning Program, W-PROG-WM-0003. Lower tier supporting governing documents (W-PROC-WM-0093 Planning for Decommissioning, W-STD-WM-0003 Nuclear Liability Management – Update of Cost Estimates for the Ontario Nuclear Funds Agreement and Financial Guarantee Processes, and W-STD-WM-0005 Conduct of Decommissioning) have been prepared and issued.

Pickering’s PDP demonstrates that, through the process of decommissioning, the licensed facilities can be permanently retired from service and the site restored to a predetermined end state in a manner that will ensure that the health, safety and security of workers, the public and the environment are protected. The Pickering PDP was updated and submitted to the CNSC in January 2017 (Reference 6).

2.11.5 Preparation for Management of Waste from Transition to Safe Storage State

The eventual shutdown of Pickering is expected to increase the volume and variety of waste generated in a short time period. In order to protect workers and the environment during the Safe Storage Phase, all transient hazardous substances in non-operational systems and storage will be removed, packaged and disposed through appropriate disposal channels during the Stabilization Activities Phase. Planning ahead for the influx of waste will ensure OPG has sufficient capability for the treatment of these wastes, their storage, transport and disposal.

As part of the planning for wastes in the transition to the safe storage state, a waste forecast was prepared to estimate the type, volume and schedule of wastes expected to be produced. The waste forecast identified most wastes as typical operational wastes that have established processes for removal and transport from the station.

Two forms of waste require further planning:

Intermediate Level Resin Waste: Current resin generation rates and maximum shipping capacity indicates waste resin will remain in the station for an extended period after shutdown. Further information will be required to accelerate the transport of waste resin.

Polychlorinated Biphenyl (PCB) Waste: PCB regulation SOR/2008-273 requires removal of PCBs on site by December 31, 2025. OPG is developing a phase-out plan on PCB management (including radioactive PCB), after the end of commercial operations at Pickering and is in discussions.

2.11.6 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
N-PROG-OP-0006	Environmental Management
N-PROC-OP-0043	Waste Management
N-PROC-RA-0017	Segregation and Handling of Radioactive Wastes
W-PROG-WM-0003	Decommissioning Program
P-PLAN-00960-00001	Preliminary Decommissioning Plan-Pickering Nuclear Generating Stations A and B

2.12 Security

Pickering NGS has an effective security program that meets or exceeds all applicable regulatory requirements and related objectives. It effectively prevents the loss, theft or sabotage of nuclear material and the sabotage of the licensed facility.

For specific areas within this SCA, the following subsections describe the objectives, key results from the current licensing period, and planned improvements over the next licensing period. These discussions also support that:

- Nuclear safety will be assured such that the public is protected (e.g., Sections 2.12.1 and 2.12.4).
- OPG continues to invest in additional security measures at Pickering (e.g., planned improvements mentioned in Sections 2.12.1 and 2.12.4).

2.12.1 Nuclear Security Program

The *Nuclear Security Program*, N-PROG-RA-0011 ensures the safe and secure operation of the station and compliance with the legislative requirements by maximizing protection through use of equipment, personnel, and procedures.

OPG documents the specific regulatory security requirements for the security program in the OPG report, 8690-REP-61400-10003, *Pickering Site Security Report*. This security protected report will be updated in 2017.

Pickering Security personnel consist of two roles, Nuclear Security Officers (NSO) and Armed Nuclear Security Officers (ANSO). NSO's perform all security functions for Pickering NGS, while ANSO's provide on-site armed support capable of dealing with situations as outlined in the Design Basis Threat.

OPG Nuclear Security continues to participate in the inter-utility working group that includes security representatives from all commercial nuclear reactor operators in Canada. The group ensures nuclear security programs in Canada continue to evolve to meet future requirements, through the sharing of OPEX, and the promotion of best security practices.

Planned Improvement

OPG is in the process of developing an implementation plan in 2017 to comply with new mandatory credit checks and digital fingerprinting requirements as a result of changes to the Treasury Board Secretariat Security Screening Standard and the Royal Canadian Mounted Police (RCMP) Law Enforcement Records Check.

Facilities and Equipment

The objective for Facilities and Equipment is to ensure that Pickering Security and Emergency Services possess and operate the required equipment needed to comply with the Nuclear Security Regulations.

The Pickering search facilities are equipped with dedicated equipment for conducting personnel and vehicle security searches in order to enter the protected area of the Pickering plant. Personnel are also required to perform identity checks using both a proximity card and biometric hand geometry.

All exterior doors of the Pickering powerhouse are hardened against explosive or forced entry, and the doors are equipped with a robust lock system to prevent unauthorized access. The doors are alarmed and monitored.

Exits are also monitored with portal monitors for the detection of Category I, II or III nuclear material to prevent theft of material.

Searches are conducted on all packages and equipment entering the protected area for weapons and explosive substances.

The Pickering NGS protected area is surrounded by a security fence equipped with devices intended to detect any attempt at unauthorized intrusion into the protected area, and to detect any tampering or component failures that could cause the system to malfunction. The system is monitored at all times by Nuclear Security officers in the Security Monitoring Room. Alarms within the protected area are responded to by armed Nuclear Security officers. Pickering NGS also has physical protection measures against forced land vehicle penetration of the protected area.

Planned Improvements

There are initiatives underway that will enhance the Security Monitoring Room in order to improve the overall response capability and are expected to be completed in 2019.

2.12.2 Drills and Exercises

Security Drills are regularly conducted at the Pickering site with the objectives of validating security practices, ensuring regulatory compliance, and to identify security improvements. Security Training has been recognized by the American Society for Industrial Security (ASIS) International for providing industry leading training

OPG conducts a CNSC audited security exercise at the Pickering facility every two years. Also, a security drill that tests the operation of one or more of Pickering's physical protection measures and readiness of security personnel is conducted at least once every 30 days.

In 2014 and 2016, major security CNSC exercises were conducted. These exercises involved the integrated response of the Nuclear Security personnel as well as offsite police personnel and members of the Emergency Response Team. All of the exercises were conducted in a safe manner and the lessons learned improved security efficiency.

Currently, Security Training is conducting Incident Command Training based on the systematic approach to training process developed by all of the Nuclear Security groups in Canada. This training involves the active participation of the Durham Regional Police Service and ensures a smooth incident command transfer if it is necessary, during a security event.

OPG is partnering in the Durham Regional NextGen public safety radio system and is installing radio system infrastructure at the site. This will allow an improved communication link to offsite services in Durham Region and is expected to be completed by the end of 2017.

2.12.3 Response Arrangements

OPG has a Memorandum of Understanding (MOU) with the Durham Regional Police Service (DRPS) to provide off-site armed response force support to the Pickering Nuclear Generating Station pursuant to the Nuclear Security Regulations.

An update to the Memorandum of Understanding with DRPS is currently being agreed upon between Security and Emergency Services and DRPS. An updated copy of this MOU will be included in the 2017 Site Security Report.

2.12.4 Cyber Security

OPG's cyber security program is designed to implement OPG's corporate cyber security policy OPG-POL-0035, *Cyber Security Policy*. Information technology and industrial control systems are managed in a secure, vigilant and resilient manner that minimizes cyber risks to information assets and generation facilities.

The objective of nuclear cyber security is to provide for the secure operations of computer systems governed by the nuclear software program. Cyber security is applied to plant systems including those used to ensure safe operations and those which provide for physical security of the facility. Since 2013, there have been cyber security related updates to Engineering Change Control (ECC), employee training, and various maintenance and engineering instructions, guides, procedures and standards in addition to OPG's corporate cyber security policy.

ECC ensures all modifications to OPG nuclear systems, structures, and components (SSCs), including software and engineered tooling, are planned, designed, installed, commissioned, placed into service, or removed from service within the licensing basis. Within the ECC program, the modification process is followed for all changes to the OPG Nuclear design basis. Cyber Security is initially addressed during the design scoping phase of the modification process and issues are tracked through to the in-service declaration.

Employee training has included new qualifications for the Cyber Security Subject Matter Experts and the Cyber Security Single Point of Contact to support cyber security under the nuclear software program during design scoping and cyber essential asset identification and classification. Supplementing the internal training, a number of staff participated in a National Training Course on cyber security assessments sponsored by the CNSC and delivered by the International Atomic Energy Agency. For individuals performing maintenance related work, a training course was created to reinforce expectations with regard to portable computing devices (e.g., laptops), removable media (e.g., USB keys), and virus detection. Supporting the training, new instructions and guides have been issued to improve cyber security for portable and mobile computing, removable media devices and vendor digital assets.

OPG is improving the cyber security program by continuing to address the identified gaps communicated to the CNSC in order to comply with CSA N290.7-14, *Cyber Security*. These gaps are associated with the new identification and classification scheme for cyber assets and require a different selection and implementation of risk-based controls for the expanded inventory of cyber assets. As a consequence, a new engineering standard has been produced to provide direction for the identification and classification of *Cyber Essential Assets (CEAs)* in alignment with CSA N290.7-14. Subsequently, all station systems were systematically reviewed to identify and classify the CEAs. In some instances, modifications to newly identified cyber assets will be required to achieve compliance with CSA N290.7-14. The need to proceed with such modifications will be evaluated using the normal engineering change request process.

2.12.5 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document	Title
N-PROG-RA-0011	Nuclear Security
8690-D0H-14100-1003	Pickering GS Site Security Taut Wire Fence Layout and Survey
8690-REP-61400-10003	Pickering Nuclear Generating Station Security Report
N-CORR-00531-04980	Attachment 1: Primary Firearm Course of Fire and Qualification
N-CORR-00531-06348	Secondary Firearms Qualification
8690-CORR-00531-00483	Addendum to Pickering NGS Security Report R008
8690-CORR-00531-00459	Addendum to Pickering NGS Security Report R008
8690-CORR-00531-00544	Addendum to Pickering NGS Security Report R008
N-PROC-MP-0103	Security for Real-Time Process Computing System
N-STI-69000-10015	Cyber Asset Identification for Real-Time Process Computer Systems
N-STI-69000-10016	Cyber Security for Real Time Process Computing System
P-LIST-69000-00001	Significant Cyber Assets
TRAN-PLAN-03450-10000	Transport Security Plan

2.13 Safeguards and Non-Proliferation

Pickering NGS has an effective safeguards and non-proliferation program that meets or exceeds all applicable regulatory requirements and related objectives. Pickering NGS takes adequate measures to meet Canada's international safeguards obligations arising from the Canada/International Atomic Energy Agency (IAEA) safeguards agreements as well as other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons.

For specific areas within this SCA, the following subsections describe the main objectives and OPG activities at Pickering NGS. These discussions also support that:

- Pickering continues to provide the required level of transparency and co-operation with IAEA and CNSC staff for this area.

2.13.1 Nuclear Safeguards Program

OPG's *Safeguards Program* N-PROG-RA-0015 is designed to establish, maintain, and verify compliance with nuclear safeguards requirements for nuclear operations and to ensure that all necessary measures are taken to facilitate Canada's

compliance with safeguards agreements as well as all other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons.

The safeguards implementing document, N-STD-RA-0024, provides direction to ensure OPG complies with its licence conditions, the Nuclear Safety and Control Act, the General Nuclear Safety and Control Regulations, and any other related regulations in support of Canada's safeguards agreements.

During the current licence period, Pickering has met all Safeguards conditions in its operating licences and the terms of the agreement between Canada and the IAEA pursuant to the Treaty on Non-Proliferation of Nuclear Weapons. Pickering staff has fully cooperated with the IAEA and facilitated achievement of IAEA Safeguards goals

Pickering's compliance with the IAEA's Fuel Verification Program is met through the following activities:

- Complying with the Safeguards Agreement and the Additional Protocol,
- Providing services and assistance for IAEA staff tasks and equipment operation,
- Disclosing any records to the IAEA upon request,
- Installing, servicing and operating safeguards equipment,
- Not interfering in any way with safeguards equipment, samples or seals,
- Making no changes to operations, equipment or procedures that would affect safeguards implementation without prior written CNSC approval, and
- Preparing and submitting nuclear material accountancy reports per CNSC regulatory document RD-336, *Accounting and Reporting of Nuclear Material*, and as required under Regulatory Document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

2.13.2 Operational and Design Information

The Design Information Questionnaire (DIQ) provides the IAEA/CNSC with information pertaining to PNGS' design to ensure safeguards responsibilities are met as per the facility attachment. The DIQ is provided upon request from the IAEA/CNSC. The DIQ ensures that general information describing the Pickering NGS facility, design and operation, nuclear material descriptions, processing and flow of nuclear materials, safeguard measures, and accounting and reporting of nuclear materials are accurate and available to support a Design Information Verification (DIV) inspection.

2.13.3 Safeguards Equipment and Surveillance

Safeguards equipment is labelled and secured to prevent interference or tampering. The IAEA conducts annual inspections to ensure functionality and that no tampering of remote monitoring equipment has occurred. Surveillance systems (e.g., digital multi-camera surveillance systems, bundle counters and core discharge monitors) are installed at Pickering to provide the IAEA with continuous detailed data of

safeguards-related functions. The information is compared against Pickering's monthly declarations.

After an IAEA inspection, an accessibility issue was raised for a portion of the spent fuel bays due to the stacking of the fuel frames. This issue will be addressed to the satisfaction of IAEA and CNSC staff.

2.13.4 Import and Export

The scope of the non-proliferation program at Pickering is limited to the tracking and reporting of foreign obligations and origins of nuclear material. Import and export of controlled nuclear substances, equipment and information as identified in the *Nuclear Non-proliferation Import and Export Control Regulations*, is not currently permitted under the Pickering site licence and any application is made in accordance with applicable regulations.

2.13.5 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document Number	Document Title
N-PROG-RA-0015	Nuclear Safeguards
N-STD-RA-0024	Nuclear Safeguards Implementation

2.14 Packaging and Transport

Pickering NGS has an effective packaging and transport program that meets or exceeds all applicable regulatory requirements and related objectives. Packaging and transport of nuclear substances are conducted safely.

For specific areas within this SCA, the following subsections describe the objectives, key activities performed, and some planned improvements. These discussions also support that:

- Packaging and transport activities associated with the continued operation of the Pickering NGS will be conducted in a manner such that the risk to the public, workers, and the environment will be low.

2.14.1 Package Design and Maintenance

OPG controls the design of its radioactive materials packages and performs maintenance on the packages to ensure compliance with the Packaging and Transport of Nuclear Substances Regulations (PTNSR).

OPG owns and operates a fleet of radioactive materials packages of various types and capabilities. Some of the packages were designed by OPG and some were designed by external agencies. The engineering of new package designs (internally or externally produced) and modifications to existing packages are conducted in accordance with OPG's Engineering Change Control program and associated governance.

Each OPG radioactive materials transportation package (with the exception of one-time use packages) is subject to an annual maintenance outage. Package maintenance is performed in a dedicated facility located at the Western Waste Management Facility.

Each package is maintained in accordance with a package-specific procedure. Maintenance tasks include disassembly of major components, visual inspections of critical package features and components such as fasteners, and replacement or refurbishment of worn parts. The containment system of each package is tested to ensure its effectiveness.

Modifications to OPG's existing radioactive materials transportation packages are a rare occurrence due to the maturity of the designs.

All packages are maintained in proper condition to ensure there is no reduction in safety or operability.

Planned Improvements

OPG Nuclear Waste Management (NWM) is in the process of replacing its older transportation packages. The designs of the new packages incorporate improvements based on NWM's operating and maintenance experience, and utilize industry best practices.

2.14.2 Radioactive Material Transportation

The objective of the Radioactive Material Transportation (RMT) program is to ensure that shipments of radioactive material for which OPG is the consignor are prepared and offered for transport in a manner that is compliant with the Transportation of Dangerous Goods Regulations (TDG) and the Packaging and Transport of Nuclear Substances Regulations (PTNSR). This is done to ensure the safety of workers, the public, and the environment.

The *Radioactive Material Transportation* Program is owned by the Low and Intermediate Level Waste Operations and Radioactive Material Transportation (RMT) Department within the Nuclear Waste Management (NWM) division of OPG. The overall structure of the program is provided in W-PROG-WM-0002. OPG ensures that radioactive shipments are characterized, classified, packed, shipped, and received in accordance with approved procedures and applicable regulations. To ensure regulatory compliance, NWM issues and maintains a set of procedures and instructions that provide information on the correct means of handling, loading, and offering of radioactive material for shipment.

Table 8 below describes the various types of radioactive waste commonly shipped by Pickering Nuclear, and the packaging in which they are typically shipped.

Material	Packaging
Active Zone 2, and Zone 3 Waste	ISO-40 Trailer (IP-2 or Type A) & other Less than Type A Packaging
Filters, IX columns, hot particles	Radioactive Filter Transportation Package (Type B) & Multi-Purpose Transportation Package (Type B)
Spent Resin (in stainless steel liner)	Trillium Transportation Package (Type B)
High Active Waste (in drums)	Trillium Transportation Package (Type B)
Tritiated Heavy Water	TDO Package (Type B) Multi-Purpose Transportation Package (Type B)

Table 8 - Radioactive Material and Packaging

TDG regulations require that anyone who handles (i.e. loads, unloads, receives, classifies or ships) radioactive material in preparation for transport must be adequately trained or under the direct supervision of someone who is qualified. Within OPG, evidence that an employee is adequately trained for their function is demonstrated by holding a valid Class 7 Certificate of Training issued by RMT. To meet their responsibilities to the RMT Program, each work group maintains an adequate complement of trained Class 7 Handler/Receivers and Shippers. Each work group receives sufficient oversight from their line management to ensure compliance with RMT procedures. In addition, all Type A or Type B radioactive shipments are approved by an RMT Transportation Officer prior to leaving site.

Pickering has safely shipped hundreds of radioactive material packages, without any incident resulting in a radioactive release or serious personal injury.

2.14.3 Registration for Use

The objective of the user registration process is to ensure that OPG applies for and obtains confirmation from the CNSC that OPG's intended use of a radioactive materials transportation package of certified design has been registered. OPG has procedures in place for the registration for use of certified design packages.

OPG is currently a registered user for 12 different package designs. These packages include OPG's intermediate level waste and tritiated heavy water transportation packages, and shipping packages from external agencies and companies for used fuel, Cobalt-60, and radiation devices such as radiography cameras.

2.14.4 Transport Security Plan

The purpose of the transportation security plan is to govern security arrangements for shipments of Category III nuclear material by OPG. Specifically, it provides a description of the threat assessment of actions to be taken during the planning and execution of a Category III shipment.

There is a licensing requirement (Licence Condition 4) in the Licence to Transport (TL-S-12861-06.00/2018) to have a security plan, to ensure it is in effect during the licensing period and to review and update it annually.

The *Transport Security Plan* is documented in OPG document, TRAN-PLAN-03450-10000.

2.14.5 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document Number	Document Title
W-PROG-WM-0002	Radioactive Material Transportation
N-STD-RA-0036	Radioactive Materials Transportation Emergency Response Plan

3.0 Licensee Public Information Program

3.1 Public Information Program

OPG believes in open and transparent communication in a timely manner to maintain positive and supportive relationships and confidence of key stakeholders. OPG's Corporate Relations and Communications organization adheres to the principles and process for external communications as governed by the nuclear standard N-STD-AS -0013, *Nuclear Public Information and Disclosure*.

This document guides OPG's external community stakeholder activities, public response requirements of issues or significant events and OPG's standards to respond to concerns expressed by the public.

OPG's community relations and public information program has been recognized as a strength by national and international utility peers. OPG benchmarks current practices amongst other industries to ensure continuous performance improvement.

Each year a community engagement and consultation plan is developed to support OPG's business strategy to build community awareness and support of OPG and site operations that will result in sustained company reputation and positive community relations. The community relations program proactively provides information to stakeholders on Pickering operations and any effects on the community or environment that may result. The community information program ensures OPG continues to operate within an environment of limited public concern or intervention.

Pickering's community relations and public information program manages communications and relationships between Pickering and host communities by fostering healthy, open relationships and sustainable partnerships with community stakeholders, including government, media, business leaders, educational institutions, interest groups, and community organizations. In addition, Pickering strives to ensure transparent disclosure of operations and potential impacts, both positive and negative that may occur as a result of those operations.

OPG provides a quick response to issues and questions raised by stakeholders and the public, and tracks issues and questions to identify trends in order to further refine proactive communications. Two-way dialogue with community stakeholders and residents is facilitated through personal contact, community newsletters, speaking engagements, paid advertising and educational outreach.

3.1.1 Key Yearly Activities

OPG relies heavily on websites to provide up-to-date information that is easily accessible by the public and offers opportunities for further contact. The OPG website provides online access to information on environmental assessments and projects. It also carries regulatory information, such as relicensing hearings and event reports. Information brochures and fact sheets are also posted. OPG Nuclear and Pickering Nuclear Performance Reports are produced quarterly and published to

the OPG website. The website provides an opportunity for users to email questions, comments and concerns.

Social media continues to increase in popularity and use. OPG actively monitors and responds to activity through Tweets, Facebook, and other social media platforms. OPG maintains a Twitter account, an Instagram account, and Tweets on relevant nuclear activities and information.

3.1.2 Station reporting

OPG regularly and proactively provides information to the public on its facility activities. For operational status changes or unscheduled operations that may cause public concern or media interest, OPG follows a protocol to notify key community stakeholders in a timely manner. OPG maintains a duty on-call position 24 hours a day, seven days a week.

In conjunction with the Durham Emergency Management Organization, OPG maintains a protocol to notify key community stakeholders via faxes, e-mails and telephone (as warranted) when there are activities or events that have the potential to garner public or media interest. The purpose of the protocol is to ensure contacts in the emergency agencies (fire, police, and emergency management) and political offices are kept aware and are able to respond accurately if they receive questions from constituents.

On a quarterly basis, OPG publicly posts performance reports on station operations at www.opg.com and shares this document electronically with key stakeholders. Additionally, starting in 2014 OPG developed and began issuing a quarterly Environment report in an easy to read and understandable format. Annually, OPG posts the Environmental Monitoring Program report on www.opg.com for both Pickering and Darlington.

3.1.3 Welcoming Visitors

Pickering NGS maintains an Information Centre to host public and school visitors. Visitors receive information on current operations and issues and are provided an opportunity to have questions addressed. Students are offered curriculum-based educational presentations and self-directed use of the centre.

OPG encourages community groups to use the Information Centre for events unrelated to the industry. Its meeting room and event space were built to help build greater ties to the community. By creating a meeting space, organizations otherwise unrelated to the industry gain a comfort and familiarity with the technology.

Information about station operations and public waterfront trails is distributed to new residents in the Pickering and Ajax community via the Welcome Wagon.

3.1.4 Community Outreach

OPG hosts an annual community information session. The sessions are widely advertised in the community and in nearby Toronto. At many of the sessions, staff from OPG, the Canadian Nuclear Safety Commission (CNSC), the Region of Durham, the City of Toronto Emergency Management Office, and the Office of the Fire Marshal and Emergency Management were on hand to answer questions and provide information about safety and station operations.



Figure 22 - 2015 Pickering Nuclear Community Information Session



Figure 23 - Information Sharing Session and Station Tour

As well, Pickering Nuclear provides presentations and tours to community groups, key stakeholders, industry partners and the general public as shown in Figure 22 and Figure 23.

Quarterly ads on station performance are placed in local newspapers. Ads on station activities and community events are also run in newspapers and aired on local television stations.

120,000 copies of *Pickering Neighbours* newsletter are distributed quarterly to all residents and businesses in the City of Pickering, Town of Ajax and Toronto East.

Since 2006, Pickering Nuclear's Corporate Relations and Communications has provided a community-based program known as "Tuesdays on the Trail", reaching over 16,000 community members on Tuesdays throughout the summer months of July and August at Alex Robertson Park, which is adjacent to the Pickering Nuclear site (Figure 24). The long standing community based program has been recognized as a good practice by external reviews. This program provides a forum for the OPG staff to educate the public on plant operations while also promoting environmental awareness.



Figure 24 - Tuesdays on the Trail – Summer 2016

3.1.5 Community Committees

Pickering Nuclear manages the Pickering Community Advisory Council (CAC) which meets monthly to exchange information and provide advice to senior plant management on environmental, economic and public concern. Media attends and reports on the meetings. Figure 25 shows a CAC meeting in progress.



Figure 25 - Joint DNGS and PNGS CAC meeting June 2015

Pickering Nuclear has a representative on the Durham Nuclear Health Committee (DNHC) and OPG Nuclear staff makes regular presentations to the DNHC on a variety of environmental, community outreach and operational issues. The committee is chaired by the Durham Region Medical Officer of Health.

3.1.6 Environmental Partnerships and Programs

Pickering Nuclear is committed to biodiversity work on public lands, on OPG property and within the host community. Pickering Nuclear's biodiversity program continues to provide planting, butterfly gardens, and numerous other initiatives. More than 15,000 native trees and shrubs have been planted in the vicinity of Pickering Nuclear since 2000 by OPG staff and community volunteers.

Since 2011, OPG has been a lead partner in the Bring Back the Salmon program with the Ontario Ministry of Natural Resources, and the Ontario Federation of Anglers and Hunters. The program is designed to help restore the Atlantic salmon population in Lake Ontario by 2020 as shown in Figure 26. The success of this partnership led to a recent nomination for Wildlife Habitat Council – Partnership of the Year award.

In January 2017, OPG's Nuclear Operations successfully received "Conservation Certification" for 2017-2019 from the international Wildlife Habitat Council and Pickering Nuclear has twice been recognized as Wildlife Habitat of the Year.



Figure 26 - Students helping to raise salmon eggs in the Pickering Information Centre.

3.1.7 Employee Communications

The Corporate Relations and Communications (CRC) Department's Employee Communication division at Pickering Nuclear works to keep employees informed on station, fleet-wide company and industry issues in a timely, accurate and consistent manner by working collaboratively with station leadership and staff to develop and

implement strategic station-wide communications programs. These comprehensive programs support Pickering's vision of working together, as well as overall business objectives, work programs and goals to effectively drive improvements and support the safe and reliable operations of the plant. Additionally, the messages used within these communication programs help to foster alignment, engagement and teamwork amongst the intended audiences.

The internal CRC team develops annual communications strategies to support Pickering's business plans and vision, major on-site projects, initiatives and events. They include selected services and materials designed to achieve the communications goals. This ensures consistent communications have a positive, long-term impact on workforce alignment and engagement using a reliable two-way information exchange by way of the supervisory chain and meaningful face-to-face communication with direct reports, as well as more informal and formal online information channels. Pickering site communications anchor and reinforce key messages through multiple channels, including but not limited to face-to-face meetings, intranet websites, site-wide emails, posters and banners, in-station TV screens, and videos.

The CRC leads a number of initiatives throughout the year to measure and gauge the effectiveness of the strategies to promote a process of continual learning and improvement.

External evaluators and review teams continue to recognize the positive contributions of internal communications on the culture at Pickering.

3.1.8 Applicable OPG Documents

The following documents are the applicable OPG documents which support the licensing basis and are to be listed in the Licence Conditions Handbook.

Document Number	Document Title
N-STD-AS-0013	Nuclear Public Information and Disclosure

3.2 Aboriginal Consultation

Pickering NGS has an Indigenous Relations program in compliance with *REGDOC-3.2.2 Aboriginal Engagement*.

Under its Indigenous Relation Policy, OPG acknowledges the Aboriginal and Treaty rights of Indigenous communities as recognized in the *Constitution Act, 1982* and regularly undertakes engagement with Indigenous communities with asserted or established Aboriginal and treaty rights and/or interests proximate to Pickering NGS. These communities include:

- Members of the Williams Treaties First Nations:
 - Scugog First Nation;
 - Hiawatha First Nation;
 - Curve Lake First Nation, and
 - Alderville First Nation.
- Mississaugas of the New Credit First Nation
- Mohawks of the Bay of Quinte
- Métis Nation of Ontario, Region 8

OPG meets with these Indigenous communities on an ongoing basis to provide details of nuclear operations, reports and to discuss interests and identify concerns over current and future operations. OPG also maintains a listing of all relevant documents and notices on a designated external website for such events as the Pickering NGS licence renewal, and provides notification of site updates to communities when they occur.

Beginning in 2015, OPG began a renewed series of conversations on how communities proximate to Pickering NGS wished to be engaged; what information should be provided and discussed; frequency of meetings; and capacity support for communities to assist them in understanding potential impacts or concerns. The scope of the engagement was discussed and agreed upon; consultation protocols were reviewed; representatives were identified, and work objectives outlined.

OPG also provided community information sessions to Curve Lake and Hiawatha at their request in August 2016 (both members of the Williams Treaties First Nations), which covered the Pickering Waste Management Facility (PWMF) and Pickering site licensing processes among other topics.

As a part of OPG's overall engagement with the Indigenous community as a whole, tours have been undertaken by Indigenous communities that have rights or interests in current and planned OPG Nuclear and related operations. There were two Indigenous community specific tours in 2016 of the PWMF, with twenty-two participants. There was also a tour for Williams Treaties First Nations representatives on January 19, 2017.

Further, engagement meetings were undertaken with representatives of the Williams Treaties First Nations, Mississaugas of New Credit, Mohawks of the Bay of Quinte and the Métis Nation of Ontario Region 8 between January and March 2017 regarding OPG's fish impingement and entrainment mitigation and off-set measures. Engagement on this topic and others, with an emphasis on Pickering re-licensing, will be undertaken between September 2017 and February 2018.

Additionally, OPG participated in the second annual Aboriginal Apprenticeship Board of Ontario (AABO) *Day in the Trades* event, hosted by LiUNA Local 183 at their facility in Cobourg. Representatives from various building trades, suppliers and contractors interacted with Indigenous high school students from the communities as diverse as the Mohawks of the Bay Quinte, Curve Lake First Nation, Pikwakanagan First Nation and Durham Region Métis.

The OPG Native Circle, made up of Indigenous employees, organizes and hosts the annual National Aboriginal Day celebrations every June and oversees the John Wesley Beaver Memorial Awards for Indigenous post-secondary students. The Native Circle serves, in part, as a connection to the wider Indigenous community and participates in various Indigenous events, e.g., the annual *Indspire* career fair, where OPG is one of the sponsors.

Indigenous community representatives have expressed the following concerns and OPG has initiated or will implement the following communication sessions:

- Transportation and storage of nuclear waste - OPG continues to inform and educate communities, additional information sessions are being planned on OPG's Transportation Emergency Response Plan.
- Emergency preparedness and the ability for community members to be notified - OPG has provided information on notification protocols by OPG and appropriate authorities.
- Environment and fish impact as a result of operations - Numerous presentations on OPG's efforts to reduce fish impingement and entrainment have been provided.
- Potential outcome of an event that could impact their traditional territories given the close relationship First Nations and Métis have with the land - OPG continues to provide information on actual risks of operations and response and lessons learned that have been applied as a result of the Fukushima event in Japan.
- Desire to remain involved in future environmental monitoring opportunities - OPG commits to ongoing, participatory engagement and involvement of communities in the results and efforts to appropriately confirm environmental impacts of operations.
- An expressed interest in economic opportunities through procurement and employment through OPG's nuclear operations – as part of its Silver designation from the Canadian Council for Aboriginal Business' Progressive Aboriginal Relations (PAR) program, OPG is working to improve its business procurement and employee recruitment with local Indigenous communities.

4.0 Program for Cobalt-60

4.1 Cobalt-60

OPG produces Cobalt-60 as a commercial by-product at Pickering 5-8. Cobalt-60 is an important radioisotope with a wide range of industrial, medical, and food processing applications, and is a product that provides broad societal benefits. Cobalt production has been an important part of the Canadian nuclear industry since its inception, and Pickering NGS is a major supplier of Co-60. Pickering Units 6, 7 and 8 are fitted with adjuster elements consisting of a number of bundles strung end to end (similar in configuration to that of a fuel bundle). Each bundle is comprised of a number of pencils containing cobalt slugs. The Cobalt adjuster elements are then harvested during planned unit outages. Cobalt-60 rods are then packaged and shipped off-site.

Cobalt-60 is shipped off-site in accordance with the Transportation of Dangerous Goods Regulations and Packaging and Transport of Nuclear Substances Regulations. No spent Cobalt-60 has been received at Pickering from any off-site commercial facility.

The procedures which are used for Cobalt-60 processing and transfer are listed below. Pickering has not received any cobalt from MDS Nordion with an activity greater than 0.3 TBq in this licence period to-date, and will continue to submit the appropriate reports should any Cobalt-60 be received.

4.2 Applicable OPG Documents

Document Number	Document Title
P-OP-31985-0001	Cobalt Processing Procedure
P-OM-018-31985-01	Cobalt Processing – Table of Contents / Revision History
P-OM-018-31985-04.04.12	Cobalt Processing – Cobalt Handling

5.0 References

- 1 Letter, G. Carl Andognini to J. D. Harvie, "Pickering A – Request for Approval to Return to Service", November 24, 1999, [N-CORR-00531-00521](#).
- 2 Letter, P. Pasquet to T.E. Schaubel, "Pickering B:Submission of the Pickering B Continued Operations Plan – CNSC Action Item 2010-8-05", September 29, 2010, [NK30-CORR-00531-05693](#).
- 3 Letter, B. McGee to H. Overton, "Submission of Pickering NGS Periodic Safety Review 2 (PSR2) Basis Document Revision 001", June 3, 2016, [P-CORR-00531-04752](#).
- 4 Letter, R. Lockwood to G. Frappier, "End Date of Commercial Operations for Pickering NGS", June 28, 2017, [P-CORR-00531-04930](#).
- 5 Letter, B. McGee to A. Viktorov, "Pickering NGS Stabilization Activity Plan (SAP) – 2016 Annual Update", December 2, 2016, [P-CORR-00531-04880](#).
- 6 Letter, S. Granville to K. Glenn, A. Viktorov and M. Santini, "Submission of Preliminary Decommissioning Plans", January 30, 2017, [N-CORR-00531-18384](#).
- 7 Letter, G. Jager to M. Leblanc, "Notice of Participation Pursuant to Rule 18 of CNSC Rules of Procedure - Pickering NGS Licence Renewal Application Hearing - February 20, 2013", January 21, 2013, [P-CORR-00531-03860](#).
- 8 Letter, B. McGee to A. Viktorov, "Pickering NGS – CNSC Action Item 2016-48-7470 Status Update on Emergency Mitigation Equipment and Telecommunications Projects", February 16, 2017, [P-CORR-00531-04945](#).
- 9 Letter, B. McGee to A. Viktorov, "Pickering NGS – Risk Improvement Plan Update", February 27, 2017, [P-CORR-00531-04946](#).
- 10 Letter, B. McGee to M. Santini, "Pickering NGS - Assurance of Structural Fuel Channel Fitness-for-Service for the Target Service Life of Pickering Units 5-8", June 10, 2015, [P-CORR-00531-04293](#).
- 11 Letter, M. Santini to B. McGee, "Pickering NGS - Assurance of Structural Fuel Channel Fitness-for-Service for the Target Service Life of Pickering Units 5-8", March 9, 2016, [NK30-CORR-00531-07215](#).
- 12 Letter, R. Lockwood to A. Viktorov, "Pickering NGS - Assurance of Fuel Channel Fitness-for-Service for the Assumed Target Service Life of the Pickering Units", April 4, 2017, [P-CORR-00531-04953](#).
- 13 Protocol, "OPG-CNSC Protocol for the Conduct of a Periodic Safety Review in Support of Pickering NGS Licence Renewal", January 17, 2017, e-Doc 5143721, [P-CORR-00531-04725 R001](#).
- 14 Email, P. Herrera to A. Viktorov, "Pickering NGS Sustainable Operations Plan (SOP) - Revision to 2016 Update", January 9, 2017, [P-CORR-00531-04943](#).

- 15 Letter, R. Lockwood to A. Viktorov, "Environmental Risk Assessment Report for Pickering Nuclear and Predictive Effects Assessment for Pickering Nuclear Safe Storage", April 28, 2017, [P-CORR-00531-04982](#).
- 16 Letter, K. Dehdashtian to A. Viktorov, "Pickering Quarterly Report on Nuclear Power Plant Personnel - Fourth Quarter 2016", March 30, 2017, [P-CORR-00531-04986](#).
- 17 Letter, K. Dehdashtian to A. Viktorov, "Pickering Quarterly Report on Nuclear Power Plant Personnel - First Quarter 2017", June 30, 2017, [P-CORR-00531-05066](#).
- 18 Email, L. Mitchell to M. Santini and A. Viktorov, "CNSC Staff's Written Notification of Document Change: N-PROG-RA-0018, Nuclear Pandemic Plan, R003 Superseded", June 27, 2017, [N-CORR-00531-18652](#).
- 19 Letter, W.S. Woods to A. Viktorov and M. Santini, "Progress Report on OPG Heat Transport System Aging Safety Analysis", February 24, 2017, [N-CORR-00531-18427](#).
- 20 Letter, R. Lockwood to A. Viktorov, Pickering Units 1 to 4: Updated Fire Hazard Assessment (FHA) and Fire Safe Shutdown Analysis (FSSA) Reports - CNSC Action Item 2015-48-6623 - Request for Closure", June 30, 2017, [P-CORR-00531-05062](#).
- 21 Letter, B. McGee to A. Viktorov, "Pickering Units 5 to 8: Updated Fire Hazard Assessment (FHA) and Fire Safe Shutdown Analysis (FSSA) Reports - CNSC Action Item 2015-48-6303 - Request for Closure", March 31, 2017, [NK30-CORR-00531-07407](#).

Appendix A – Activities and Nuclear Substances to be Encompassed by the Licence

The information below is provided to satisfy the requirements of Section 3(1)(b) of the General Nuclear Safety and Control Regulations.

Activities to be Licensed:

The application for renewal of Power Reactor Operating Licence (PROL) 48.03/2018 contains information for the activities to be licensed. These activities include those currently licensed in PROL 48.03/2018:

- (i) Operate the Pickering Nuclear Generating Station units 1, 4, 5, 6, 7 and 8, for power production, and operate units 2 and 3 in the safe storage phase at a site located in the City of Pickering, in the Regional Municipality of Durham, in the Province of Ontario.
- (ii) Possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in [i].
- (iii) Possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in [i].
- (iv) Possess, use, manage and store enriched uranium as required for fission chambers for the Pickering Nuclear Generating Station units 1 and 4 Shutdown System Enhancement, including spares.
- (v) Possess, produce, manage, transfer and store Cobalt-60.
- (vi) Possess, manage and store Cobalt-60 sealed sources.
- (vii) Possess, transfer, manage and store heavy water from other nuclear facilities.

Additional activities requested to be licensed include the activities associated with the Stabilization and Safe Storage with Surveillance phases described in this application, including to:

Operate the Pickering Nuclear Generating Station units 1, 4, 5, 6, 7 and 8 in the safe storage phase at a site located in the City of Pickering, in the Regional Municipality of Durham, in the Province of Ontario, following the end of commercial operation of these units.

The table below is provided to satisfy the requirements of Section 3(1)(c) of the General Nuclear Safety and Control Regulations. The data provided are current as of June 2017.

Nuclear Substance	Form	Location	Maximum Quantity
Natural Uranium	Solid Fuel Bundles ¹	New Fuel Inventory	11177 bundles
Depleted Uranium	Solid Fuel Bundles ¹	New Fuel Inventory	508 bundles
	Solid	Tooling and Shielding	~26000 kg
	Solid Spent Fuel Bundles ¹	IFB-A, AIFB & IFB-B	399703 bundles
Irradiated Uranium	Solid ^{1,2} Fuel Bundles	Pick A Reactor Cores - Units 1 & 4	9360 bundles
	Solid ¹ Fuel Bundles	Pick B Reactor Cores - Units 5, 6, 7 & 8	18240 bundles
Heavy Water	Liquid (D ₂ O)	Units 1,4,5,6,7 & 8	3000 Mg
	Liquid (D ₂ O) ³	Storage	2100 Mg (Note 3)
Cobalt-60	Solid	Units 6, 7 & 8	6.3 MCi
	Solid	AIFB	0 MCi
Enriched Uranium	Solid	Painted layer on the tubes of Fission Chambers ⁴	24 Fission chambers

Notes:

1. A fuel bundle contains on average 20.142 kg U.
2. Pickering Unit 2 and 3 have been defueled and are in the Safe Storage State.
3. Heavy water storage is the maximum capacity of heavy water that can be stored at Pickering; the current inventory of heavy water (in the units and stored) is 3556 Mg.
4. A fission chamber contains on average 3.56 g U-235 (93% enriched). This includes Fission chamber detectors used in SDSE in PNGS 014 and in Core Discharge Monitoring System in PNGS 014 and 058.

Appendix B - Financial Guarantee, Nuclear Liability Insurance and Cost Recovery

Financial Guarantee

The objective of OPG's financial guarantee is to ensure that sufficient funds are estimated, collected and administered for the management of liabilities associated with operating and decommissioning of all its nuclear facilities. The financial guarantee is prepared for all OPG owned or leased facilities and makes specific financial provisions for the decommissioning of the Pickering Nuclear Generating Station. The Pickering *Preliminary Decommissioning Plan* (Reference B-1) forms the basis for establishing and maintaining an acceptable Financial Guarantee.

In addition to the decommissioning program, OPG's Financial Guarantee also covers financial provisions for the long-term management (storage and eventual disposal) of all operational and decommissioning wastes (Used Fuel, Low Level and Intermediate Level Wastes).

OPG's financial guarantee is prepared and maintained on a five-year cycle in accordance with the requirements set out in CSA Standard N294-09 and CNSC regulatory documents G-219 and G-206. OPG also provides an annual financial guarantee report to the CNSC detailing the status of the guarantee including the amounts accumulated in segregated funds and the value of the Provincial guarantee required. The report compares the amount of the liabilities and the financial resources available to discharge the obligations.

The financial guarantee provisions for Pickering demonstrate that the current level of funding is adequate for decommissioning the station and returning the site to an end state agreed with the Regulators. The 2013 - 2017 CNSC financial guarantee was approved by the CNSC in December 2012.

The 2018 - 2022 CNSC financial guarantee is based on the decommissioning and operational waste management cost estimates completed by OPG in 2016 as part of the five-year Ontario Nuclear Funds Agreement (ONFA) reference plan update cycle and was submitted to the CNSC in the spring of 2017 for Commission approval by Hearing, to be held before the end of 2017. The update has been previously submitted for approval to the Ontario Finance Authority (OFA) and approved in December 2016 [Reference B-2].

OPG will continue to provide annual Financial Guarantee reports to the CNSC detailing the status of the guarantee including the amounts accumulated in segregated funds and the value of the Provincial Guarantee (if required).

Nuclear Liability

OPG is required, under the Nuclear Liability and Compensation Act (NLCA), to maintain \$650 million of nuclear liability insurance for its Pickering nuclear generating station in 2017. The NLCA increases OPG's nuclear liability limit from \$650M to \$750M, \$850M and \$1B in 2018, 2019 and 2020 respectively. OPG will purchase nuclear liability insurance in accordance with the requirements of the NLCA. The following certificate of insurance verifies that the insurance required by the NLCA for 2017 is in place. Insurance inspections are conducted at Pickering every 18 months by nuclear property insurers. These inspections are also attended by conventional insurers who inspect the non-nuclear side of the station.



Certificate of Insurance

No.: 2017-2

Dated: January 03, 2017

This document supersedes any certificate previously issued under this number

<p>This is to certify that the Policy(ies) of insurance listed below ("Policy" or "Policies") have been issued to the Named Insured identified below for the policy period(s) indicated. This certificate is issued as a matter of information only and confers no rights upon the Certificate Holder named below other than those provided by the Policy(ies).</p> <p>Notwithstanding any requirement, term, or condition of any contract or any other document with respect to which this certificate may be issued or may pertain, the insurance afforded by the Policy(ies) is subject to all the terms, conditions, and exclusions of such Policy(ies). This certificate does not amend, extend, or alter the coverage afforded by the Policy(ies). Limits shown are intended to address contractual obligations of the Named Insured.</p> <p>Limits may have been reduced since Policy effective date(s) as a result of a claim or claims.</p>	
<p>Certificate Holder: Canadian Nuclear Safety Commission Headquarters 280 Slater Street P.O. Box 1046 Station B Ottawa, ON K1P 5S9</p>	<p>Named Insured and Address: Ontario Power Generation Inc. 700 University Avenue, H18-J18 Toronto, ON M5G 1X6</p>

This certificate is issued regarding:
 Pickering NGS

Type(s) of Insurance	Insurer(s)	Policy Number(s)	Effective/Expiry Dates	Sums Insured Or Limits of Liability	
NUCLEAR LIABILITY • Pickering	Nuclear Insurance Association of Canada	OF104	Jan 01, 2017 to Jan 01, 2018	Limit of Liability	\$ 403,000,000 out of \$650,000,000
NUCLEAR LIABILITY • Pickering	Lloyd's Underwriters	NCNTPL56	Jan 01, 2017 to Jan 01, 2018	Limit of Liability	\$ 47,000,000 out of \$650,000,000
NUCLEAR LIABILITY • Pickering	Euro Liab. Ins for the Nuc. Ind. (ELINI)	EL031CA17	Jan 01, 2017 to Jan 01, 2018	Limit of Liability	\$ 25,000,000 out of \$650,000,000

Additional Information:

In accordance with their rights under the Nuclear Liability and Compensation Act, Ontario Power Generation Inc. has retained \$175,000,000 out of the total policy limit of \$650,000,000.

Notice of cancellation:

The insurer(s) affording coverage under the policies described herein will not notify the certificate holder named herein of the cancellation of such coverage.

<p>Marsh Canada Limited 120 Bremner Boulevard Suite 800 Toronto, ON M5J 0A8 Telephone: 1-844-990-2378 Fax: 416-868-2526 certificaterequestscanada@marsh.com</p>	<p>Marsh Canada Limited</p> <p>By: </p>
--	--

Cost Recovery

Pursuant to the *Canadian Nuclear Safety Commission Cost Recovery Fees Regulation*, Ontario Power Generation pays the CNSC's fees on a quarterly basis.

References

- B-1 OPG letter, S. Granville to K. Glenn, A. Viktorov, and M. Santini, "Submission of Preliminary Decommissioning Plans," January 30, 2017, [N-CORR-00531-18384](#).
- B-2 OFA Memorandum, R. Kwan to J. Mauti, "Ontario Nuclear Funds Agreement Reference Plan," December 20, 2016, [N-CORR-00960-0634854](#).

Appendix C - Licences, Internal Authorizations, Certificates and Summary of Environmental Regulatory Requirements

C.1 Licences, Internal Authorizations and Certificates

The following provides a list of Licences, Authorizations and Certificates held by OPG that are relevant to the Pickering Nuclear Generating Station. Note this information is current as of February 28, 2017.

Federal (other than CNSC)

Certificates and Authorizations	
Transport Canada	
Permit	Description
8200-08- 7095	The Pickering Fish Diversion System (Mesh Barrier) has a permit under the <i>Navigation Protection Act</i> (formerly the <i>Navigable Waters Protection Act</i>).

Provincial

Certificates and Authorizations	
Technical Standards and Safety Authority (TSSA)	
Registration Number	Description
R-8261	The Pickering heating steam boiler (OIN 5.913573) has been issued an Ontario Certificate of Registration of a Plant, Registration Number R-8261 (issue date Aug. 2, 2006 for Standby Boiler and Main Security Building (MSB) HP Chiller Refrigeration unit). The boiler supports Pickering 014 and Pickering 058 (formerly referenced as Pickering A and Pickering B stations) and is physically located at Pickering 058. The chiller supports the MSB only.
Elevators	Licences to operate elevators are granted by the Technical Standards and Safety Authority (TSSA), Elevating Device Branch. The complete list of the licences for elevators at Pickering can be provided as requested.
Pressure Vessels	An electronic register is maintained at Pickering of all valid pressure vessel certificates issued by the Technical Standards and Safety Authority. This register is maintained on an on-going basis. Copies of certificates are available upon request.

Certificates of Authorization	Description
QA 00854	Repair and alteration of boilers and pressure vessels, fittings and piping.
QA 00853	Fabrication of welded and non-welded category A, B, D & H type fittings.
QA 00852	Fabrication and assembly of refrigeration piping.
QA 00851	Fabrication and assembly of process piping.
QA 00850	Fabrication and assembly of power piping.
QA 00845	Fabrication of Class 1, 2 & 3 Welded and Non-Welded category A, B, D & H type fittings.
QA 00844	Fabrication of Class 1, 2, 3 & 4 Welded and Non-Welded Supports.
QA 00843	Class 1, 2, 3 & 4 With Design Responsibility for Appurtenance and Supports; as a Material Organization Supplying Ferrous and Nonferrous Material.
QA 00842	Construction of Class 1, 2, 3 & 4 Piping Systems; Class 1, 2 & 3 Shop Assembly; as a Material Organization Supplying Ferrous and Nonferrous Material.
QA 04144	Repairs, Modifications or Replacements of Class 1, 1C, 2, 2C, 3, 3C, and 4 Nuclear Items.

Ministry of Labour (MOL)			
X-Ray Machine Registrations			
MOL Site Registration Code	Location	Portable/Fixed Equipment	Quantity
0243.3	Main & Aux Security Buildings	Fixed - Baggage Security	6
0243.3	East Complex Warehouse	Fixed – Large Article Security	1
0243.3	PNGS	Portable XRF	3
0243.3	PNGS	Portable Pulsed X-Ray	4
0243.3	PNGS	Portable/Bench Top Analytical XRF	1
0243.3	PNGS	Portable/Bench Top Analytical XRF Analyzer	1

Ministry of the Environment and Climate Change (MOECC)		
Environmental Compliance Approval (ECA)	Description	MOE Routine Reporting Requirements
4881-5MHQ9F (Industrial Sewage)	<p>Pickering Site Operation</p> <p>Comprehensive Certificate of Approval (sewage) dealing with (but not limited to):</p> <ul style="list-style-type: none"> • Outfall chemical limits • Service water chlorination and dechlorination limits • Condenser Leak Testing • Condenser Tube Cleaning • Phosphate Detergent use • Secondary Side Discharge volume and chemical limits • Standby Boiler Discharge volume and chemical limits • Spill Containment Discharge chemical limits • Yard Drainage Discharge chemical limits • Inactive Drainage Discharge chemical limits • Standby Generator Spill Containment Discharge chemical limits • Upgrader Discharge chemical limits 	<p>Annual performance report by June 1 of following calendar year summarising (but not limited to):</p> <ul style="list-style-type: none"> • Compliance data • Exceedances and actions taken • Number of condenser leak tests conducted
4881-5MHQ9F Notice 5 (Industrial Sewage)	<p>Station Temperature Limits</p> <p>Catering to:</p> <ol style="list-style-type: none"> 1. Normal Operation 2. Electricity Supply Emergencies <p>Algae Runs</p>	<p>Notification as follows (but not limited to):</p> <ul style="list-style-type: none"> • Whenever Electricity Supply Emergency Declared by IESO • Whenever Algae Run results in evident fish kill • Whenever limit exceedances occurs <p>Temperature monitoring data compiled by end of Q1 of following calendar year and provided to MOE upon request.</p>
2460-A2NHF2	PNGS-A Permit to Take Water	Notify Director of complaints received, annual use, changes of address, ownership etc.
2731-8ULK95	PNGS-B (Pickering 058) Permit to Take Water	Notify Director of complaints received, annual use, changes of address, ownership etc.
A390401 (Waste Disposal)	Closure of East Landfill Site	None
A390407 (Waste Disposal)	Closure of West Landfill Site	None

Certificate of Approval (C of A)	Description	MOE Routine Reporting Requirements
4766-A3YMB9 (Air)	Pickering Site Operation Environmental Compliance Approval (Air) (Limited Operational Flexibility)	Annual performance report by June 1 of following calendar year summarising (but not limited to): <ul style="list-style-type: none"> • Changes to Point of Impingement concentrations or emission rates for Compounds of Concern • Listing of Compounds of Concern Physical changes affecting Compounds of Concern
5683-6XAMAB (Industrial Sewage)	Auxiliary Power System	Notify the District Manager if the process is not operated in accordance with limits/requirements set out in certificate.
0947-A7NM85	New Water Treatment Plant Operation- Environmental Compliance Approval (Sewage) (Limited Operational Flexibility)	OPG, on behalf of Odeco-Nalco, to provide reports on: <ul style="list-style-type: none"> • Sampling results as required under MISA Regulation Part II • Sampling point or toxicity testing frequency changes • MISA reports as required under MISA Regulation part VIII. OPG to submit to District Manager no later than 45 days after end of each quarter a summary of the chlorine and anti-scalant monitoring results.

C.2 Summary of Environmental Regulatory Requirements

OPG Law Division maintains a summary list of federal, provincial and municipal environmental regulatory requirements that may be applicable to the nuclear facility. Some examples of environmental regulatory requirements included in the Registry are identified in the table below, a list of all regulations can be provided as requested.

Federal Requirements
Canada Wildlife Act
Canadian Environmental Assessment Act, 2012
Canadian Environmental Protection Act
Environmental Violations Administrative Monetary Penalties Act
Fisheries Act
Migratory Birds Convention Act
National Fire Code
Navigation Protection Act
Pest Control Products Act
Species at Risk Act
Transportation of Dangerous Goods Act

Provincial Requirements
Beds of Navigable Waters Act
Clean Water Act
Conservation Authorities Act
Dangerous Goods Transportation Act
Drainage Act
Emergency Management and Civil Protection Act
Endangered Species Act
Environmental Assessment Act
Environmental Bill of Rights
Environmental Protection Act
Fire Protection and Prevention Act
Fish and Wildlife Conservation Act
Green Energy Act
Highway Traffic Act
Municipal Act
Occupational Health and Safety Act
Ontario Building Code
Ontario Heritage Act
Ontario Water Resources Act
Pesticide Act
Planning Act
Public Lands Act
Road Access Act
Safe Drinking Water Act
Technical Standards and Safety Act
Toxics Reduction Act
Water Opportunities Act
Weed Control Act
Waste Diversion Act

Municipal and Regional Requirements: By-laws of the City of Pickering and Durham Region	
Sewer Use By-law	
Noise By-Law	
Waste By-law	
Emergency Management By-law	
Tree Conservation By-law	
Municipal Waste Collection By-law	
Other Provincial Regulatory Requirements	
Electricity Act – 1998 and Market Rules	

Table of Routine Environmental Regulatory Reporting (not including the CNSC reporting)

Report Title	Frequency	Required By:
Environment Canada		
Halocarbon Release Report	Semi-Annual	Federal Halocarbon Regulations SOR/2003-289 Section 33.1
Environment Canada and Ontario Ministry of Environment and Climate Change		
National Pollutant Release Inventory (NPRI)	Annual	CEPA 99 Sect. 48.
Ontario Ministry of Environment and Climate Change		
Municipal/Industrial Strategy for Abatement (MISA) Report	Annual	O. Reg. 215/95
Municipal/Industrial Strategy for Abatement (MISA) Quarterly Report ⁽³⁾	Quarterly	O. Reg. 215/95
Landfill Inspection	Biannual	C of A A390401
Registration of Wastes to MOE (hazardous wastes)	Annual	O. Reg. 347
PCB Report	Annual	Director's Instructions for site 304-86A-022 and 304-82-A-009
Waste Reduction Work Plan (Conventional)	Annual	O. Reg. 102/94
Annual Water Taking and Use Report	Annual	O. Reg. 387/04
Certificate of Approval Industrial Sewage Works Annual Performance Report	Annual	C of A Sewage Works # 4881 - 5MHQ9F
Certificate of Approval Air Written Summary	Annual	C of A Air # 9090 - 6SBGEH
Ontario Regulation 127/01 Report	Annual	O. Reg. 127 / 01

Appendix D – CNSC Action Items

(Freeze Date for New Action Items is May 2, 2017)

Action Item	Title	Status	Next Update Due
2017-OPG-9746	Darlington and Pickering NGS: CNSC Type II Compliance Inspection Report: Organization, Roles and Responsibilities	OPG to provide a progress update	13SEP2017
2017-OPG-9721	DNG and PNG: 2016 Third Party Industrial Fire Brigade Drill Audit Reports	OPG to provide a progress update	30JAN2018
2017-OPG-9657	Darlington and Pickering NGS: CNSC Calandria-tube Strain Contact Boiling Experiments	OPG to provide a progress update	15SEP2017
2017-OPG-9637	Darlington and Pickering NGS: Implementation of REGDOC-2.2.4 Human Performance Management -Worker Fatigue	OPG to provide a progress update	30SEP2017
2017-OPG-9636	Darlington and Pickering NGS: Fuel and Pressure Tube Fitness-For-Service	OPG to provide a progress update	15DEC2017
2017-OPG-8928	Darlington and Pickering NGS: Desktop Review of OPG's Procedure N-INS-61400-10008 R005	OPG requested closure of Action Item	N/A
2017-48-9902	PNGS: Morpholine Sampling At The 058 Condenser	OPG to provide a progress update	16FEB2018
2017-48-9791	PNGS: Inspection report: Planned maintenance outage	OPG requested closure of Action Item	N/A
2017-48-9745	PNGS: Type II compliance report: worker dose control	OPG to provide a progress update	01NOV2017
2017-48-9588	Pickering NGS: CNSC Type II Compliance Inspection Report: Q3, Fiscal Year 2016-2017	OPG to provide a progress update	30NOV2017
2017-48-9550	Pickering NGS: CNSC Type II System Inspection Report: Monitoring System	OPG to provide a progress update	30OCT2017
2017-48-9469	Pickering NGS: CNSC Desktop Review Report- Radiation Protection Technician Training Program	OPG requested closure of Action Item	N/A
2017-48-9430	Pickering NGS: CNSC Type II Compliance Inspection Report: Environmental	OPG to provide a progress update	13OCT2017
2017-48-9329	Pickering NGS: CNSC Type II Compliance Inspection Report: Electrical Distribution System	OPG to provide a progress update	25AUG2017
2017-48-9205	Procedures for Obtaining Material Samples with Circumferential Wet Scrape Tool (CWEST)	OPG requested closure of Action Item	N/A

Action Item	Title	Status	Next Update Due
2017-48-10956	PNGS: Accessibility for IAEA inspections	OPG to provide a progress update	08MAR2018
2016-OPG-8975	Darlington and Pickering NGS: Revised CSA N285.8 Compliance Plan	OPG requested closure of Action Item	N/A
2016-OPG-8370	Darlington and Pickering NGS: Supplemental Response Regarding Stack Effluent	OPG to provide a progress update	30SEP2017
2016-OPG-8250	Darlington and Pickering NGS: Post Closure Fuel Management and Surveillance Software Upgrade	OPG to provide a progress update	31MAY2018
2016-OPG-8187	Darlington and Pickering NGS: Engineering Training Programs	OPG to provide a progress update	27OCT2017
2016-OPG-7967	Darlington and Pickering NGS: Direct Plant Data Transfer to the CNSC Emergency Operating Centre (EOC)	OPG to provide a progress update	30NOV2017
2016-OPG-7469	Fukushima- Implementation of the ERP code upgrades	OPG requested closure of Action Item	N/A
2016-OPG-7413	Darlington and Pickering NGS: CNSC Type II Compliance Inspection Report: Environmental Monitoring	OPG to provide a progress update	29SEP2017
2016-48-8871	Pickering Unit 6: 2015 Outage Fuel Channel Inspections -	OPG requested closure of Action Item	N/A
2016-48-8142	Revision of PBRA, include Rod Based GSS	OPG to provide a progress update	15DEC2017
2016-48-8096	Pickering NGS: CNSC Type II Compliance Inspection Report: PRPD-2016-009, Fiscal Year 2015-2016	OPG requested closure of Action Item	N/A
2016-48-8028	Pickering NGS: CNSC Type II Compliance Inspection Report: Configuration management	OPG to provide a progress update	22SEP2017
2016-48-7893	PNGS REGDOC 3.1.1 Preliminary Event Report	OPG to provide a progress update	25AUG2017
2016-48-7797	Pickering NGS: CNSC Type II Compliance Inspection Report: Preservation of Seismic Design Basis	OPG to provide a progress update	16MAR2018
2016-48-7613	Pickering NGS: CNSC Type II Compliance Inspection Report: Fuel Channel Pressure Tubes Supplementary Inspections	OPG requested closure of Action Item	N/A

Action Item	Title	Status	Next Update Due
2016-48-7588	PNGS: Type II Inspection Effluent Control and Monitoring	OPG to provide a progress update	15MAR2018
2016-48-7470	Implementation of the Emergency Mitigating Equipment (EME) and Telecommunications projects	OPG to provide a progress update	07MAR2018
2016-13-7638	PNGS Changes to Site Access Security Clearance Process	OPG to provide a progress update	30SEP2017
2015-OPG-7000	Darlington and Pickering NGS: Acceptance Criterion for Method	OPG to provide a progress update	29SEP2017
2015-48-7304	Pickering NGS: CNSC Type II Compliance Inspection Report, Electrical Power System	OPG to provide a progress update	08NOV2017
2015-48-7237	PNGS: CNSC Type II Compliance Inspection Report: PRPD-2015-019, Fiscal Year 2015-2016	OPG requested closure of Action Item	N/A
2015-48-7043	Type II Compliance Inspection Report - Integrated Aging Management Program	OPG to provide a progress update	23FEB2018
2015-48-6946	Type II Compliance Inspection – Management Review – PRPD-2015-013	OPG to provide a progress update	25AUG2017
2015-48-6623	Request for Acceptance of the Fire Hazard Assessment (FHA) and Fire Shutdown Assessment (FSSA)	OPG requested closure of Action Item	N/A
2015-48-6500	Pickering NGS - Type II Compliance Inspection - System Inspection Irradiated Fuel Bays	OPG to provide a progress update	31DEC2017
2015-48-6459	Pickering NGS - Type II Compliance Inspection - Equipment Inspection	OPG to provide a progress update	24NOV2017
2015-48-6458	Pickering Units 1 &4: Revised Component Disposition – Pressure Tube to Calandria Tube Contact	OPG requested closure of Action Item	N/A
2015-48-6450	Pickering NGS - Type II Compliance Inspection - Maintenance Work Execution	OPG to provide a progress update	25AUG2017
2015-48-6381	Replacement of SDS1 Ion Chamber Amplifiers	OPG to provide a progress update	31JUL2018
2015-48-6303	Pickering Units 5-8: Fire Hazard Assessment (FHA) and Fire Safe Shutdown Assessment (FSSA)	OPG requested closure of Action Item	N/A
2014-OPG-5632	Darlington and Pickering NGS: Request for re-categorization of Safety Issue: Computer Code and Plant Model Validation	OPG requested closure of Action Item	N/A

Action Item	Title	Status	Next Update Due
2014-OPG-4862	Darlington and Pickering NGS: OPG Revised CSA N285.8 Compliance Plan	OPG requested closure of Action Item	N/A
2014-OPG-4782	Approach to Fitness for Service Assessment for Pressure Tubes	OPG to provide semi-annual progress updates	31OCT2017
2014-48-5823	Type II Compliance Inspection - Implementation of Pressure Boundary Program	OPG to provide a progress update	06OCT2017
2014-48-5658	Configuration Management Findings Related to Maintenance Outage	OPG to provide a progress update	13DEC2017
2014-48-5396	P1481 Rolled Joint Scrape Inspection Report	OPG requested closure of Action Item	N/A
2014-48-5386	CNSC Review of 2013 Pickering Nuclear Groundwater Monitoring Program Results Report	OPG to provide a progress update	22FEB2018
2014-48-5348	Pickering Units 5-8: Core Assessments Relating to Pressure Tube Integrity	OPG to provide a progress update	26JAN2018
2014-48-5032	Pickering Units 1 to 4: Type II Compliance Inspection Report - Quarterly Field Inspection Report,	OPG to provide a progress update	12OCT2017
2014-48-4629	Pickering NGS Type II Compliance Inspection - Chlorination and De-Chlorination Systems	OPG to provide a progress update	01DEC2017
2014-4-4856	CNSC Type II Compliance Inspection Report: Planned Maintenance Outage	OPG to provide a progress update	04DEC2018
2013-4-4047	Type II Compliance Inspection - Report #PRPD-PICKA-2012-165	OPG to provide a progress update	31JAN2018
2013-4-3947	Pickering A Type II Compliance Inspection Report, Q2 2012-2013, PRPD-PICKA-2012-155	OPG requested closure of Action Item	N/A
2012-4-3761	Type II Compliance Inspection Electrical Distribution System	OPG to provide a progress update	20APR2018
2012-4-3078	Pickering NGS-A Type II Compliance Inspection Report, Q2 2011-2012, EPRPD-PICKA-2011-120	OPG to provide a progress update	16MAR2018

Appendix E – Periodic Safety Review (PSR2)

E.1 Introduction

OPG is evaluating extended operation of the Pickering station beyond the year 2020. In support of this evaluation and licence renewal a subsequent Periodic Safety Review (PSR) is being conducted in accordance with CNSC Regulatory Document 2.3.3, *Periodic Safety Reviews* and International Atomic Energy Agency's (IAEA) Safety Standards Series, Specific Safety Guide No. SSG-25, *Periodic Safety Review for Nuclear Power Plants*.

CNSC REGDOC-2.3.3 and IAEA SSG-25 identify that subsequent PSRs should focus on changes in requirements, facility conditions, operating experience and new information, rather than repeating activities conducted in previous safety reviews. As such it is forward looking, focusing on: changes to requirements since the last applicable assessment, confirmation that the condition of Pickering NGS supports the additional years of commercial operation, and new operating experience since the last assessments.

The objective of Pickering's PSR is to confirm that the design, operation and safety-significant structures, systems, and components support continued safe operation and to determine reasonable and practical safety enhancements to further improve the already low risk of plant operation.

The subsequent PSR, referred to as PSR2, builds on earlier OPG PSR work (referred to as PSR1) and other associated assessments, specifically:

1. The Pickering B Integrated Safety Review (ISR), which included a comprehensive review of Codes and Standards that was completed in 2009 to support potential refurbishment and continued operation of Pickering 5-8 units for an additional 30 years.

For economic reasons, OPG decided to not refurbish Pickering Units 5-8, instead pursuing the option of extended operation to the end of 2020 without the replacement of the major reactor components. In support of this approach, safety enhancements were identified (based on the results of the ISR) in the context of an operation timeframe extending to approximately 2025. Outstanding actions from the ISR were subsequently documented in the Continued Operations Plan (COP) for which annual updates have been submitted to the CNSC.

2. Pickering Units 1 and 4 integrated safety assessments were performed during the Pickering A Return to Service (PARTS) work in support of approval to restart Units 1 and 4 following the extended shutdown of these units. (The pressure tubes on these units had previously been replaced in the late 1980's and early 1990's). Based on the results of these safety assessments, termed Systematic Review of Safety, Pickering Units 1 and 4 were restarted. Units 2 and 3 were not restarted for economic reasons and were placed in the safe storage state (fuel and water removed, systems isolated/de-energized, and separation from common containment).
3. The Darlington ISR was performed in support of refurbishment and continued operation of the Darlington units for an additional 30 years. Extensive reviews (primarily clause-by-clause reviews) of Codes and Standards were completed.

Much of the compliance assessment and evaluation of Safety Factor health for the Darlington ISR was based on programs and practices that apply across OPG's nuclear operations. As a result, Darlington ISR programmatic conclusions are applicable to the Pickering PSR2 for nuclear programs and practices that are relevant to Pickering.

Pickering PSR1 results are applicable to PSR2 if there was a PSR1 gap that was still open, or if a closed PSR1 gap could be affected by extended operation. If so, these gaps are carried forward into the PSR2 for consideration in the Global Assessment.

E.2 PSR2 Scope

The safety of Pickering NGS is regularly and thoroughly assessed, verified and assured through several processes that are part of the current licensing framework. OPG also applies routine comprehensive safety assessment and improvement programs that deal with specific safety issues, significant events and changes in standards and operating practices as they arise. These programs allow assessment of safety and plant operation to be improved on a continuous basis that can be correlated to all of the Safety Factors reviewed in PSR2. They include programs that ensure safe operations, effective configuration management, equipment reliability, life cycle management, aging management, periodic inspection and maintenance. Programs are also in place in the area of organization management and safety culture that focus on safety-related behaviours and accountability.

A protocol agreement between OPG and the CNSC staff (Reference E-1) is currently in place that documents OPG/CNSC interactions and a schedule for key submissions.

Current Laws, Regulations, Codes and Standards Applicable to PSR2

The PSR evaluates the extent to which the plant meets current laws, regulations, codes and standards. The process to identify those documents that are applicable to the PSR2 assessment basis involved first creating a broad list from multiple sources (potential candidate laws, regulations, codes and standards) and then filtering them to identify those that are most significant, and that are applicable to the PSR2 scope.

For the purpose of the performance of PSR2, OPG has defined the cut-off date for current laws, regulations, codes and standards to be January 15, 2016.

Structures, Systems and Components within the Scope of the PSR2 Review

The Structures, Systems and Components (SSC) within the scope of the PSR2 review encompass the Systems Important to Safety (SIS) and the Safe Operating Envelope (SOE) systems.

The scope of PSR2 is restricted to the facilities that are regulated under the Pickering NGS Power Reactor Operating Licence, therefore the Pickering Waste Management Facility, which has a separate operating licence, is not considered within the Pickering PSR2 scope.

E.3 PSR2 Overview

The general process overview for PSR2 is shown in Figure E.1. Pickering's PSR2 is comprised of the following four key elements which are explained in the sections that follow:

1. PSR2 Basis Document
2. Safety Factor Reviews
3. Global Assessment
4. Integrated Implementation Plan

Additional assessments (COP and Fukushima Action Items) were also performed to confirm the impact of extended operation beyond 2020. Where there are implications for extended operation, an associated gap was identified for consideration in the Global Assessment.

E.4 PSR2 Basis Document:

The Pickering PSR2 basis document, which was submitted by OPG and accepted by the CNSC in References E-2 and E-5 respectively, defines the approach for completing the PSR2, specifically;

- The proposed operating strategy of the facility,
- Scope and methodology, including the conduct of Safety Factor reviews and identification of compliances and gaps,
- The process for categorizing, prioritizing, tracking and resolving Gaps arising from the Safety Factor reviews,
- Conduct of the Global Assessment,
- The methodology for preparing the Integrated Implementation Plan,
- Applicable current versions of Laws, Regulations, Codes and Standards,
- The major milestones, including the freeze date for document revisions, and,
- The project management and quality management processes.

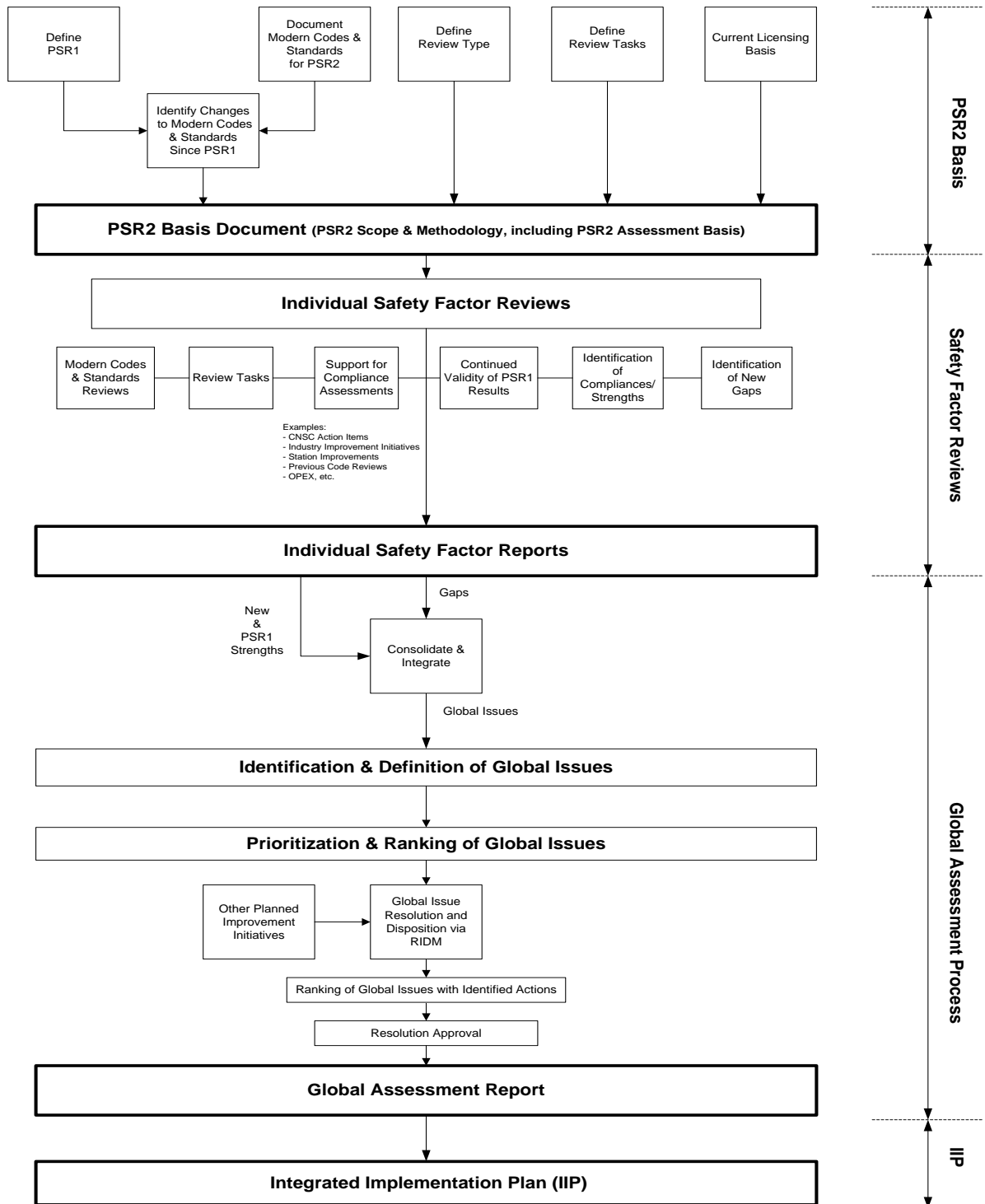


Figure E.1: Pickering PSR2 Process Flowchart

E.5 Safety Factor Reviews:

Safety Factors cover all aspects important to the safety of an operating nuclear power plant. There are 15 Safety Factors used in the PSR2 review; 14 are identified in IAEA SSG-25, and one additional Safety Factor (Radiation Protection) as identified in CNSC REGDOC-2.3.3.

OPG has submitted all 15 Safety Factor Review reports for CNSC staff review.

1. Safety Factor Report 1: Plant Design
2. Safety Factor Report 2: Actual Condition of Structures, Systems and Components Important to Safety
3. Safety Factor Report 3: Equipment Qualification (Seismic and Environmental)
4. Safety Factor Report 4: Aging
5. Safety Factor Report 5: Deterministic Safety Analysis
6. Safety Factor Report 6: Probabilistic Safety Assessment
7. Safety Factor Report 7: Hazard Analysis
8. Safety Factor Report 8: Safety Performance
9. Safety Factor Report 9: Use of Experience from Other Nuclear Power Plants and Research Findings
10. Safety Factor Report 10: Organization, Management System and Safety Culture
11. Safety Factor Report 11: Procedures
12. Safety Factor Report 12: Human Factors
13. Safety Factor Report 13: Emergency Planning
14. Safety Factor Report 14: Radiological Impact on the Environment
15. Safety Factor Report 15: Radiation Protection

These reports conclude that there are no fundamental safety issues and that OPG has in place effective programs and processes for continued safe operation of the Pickering NGS until 2024. Any identified gaps from these Safety Factor Reviews are being assessed in the Global Assessment.

As a subsequent PSR, the PSR2 Safety Factor reviews focused on changes in requirements (Laws, Regulations, Codes and Standards), updated plant conditions, operating experience and information from research, rather than repeating the activities of previous reviews. The methodology for performing the Safety Factor reviews takes full advantage of the safety assessments and Law, Regulation, Code and Standard compliance work previously completed by OPG.

This approach is in accordance with the guidance provided by the CNSC in REGDOC-2.3.3 that the effort required to undertake a subsequent PSR should require considerably less effort, subject to confirmation that previous conclusions remain valid.

Safety Factor Results and Reports

The Safety Factor reviews identified compliances and gaps with respect to the review elements in the PSR2 assessment basis. Specifically:

Compliance:

- For Clause-by-Clause reviews of current Laws, Regulations, Codes and Standards, Compliance indicates that the safety requirement is met.
- Where a High Level review has been performed, Compliance indicates that the intent of the safety requirement is met.
- Where an Incremental review has been performed, Compliance indicates that the change in the safety requirement, per the topical review, is met.
- For reviews of Safety Factor Review Tasks, Compliance indicates that either the safety requirement or the intent of the Review Task is met.

Gap:

- For Clause-by-Clause reviews of current Laws, Regulations, Codes and Standards, a gap indicates that the safety requirement is not met.
- Where a High Level review has been performed, a gap indicates that the intent of the safety requirement is not met.
- Where an Incremental review has been performed, a gap indicates that the change in the safety requirement, per the topical review, is not met.
- For reviews of Safety Factor Review Tasks, a gap indicates that the intent of the Review Task is not met.

Compliances that are equivalent to or surpass PSR2 assessment basis requirements or practices will be forwarded into the global assessment process for consideration as strengths. Gaps will be evaluated by the global assessment methodology to identify global issues and, with justification, acceptable deviations.

The results of the Safety Factor reviews have been documented in Safety Factor Reports that have been submitted to CNSC. These reports include:

- The scope of the review,
- Applicable elements of the PSR2 Assessment Basis (Review Tasks and applicable Laws, Regulations, Codes and Standards),
- Review methodology,
- Assessment of compliance with Review Tasks,
- Effectiveness review of OPG programs supporting compliance assessments,
- Review findings (Compliances and Gaps),
- Impacts on other Safety Factor reviews,
- Overall assessment of the Safety Factor.

Separate reports have been produced to document:

- (a) The reviews of Laws, Regulations, Codes and Standards in the PSR2 assessment basis, and
- (b) The derivation of the safety factor review tasks from IAEA SSG-25 and CNSC REGDOC-2.3.3. The Safety Factor reports have drawn on the information in these reports.

Safety factor compliance assessments will incorporate information from:

- OPG programs and procedures listed in the LCH, and any other programs and procedures which support the compliance arguments;

- Plant Condition Assessments (for Safety Factor 2);
- Commitments previously made to the CNSC, open CNSC action items, and exemptions granted by CNSC since the current operating licence was issued (safety significant issues, per the Pickering LCH) to determine if there are any impacts associated with Pickering operation past 2020.
- Previously identified ISR gaps related to each Safety Factor and the status of OPG's improvement plans or other dispositions to address these;
- Assessments and reviews performed since the PSR1 documents were completed.

E.6 Global Assessment:

The objective of the Global Assessment is to provide an overall assessment of the safety of the plant, and to arrive at a judgement of the plant's suitability for continued operation on the basis of a balanced view of the results from the reviews of the separate Safety Factors. This judgement takes into account the safety enhancements identified in the Global Assessment (plant and process modifications), strengths and residual global issues/acceptable deviations that impact on aggregate effects of the results, and consideration of existing planned safety enhancements and recent overall station safety performance.

Consistent with the requirements of IAEA SS-25, the Global Assessment is being conducted by an interdisciplinary team with appropriate expertise in Operations, Design and plant safety, including appropriate participants from the safety factor reviews, and members who are independent from the safety factor review teams.

The Global Assessment Process consists of the following elements:

1. Identification and consolidation of Strengths and Gaps from the Safety Factor Reports.
2. Identification of Global Issues.
3. Assessment of interfaces between the various Safety Factors, Aggregate Impact of Global Issues.
4. Prioritization of Global Issues.
5. Development of Resolutions / Dispositions of Global Issues (and Gaps).
6. Consideration of defence-in-depth and aggregate impact of residual Global Issues / Acceptable Deviations.
7. Ranking of Global Issues with identified actions.
8. Senior Management Scope Review Board approval of proposed modifications for the purposes of PSR2.
9. Assessment of overall acceptability of operation of the plant over the period considered in PSR2.
10. Preparation of the Global Assessment Report to summarize the assessments, and document the Global Assessment.

Global Assessment Logistics

The strengths and gaps from the 15 individual Safety Factor Reports are being consolidated and grouped by topic area to support the Global Assessment.

Recommendations from the component condition assessments conducted in support of Safety Factor 2 will also be considered as part of this review.

Identification of Global Issues:

The consolidation of gaps into global issues provides a means to assemble gaps of a common nature, facilitating the assessment of safety impact and identifying and assessing practical and effective resolutions. The global issues will be tabularized, tracking sources of the issues, to facilitate further review and assessment.

Interfaces between the Various Safety Factors, Aggregate Impact of Global Issues:

With the assembly of global issues and strengths, and considering the recommendations from component condition assessments, the aggregate impact of the global issues is being assessed. In this way, the interaction between issues can be identified. New global issues may be identified as part of this consolidation review that support the prioritization and ranking of Global Issues as described below.

Prioritization of Global Issues

PSR2 global issues will be prioritized with respect to their importance to nuclear safety. This will support the resolution evaluation method and the outcome of the resolution process. This methodology is consistent with OPG prioritization processes used in previous Integrated Safety Reviews and industry practice.

The safety significance level will consider deterministic and probabilistic safety analysis impact, as appropriate. The assignment of safety significance values for prioritization was derived based on OPG experience and takes into account the priority values from the OPG guidelines for evaluating and prioritizing Safety Report Issues, the COG benefit-cost analysis processes, and the OPG station condition record categorization process. Probability levels selected for delineation between categories are based on significance and engineering judgement, and are as used in previous Integrated Safety Reviews. These values account for overall safety impact and align, where appropriate, with requirements and limits in relevant safety standards. The relationship between safety significance level and impact on nuclear safety is shown in the table E.1.

Safety Significance Level	Impact on Nuclear Safety
1	High
2	Medium
3	Low
4	Very Low

Table E.1 Relationship between Safety Significance Level and Impact on Nuclear Safety

Development of Resolutions/Dispositions of Global Issues (and Gaps)

Resolution options are being developed and assessed using risk-informed decision making techniques utilizing the following strategy:

- In assessing potential dispositions, defence-in-depth elements will be considered.
- In developing the resolutions, consideration of overall safety significance will guide the resolution process.
- For Global Issue resolution – the process will be:
 - Evaluate the Global Issue to understand the safety basis, and intent of the requirement.
 - Consider possible options for resolution/mitigation. Consider safety significance and defence-in-depth elements.
 - Evaluate options with respect to effectiveness, cost, schedule, practicality. For potential plant modifications, this may require an evaluation of the safety impact, via both deterministic and probabilistic methods. If it is not practicable to fully resolve a Global Issue, other mitigation options will be considered for enhancements.
 - Practicality of a proposed resolution will be evaluated in terms of cost, resources, schedule, and considered in relation to the overall safety impact.
 - Propose recommended resolution/mitigation.
 - Document the decision making process.
- Items of High or Medium impact on nuclear safety (safety significance levels 1 and 2) will require more in-depth analysis to fully understand the issue and potential impact, and to develop the proposed resolution/mitigation. This may require deterministic and/or probabilistic assessments to determine the nuclear safety impact of modifications and more detailed evaluation of the cost/practicality of proposed resolutions. Insights from available probabilistic safety analyses may be used in evaluating the benefit/practicality of potential options. This will be done concurrent with the development of the Integrated Implementation Plan.
- Items of Very Low Impact on nuclear safety (safety significance level 4) will generally be deemed as acceptable deviations within the context of PSR2 (with the rationale provided). While these items will not be tracked beyond the Global Assessment, they will be shared with the accountable organizations for consideration as potential enhancement initiatives for their future work program planning purposes. This will allow the organizations to prioritize the initiatives as part of their integrated programs to ensure the focus is on the right overall priorities. A similar treatment will be applied for items of Low Impact on nuclear safety (safety significance level 3) for which a practicable solution is not readily evident.
- Proposed resolutions will be categorized as follows:
 - i) Programmatic (changes to procedures and programs),
 - ii) Engineering (plant modifications), or
 - iii) Analytical (e.g., safety analysis)

- In some cases, the development of resolutions/dispositions to the global issues will be part of an OPG or industry initiative underway or planned. Or, the resolution and development of options may require more detailed analysis and assessment, extending beyond the timelines for submission of PSR2. In these instances, the status of the initiative and plans will be included in the disposition. The work will be included in the global assessment to facilitate continued tracking.
- The results of previous global assessments for OPG stations will be considered in the review.
- If in the assessment it is determined that a global issue/gap has been closed, due to work done in the interim or for other reasons, the rationale will be documented and the global issue/gap will be set to resolved and closed.
- At the recommendation of the senior management team, an alternate process / resolution may be utilized for a particular global issue/gap.

Consideration of Defence-in-Depth and Aggregate Impact of Residual Global Issues / Acceptable Deviations

An important element of the development of proposed recommendations will be to assess the overall defence-in-depth and aggregate impact of the residual global issues/acceptable deviations. After evaluating a range of resolutions for global issues, and determining a recommended resolution to be selected, the impact on defence-in-depth, considering both deterministic and probabilistic elements, will be evaluated to assess the aggregate impact on overall safety. It may be necessary to refine the proposed resolutions based on the results of this review. This overall assessment will be an important element in supporting the enhancement plans and the planned operational strategy over the period of PSR2.

Ranking of Global Issues with Identified Actions

All global issues whose resolution involves identified actions will be ranked from 1 through N, where N is the total number, in accordance with overall safety significance. This will be based on engineering judgement applied by the assigned Global Assessment team. The ranking process will consider factors such as the priority previously determined (safety significance level), the contribution to defence-in-depth, the significance of the source (e.g., the type of document that generated the gap(s) leading to the global issue). The ranking process will also account for the extent of impact on multiple safety factors or areas.

Senior Management Scope Review Board Approval of Proposed Modifications for the Purposes of PSR2

The enhancements identified in the PSR2 Global Assessment Report, with their priority and safety basis, will be presented to the OPG Senior Management Scope Review Board for approval. This review will ensure alignment with the resolutions proposed, their basis and context, and will be the means to obtain concurrence that

the proposed enhancements are practicable and effective. This will also allow the senior management team to consider potential realignment of overall priorities based on the insights from PSR2. Consistent with OPG project management processes, additional approval gates will be required as the resolution development continues towards full implementation.

Assessment of Overall Acceptability of Operation of the Plant Over the Period Considered in PSR2

As a final step in the assessment process, the team confirms the overall acceptability of operation of the plant over the period considered in the PSR2. This entails a review of the results of the safety factor reviews, a consideration of enhancements planned (both newly identified in PSR2 and from other station initiatives) and a consideration of plant performance.

Global Assessment Report

Preparation of the Global Assessment Report is being conducted to summarize the assessments and document the Global Assessment by presenting the results, assessing the overall defence-in-depth of the plant, and documenting the conclusions, corrective actions, and enhancements to be considered. The Global Assessment Report will include a ranked list of those global issues with identified actions, with rationale for the ranking. This will be done concurrent with the development of the Integrated Implementation Plan.

Residual global issues and acceptable deviations will be noted in the report, summarizing the assessed aggregate impact on safe operations. These items will be conveyed to the responsible organizations for their consideration as potential enhancement initiatives for their work program. These initiatives will be weighed against other important program and plant modifications as part of the base and project work within these organizations. These items will not be tracked further beyond the Global Assessment Report or carried forward into the Integrated Implementation Plan.

The Global Assessment Report will include a statement of OPG's assessment of the overall acceptability of operation of the plant. Reviews and approval of the report will be conducted as required under the OPG Management System. The Global Assessment Report will be submitted to CNSC staff for review.

As documented in Reference E-1, the Global Assessment Report is scheduled to be submitted to the CNSC by October 31, 2017.

E.7 Integrated Implementation Plan:

The proposed enhancements resulting from the Global Assessment will be documented in the Integrated Implementation Plan (IIP) which will provide the proposed timeline for the implementation of the enhancements and it will also document and confirm the resulting enhancement.

The enhancements summarized in the IIP will be mapped to the CNSC Safety and Control Areas (per Appendix B of CNSC REGDOC-2.3.3) to facilitate CNSC review.

Integrated Implementation Plan Logistics

The IIP listing of enhancements will include those resulting from the Global Assessment Report, including both new modifications proposed as part of the resolution of global issues, and also considering the existing planned station modifications that were integral to the overall assessment of safety.

A review will be conducted with program owners and appropriate managers to derive plans for implementation based on priority and resources. These plans will be developed with due consideration of the other important initiatives underway or planned at Pickering NGS as part of continual improvement.

The initiatives will be tabularized with owners assigned and planned implementation dates. Existing initiatives integral to the overall assessment of safety during the Global Assessment will also be included in this listing. The listing will include the priority and the basis for the priority. The implementation of the initiatives will be tracked and reported.

The IIP will be presented to OPG senior management to obtain support for the initiatives and plans. As the IIP will be based on initial conceptual consideration of the resolution plans (or range of plans), a change management process will be implemented to manage any IIP required changes. Senior management approval for any proposed changes to resolution scope and/or completion timeframes will be required, and documented, consistent with OPG Project Management processes. The Integrated Implementation Plan will be tracked and progress will be regularly reported throughout the implementation period.

Integrated Implementation Plan Format

The IIP will be structured to allow a reader to understand the implementation plan and the basis for the plan. The plan will begin with a summary of work completed in the Safety Factor Reports and the Global Assessment Report.

The tabularized IIP will be included in the report to facilitate understanding of the related safety enhancement initiatives, their priority, and safety basis. These will include the new initiatives that came from the Safety Factor Reviews and the Global Assessment, and the existing initiatives that were integral to the overall assessment of safety.

To facilitate the CNSC review of the IIP, the plan will be presented in a manner aligned with the CNSC Safety and Control Areas. The report will also summarize the implementation tracking and reporting process and the IIP change management

process. The processes will allow tracking of initiatives to completion or resolution in an auditable manner, consistent with OPG's management system.

Consistent with CNSC REGDOC-2.3.3 and Reference E-1, the IIP is scheduled to be submitted to CNSC staff for acceptance by November 30, 2017.

E.8 Continued Operations Plan (COP) Reassessment

In accordance with the PSR Basis Document (Reference E-2), the Pickering Units 5-8 Continued Operations Plan (COP) actions were reviewed to determine if there were implications for PSR2. Specifically, the COP actions pertaining to the Pickering Units 5-8 Integrated Safety Review from 2009 and the fitness for service actions were reassessed for implications given the intent to operate Pickering Units 5-8 beyond 2020.

In addition, implications for Pickering Units 1, 4 were also identified. Where there are implications for extended operation of Pickering Units 5-8, or for Pickering Units 1, 4, a PSR2 gap was identified that will be considered in the Global Assessment process describe above.

The COP reassessment report was submitted to the CNSC (Reference E-3).

E.9 Fukushima Action Plan Reassessment

Following the events at Fukushima Daiichi in March 2011, the CNSC issued Fukushima Action Items to the Canadian Nuclear Utilities to ensure that the lessons learned from the event were appropriately incorporated into Canadian nuclear operations.

OPG has been recognized for its achievements in operational and management excellence in its response to the Fukushima Daiichi event and has confirmed that its stations remain safe with systems and procedures in place to deal with beyond design basis events.

OPG has taken the key lessons learned from the Fukushima event and incorporated changes to further enhance the safety of OPG's nuclear facilities. In 2015, all Fukushima Action Items (FAIs) for the Darlington and Pickering units were closed (Reference E-4).

In accordance with the PSR2 Basis Document, all of the FAIs pertaining to Pickering were reassessed to determine if the basis for their closure remained valid in the context of intended extension of commercial operations of the station beyond 2020. This FAI reassessment, which was submitted to the CNSC in March 2017 did not identify any gaps for PSR2, however, two items will be carried over to the Global Assessment as additional gaps as identified by CNSC staff.

E.10 Preliminary PSR2 Results

The 15 Safety Factor Review reports conclude that there are no fundamental safety issues and that OPG has in place effective programs and processes for continued safe operation of the Pickering NGS until 2024.

1. Organization, Management Systems and Safety Culture was reviewed as a safety factor for Pickering PSR2. Specifically, this review confirmed that the Pickering NGS organization, management system and safety culture are effective.
2. Human Factors was reviewed as a safety factor for Pickering PSR2. Specifically, this review confirmed that the various human factors that may affect the safe operation of Pickering NGS have been appropriately addressed, and are effective.
3. Safety Performance was reviewed as a safety factor for Pickering PSR2. Specifically, this review confirmed that the safety performance indicators and records of operating experience, including the evaluation of root causes of plant events, exist and are utilized.
4. OPEX and Research Findings was reviewed as a safety factor for Pickering PSR2. Specifically, this review confirmed that for Pickering NGS there is adequate feedback of relevant experience from other nuclear power plants and from findings of research, and that this is used to introduce reasonable and practicable safety improvements at the plant or in the operating organization.
5. The area of Procedures was reviewed as a safety factor for Pickering PSR2. Specifically, this review confirmed that the Pickering NGS processes for managing, implementing and adhering to operating and working procedures and for maintaining compliance with operational limits and conditions and regulatory requirements are adequate and effective and ensure plant safety.
6. Deterministic Safety Analysis was reviewed as a safety factor for Pickering PSR2. Specifically, this review confirmed that the deterministic safety analysis programs and procedures at OPG are comprehensive, resulting in a systematic and disciplined approach to identifying, prioritizing and addressing any safety analysis related issues.
7. Hazard Analysis was reviewed as a safety factor for Pickering PSR2. Specifically, this review has confirmed that Pickering NGS has robust protection against internal and external hazards, taking into account the plant design, site characteristics, the actual condition of the Structures, Systems and Components (SSCs) important to safety.
8. Probabilistic Safety Assessment (PSA) was reviewed as a safety factor for Pickering PSR2. Specifically, this review has confirmed that the PSA programs and procedures at OPG are comprehensive, resulting in a systematic and disciplined approach to identifying, prioritizing and addressing safety analysis related issues.

9. Plant Design was reviewed as a safety factor for Pickering PSR2. This review confirmed, by assessment against the current licensing basis and applicable standards, requirements and practices that the physical design and documentation supports continued safe operation of Pickering NGS.
10. Equipment environmental and seismic qualifications were reviewed as a safety factor for Pickering PSR2. Specifically, this review confirmed that the Pickering NGS equipment important to safety has been properly environmentally and seismically qualified and that these qualifications are being maintained through maintenance, inspection and testing programs.
11. Actual condition of Structures, Systems and Components (SSCs) important to safety was reviewed as a safety factor for Pickering PSR2. Specifically, this review concluded that the majority of the plant's SSCs are in good condition and support safe extended station operation to 2024. Recommendations for improvement have been made when required, of which many are in progress. For this life extension period, no major concerns have been identified and the SSCs Important to Safety continue to operate as per the design basis requirements.
12. Plant aging was reviewed as a safety factor for Pickering PSR2. Specifically, this review confirmed that aging aspects affecting SSCs important to safety are being effectively managed and that an effective aging management program is in place.
13. Radiation Protection was reviewed as a safety factor for Pickering PSR2. Specifically, this review has confirmed that radiation protection has been accounted for in the design and operation of Pickering NGS, and that radiation protection provisions (including design and equipment) protect workers from radiation and ensure that contamination and radiation exposures and doses to persons are monitored and controlled and maintained As Low As Reasonably Achievable (ALARA).
14. Radiological Impact on the Environment was reviewed as a safety factor for Pickering PSR2. Specifically, this review has confirmed that Pickering NGS has in place an effective program for monitoring the radiological impact of the plant on the environment, which ensures that emissions are properly controlled and are as low as reasonably achievable.
15. Emergency Planning was reviewed as a safety factor for Pickering PSR2. Specifically, this review has confirmed that OPG Nuclear has in place adequate plans, staff, facilities and equipment for dealing with emergencies. In addition, arrangements are in place for regular emergency training and exercises, and interaction and coordination with local and national authorities.

All planned improvements identified through the PSR process will be documented in a Global Assessment Report and an Integrated Implementation Plan that will be submitted to the CNSC in October and November 2017 respectively.

E.11 References

- E-1 Protocol, "OPG-CNSC Protocol for the Conduct of a Periodic Safety Review in Support of Pickering NGS Licence Renewal", January 17, 2017, e-Doc 5143721, CD# [P-CORR-00531-04725 R001](#).
- E-2 OPG Letter, B. McGee to H. Khouaja, "Submission of Pickering NGS Periodic Safety Review 2 Basis Document Revision 002", July 6, 2016, CD# [P-CORR-00531-04780](#).
- E-3 OPG Letter, B. McGee to A. Viktorov, "Pickering NGS Periodic Safety Review 2 - Submission of Continued Operations Plan (COP) Reassessment", February 13, 2017, CD# [P-CORR-00531-04927](#).
- E-4 OPG Letter, W.S. Woods to M. Santini and F. Rinfret, "OPG Progress Report No. 7 on CNSC Action Plan - Fukushima Action Items", November 30, 2015, CD# [N-CORR-00531-06906](#).
- E-5 CNSC Letter, H. Khouaja to B. McGee, "Pickering NGS: CNSC Staff Acceptance of Pickering NGS Periodic Safety Review 2 (PSR2) Basis Document", July 8, 2016, e-Doc 5037314, CD# [P-CORR-00531-04789](#).

Appendix F - CANDU Safety Issues

A safety issue is defined as an issue related to the design or analysis of a nuclear power plant that has the potential to challenge safety functions, safety barriers or both.

In 2007, the CNSC assessed the status of CANDU Safety Issues (CSIs) and, while the safety case was not in question, the CNSC identified control measures to address residual concerns on nuclear safety. The initial list of issues was developed using the IAEA TECDOC-1554 “Generic Safety Issues for Nuclear Power Plants with Pressurized Heavy Water Reactors and Measures for their Resolution”, and each issue was classified into one of the following three categories:

- Category 1: Not an issue in Canada.
- Category 2: The issue is a concern in Canada. However, the licensees have appropriate control measures in place to address the issue and to maintain safety margins.
- Category 3: The issue is a concern in Canada. Measures are in place to maintain safety margins, but further experiments and/or analysis are required to improve knowledge and understanding of the issue, and to confirm the adequacy of the measures

At present, Pickering has four Category 3 issues pending CNSC re-categorization. One issue is a Non-Large Break Loss of Coolant Accidents (LBLOCA) and three issues are related to LBLOCA.

1) Non-LBLOCA CSI – Category 3:

- IH 6 Need for systematic assessment of high energy line break effects

The methodology to assess high energy pipe breaks inside containment for Pickering was developed and presented to the CNSC. For Pickering 5-8, High Energy Line Break Assessments (HELBA) were completed and presented to the CNSC. These assessments followed the aforementioned methodology and concluded that none of the postulated line breaks would pose safety risks beyond those already documented in the Safety Report. Re-categorization of IH6 for Pickering 5-8 was requested in 2016 (Reference F1).

The results and conclusions of the Pickering 5-8 assessments could not be directly applied to Pickering 1-4 because the two stations have different design provisions for pipe supports. Consistent with the existing methodology, a leak before break (LBB) disposition strategy was adopted. LBB analyses are being completed and once the results are available, re-categorization of IH6 for Pickering 1-4 will be requested. OPG has well established programs to monitor and inspect high energy piping and to take appropriate actions when required.

2) LBLOCA CSIs – Category 3:

- AA 9 Analysis for void reactivity coefficient
- PF 9 Fuel behaviour in high temperature transients
- PF 10 Fuel behaviour in power pulse transients

OPG has requested re-categorization of these LBLOCA CSIs based on the development of the Composite Analytical Approach (CAA) (References F-2 and F-3), in collaboration with the CANDU Owners Group. More recently, OPG provided the CNSC with an update on the latest activities to address LBLOCA safety margins using the CAA as part of OPG's short-term and long-term plans to address these issues (Reference F-4). Further confirmatory research and analysis are ongoing.

References:

- F-1 OPG letter, W.S. Woods to A. Viktorov, "Re-Categorization Request for CANDU Safety Issue IH6 for Pickering NGS 5-8 and Status for Pickering NGS 1-4", December 5, 2016, CD# [N-CORR-00531-18288](#).
- F-2 CNSC letter, G. Rzentkowski to W. M. Elliott, "Darlington and Pickering NGS: Large LOCA Safety Margins - Assessment of the Proposed Composite Analytical Approach," January 7, 2015, e-Doc # 4610410, CD# [N-CORR-00531-07358](#).
- F-3 CNSC letter, M. Santini, F. Rinfret to W.M. Elliott, "Darlington and Pickering NGS: Large LOCA Safety Margins - Assessment of the Proposed Composite Analytical Approach (CAA)," June 4, 2015, e-Doc # 4767575, CD# [N-CORR-00531-06922](#).
- F-4 OPG letter, W. S. Woods to M. Santini and F. Rinfret, "Resolution of Large Break LOCA (LBLOCA) Safety Margins Issues," April 25, 2016, CD# [N-CORR-00531-18022](#).

Enclosure 1 to OPG Letter, R. Lockwood to M. Leblanc, "Application for Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence", CD# P-CORR-00531-05055.

Enclosure 1

Pickering NGS Hazardous Substances

CD# P-REP-08965-0633695 R001

(15 pages including this coversheet)

Internal Use Only	
Document Number: P-REP-08965-0633695	Usage Classification: N/A
Retention: P	Revision: R001

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

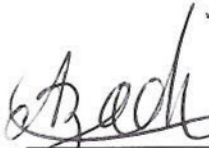
© Ontario Power Generation Inc., 2017. This document has been produced and distributed for Ontario Power Generation Inc. purposes only. No part of this document may be reproduced, published, converted, or stored in any data retrieval system, or transmitted in any form or by any means (electronic, mechanical, photocopying, recording, or otherwise) without the prior written permission of Ontario Power Generation Inc.

Pickering NGS Hazardous Substances**P-REP-08965-0633695 Rev 01**

2017-07-27

Order Number: N/A
Other Reference Number:**Internal Use Only**

Prepared by:

 July 28, 2017Gholamali Azadi
Health & Safety Advisor
PNGS Conventional
Safety

Date

Approved by:

 July 28, 2017Melissa Nikkel
Acting Manager
Nuclear West, H&S Field
Services

Date

Report

Internal Use Only		
Document Number:	P-REP-08965-0633695	Usage Classification:
Retention:	Revision Number:	Page:
P	R001	2 of 14

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

The purpose of this report is to document a list of hazardous materials at the Pickering Nuclear Generating Station with respect to a licence application requirement under Class I Nuclear Facilities Regulations SOR/2000-204.

Under Class I Nuclear Facilities Regulations SOR/2000-204, Licence Applications, General Requirements, S. 3.,

An application for a licence in respect of a Class I Nuclear Facility, other than a licence to abandon, shall contain the following information in addition to the information required by section 3 of the *General Nuclear Safety and Control Regulations*.

3 (e) the name, form, characteristics and quantity of any hazardous substances that may be on the site while the activity to be licensed is carried on.

Table 1 contains a list of the hazardous substances.

In addition to the CNSC licensing requirement above, Ontario's Occupational Health and Safety Act Sections 37-42 and Canada Labour Code Section 125.1 require employers to identify, label and control "hazardous substances" in the workplace. These substances must be labeled and material safety data sheets made available. Pickering Nuclear tracks hazardous substances (as defined by those regulations) coming on site through its hazardous materials (HAZMAT) database, enabling the Workplace Hazardous Materials Information System (WHMIS) and Material Safety Data Sheet (MSDS) regulatory requirements. The database is fully accessible to all employees on site.

This report will be reviewed on a frequency of every two years, tracked as MGMT actions in Asset Suite. If any significant changes to the hazardous substances are made, the report will be updated.

Internal Use Only	
Document Number: P-REP-08965-0633695	Usage Classification: N/A
Retention: P	Revision: R001

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Table 1: Pickering NGS Hazardous Substances List

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Boric acid	Moderator system	Reactivity control	Mixed with D2O in the liquid poison tanks	Removed by ion exchange (IX) resin in the moderator purification system	~54 pcs of 500g bottles of Boric Oxide	Pickering 014: ~1700L Pickering 058: ~850L	Solid, made into solution for addition	Toxic, irritant
Gadolinium Nitrate	Moderator system	Reactivity control	Mixed with D2O in the liquid poison tanks	Removed by IX resin in the moderator purification system	~36 pcs of 5kg bags	Pickering 058: LISS: ~19,000 L Moderator: ~1700 L	Solid, made into solution for addition	Toxic, severe irritant
Helium gas	Cover gas for moderator; Liquid zone control;	Cover gas to prevent air ingress	Gas cylinders	Periodically purged to reactor building exhaust for chemistry control	~80 cylinders 291ft ³ per cylinder	Moderator Cover Gas: P014 and P058 combined ~6000ft ³ LZC: P014 and P058 combined: ~7000ft ³	Compressed Gas	Compressed gas, simple asphyxiant, lighter than air.

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 4 of 14

Report

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Oxygen gas	Moderator cover gas; annulus gas	Added to recombine with D2 gas; to maintain pressure integrity	Gas cylinders	Consumed; emitted to reactor building exhaust	~2 cylinders 335ft ³ per cylinder	Moderator Cover Gas P058: ~2600ft ³ P014: none Annulus Gas P014 and P058 combined ~1000ft ³	Compressed Gas	Strong oxidizer - increases flammability of flammable or combustible material.
Hydrogen gas	Heat transport system; main generators	Remove O2 from the heat transport system; cooling for the generators	Mobile trailer and gas cylinders	Consumed in the heat transport system and vented to reactor building exhaust; periodically vented to atmosphere from the main generators	~2 cylinders @ 196ft ³ ; 5 cylinders @ 2.77m ³	HTS:P014 and P058 combined: ~6500ft ³ Main Generator: P014 and P058 combined: ~115,000ft ³ In a Mobile trailer hooked up directly to the system.	Compressed Gas	Flammable Compressed Gas, lighter than air.

Report

Internal Use Only		
Document Number:	Usage Classification:	
P-REP-08965-0633695	N/A	
Retention:	Revision Number:	Page:
P	R001	5 of 14

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Hydrazine (35% solution)	Emergency coolant injection system; steam generator feedwater; condensate feedwater; recirculating cooling water system; end shield cooling water	Removal of O2 and pH control	Oil and Chemical Storage Building – Totes and drums – Totes in chemical addition station in turbine hall	Consumed but residual may be discharged to lake or atmosphere. A breakdown product in feedwater is ammonia.	Pickering 014 uses drums. ~ 12 drums @ 208.65kg per drums as hydrazine hydrate Pickering 058 uses totes. ~1800 L (2x 900L totes) as hydrazine hydrate	Pickering 014: typically 1 drum (205 L) connected to the system. Pickering 058: ~1800 L This is in totes connected to the system.	Liquid	Corrosive base, Toxic
Lithium hydroxide	Heat transport system; end shield cooling system; recirculating cooling water system	pH control	Station – chemical addition systems	Consumed (used when pH must be rapidly corrected; usually the pH is controlled by lithiated IX columns)	~14 pcs of 0.5kg bags	P014 and P058 combined: HTS: ~ 240g (in solution) (0.24kg) RCW: ~2.7kg (in solution)	Solid, made into solution for addition.	Corrosive base

Report

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 6 of 14

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
IX resin: Neutral Mixed Bed Resin- IX resin: Neutral Mixed Bed Resin (cont)	Moderator system; irradiated fuel bay; auxiliary fuel bay; liquid zone control Stator Cooling Water	pH control and removal of impurities	Purification IX columns	Temporary storage – spent resin tank	~45 pcs of 1ft ³ package 2pcs of 35ft ³ package	P014 and P-58 combined: Moderator: ~55ft ³ IFB: ~ 240ft ³ AIFB ~ 200ft ³ LZC ~ 4ft ³ SCW ~ 14ft ³	Solid	Toxic, irritant
IX resin: Lithiated mixed bed resin	Heat transport system; end shield cooling system; recirculating cooling water system	pH control and removal of impurities	Purification IX columns	Temporary storage – spent resin tank	~243 pcs of 0.5ft ³ bags	All P014 and P058 combined: HTS ~30ft ³ RCW ~4ft ³ ESC ~23ft ³	Solid	Toxic, irritant
IX resin: Deoxygenating Resin	Stator cooling water system	Removal of O2	IX column	Industrial waste disposal	~4 pcs of 1ft ³ packages	All P014 and P058 combined: ~14ft ³	Solid	Toxic, irritant

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 7 of 14

Report

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
IX resin Cation	Moderator (PB only)	Removal of cations	Purification IX columns	Industrial waste disposal	~50 pcs of 1ft ³ packages (28.32 l/bag)	Moderator (P058 only) ~1ft ³	Solid	Toxic, irritant
Carbon dioxide gas	Annulus gas system; generator	Annulus gas system – carrier gas; generator – purging gas	Outdoor tank (gas cylinder)	Annulus gas system – to reactor building exhaust; generator – vented to atmosphere	~33 pcs of 12 pack cylinders (K size container)	Annulus Gas: P014 and P058 combined: ~120ft ³	Compressed Gas	Mildly toxic, asphyxiant in high concentrations, heavier than air.
Morpholine The liquid is 45%; The drum is 50%	Steam generator feedwater; condensate feedwater	pH control and corrosion control	Totes in Oil and Chemical Storage Building and chemical addition station in turbine hall	Partly consumed; atmospheric discharge; and steam generator blowdown	Pickering 014 uses drums ~45 drums @ 441lb/drum of 50% solution. Pickering 058 uses totes ~ 1800L of 45% solution	Pickering 014: typically 1 drum (205 L) connected to the system. Pickering 058: ~ 1800L. This is in totes connected directly to the system	Liquid	Combustible liquid, toxic, corrosive base.

Report

Internal Use Only		
Document Number:	Usage Classification:	
P-REP-08965-0633695	N/A	
Retention:	Revision Number:	Page:
P	R001	8 of 14

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Sodium Hypochlorite 7%	Low pressure service water	Zebra mussel control	Four tanks in chlorination house	Consumed and residual to Lake Ontario	Pickering 014: ~52,000L Pickering 058: ~54,000L	Tanks connected to the system directly	Liquid	Corrosive acid, oxidizer - increases flammability of flammable or combustible material.
Sodium Metabisulphite 38% aqueous	Inactive drainage; reactor building service water	Dechlorination	Outdoor tanks with secondary containment	Consumed	Pickering 014: ~32,000L Pickering 058: ~40,000L	Tanks connected to the system directly	Liquid	Corrosive acid, toxic
Sulphur hexafluoride	Condenser circulating water system	Leak detection	Gas cylinders	To lake (small volumes only)	~2 cylinders of 350 ft ³ (size 30 cylinder)	Pickering 014 and 058 combined: ~1800 ft ³	Compressed Gas	Compressed Gas, mildly toxic

Report

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 9 of 14

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Grade B#2 oil (litres)	Standby generator; emergency power generators,	Fuel	Outdoor tanks with secondary containment	Consumed resulting in waste gases CO ₂ , NO _x , SO _x , etc.	Pickering 014 SG: ~1,900,000L Pickering 058 SG: ~1,900,000L Pickering 058 EPG: ~550,000L	Directly connected to the system	Liquid	Combustible Liquid, toxic
Lubricating oil and seal oil Teresso #46	Turbine lubricating oil system; generator seal oil system	Lubrication and sealing	Three tanks on the north side of the turbine hall	Reused or removed by contractor	~570drums @ 205L each	P014 and P058 combined: ~375,000L	Liquid	Non-toxic during normal use.

Report

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 10 of 14

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Insulating oil (litres)	Main output and service transformers	Cooling for the transformers	Brought in by truck	Removed by contractor	P014 and P058 combined: ~65,000 L per transformer for six units (12 transformers in total)	Directly connected to the system	Liquid	Non-toxic during normal use.
Ethylene glycol	Various Systems	Chillers	Small head tanks in powerhouse	Removed by licensed contractor if necessary	~2 drums @ 205L	~1000L	Liquid	Toxic
Reolube Turbofluid 46XC [Fire Resistant Fluid (FRF)]	Turbine governor	Hydraulic fluid for turbine governor valves	Tanks in powerhouse	Reused or drummed for disposal	Pickering 014 and 058 combined: ~3400L	Tanks directly connected to the system	Liquid	Mildly toxic
Diesel (Fire pumps) (litres)	Diesel Fire Pumps	Operating Pumps	Tanks	Consumed resulting in waste gases CO ₂ , NO _x , SO _x , etc.	Pickering 014: ~ 7200 L	Directly connected to the system	Liquid	Combustible Liquid, toxic

Report

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 11 of 14

Title:
PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Hydraulic Oil Teresso 46 (litres)	Fuelling Machines	Operating Fuelling Machine	Tanks	Reused or removed by contractor	~3800 L per unit for six units	Directly connected to the system	Liquid	Non-toxic during normal use.
Gas, Mixed, 3% Nitrogen, 1.5% Oxygen	QC gas – Chemical Lab use as per chemical assessment	Quality control	gas cylinder	Vented to atmosphere	K and A size bottles	Chem Lab use	Gas	Compressed gas
GAS, Freon R134A Refrigerant	Used as a refrigerant	Maintenance - HVAC	gas cylinder	In the system	100 lb cylinder	In the station chillers on Units 0, 1,2,3,4.	Gas	Compressed gas
GAS, Argon, refrigerated liquid	Used in chem. Lab instrumentation. Also used by BTU as a cover gas for their metal analyzer	Ultra high purity ICP grade	gas cylinder	Return to empty gas bottle storage area and/or vendor as per HIS/MSDS	230 litre cylinder	Chem lab use for instrumentation	Gas	Compressed Gas
Sodium hydroxide	stator cooling water system	Alkalization	NaOH tank on 254' in the Turbine Bay	There is a plan to use this material in 2018	Not available	Dilute 2%	Liquid	Corrosive.

Report

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 12 of 14

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Xylene	various	Solvent, thinner	Flammable cabinet	Industrial waste disposal	4IX23	Used as required	Liquid	Flammable
Refrigerant "DUPONT SUVA 123 refrigerant"	HVAC	Refrigerant	HVAC System	Re-used in the system	45.4 KG DRUM	Contained within equipment	Gas	Toxic
Desiccant	CID: 193074 Compressed Air Circuit HP & LP Instrument Air	Adsorbents	General Storage Area/ Bulk Storage as per HIS/MSDS 570	Disposed as conventional waste or active waste if active as per HIS/MSDS 570	25 kg containers (140 kg and 150 kg steel drums for molecular sieve)	Connected to the system as child CAT ID 193074 to Parent CAT ID 188684 (Inlet Filter)	Solid	Not WHMIS controlled
	CID: 328987 Boiler Vapour Recovery (72210) Reactor Vault Vapour Recovery (72230) Mod Room Vapor Recover (72220)	Adsorbent material used as moisture remover in system driers.	Requires compress gas storage as per HIS/MSDS 1440	Dispose as conventional waste or active waste if active – take to appropriate chem. Waste drop off area as per HIS/MSDS 1440		connected to the system	Beads or Pellets	Toxic
Scintillant	FOR ON LINE TRITIUM MONITORS	Monitors	Corrosive cabinet	Industrial waste disposal	5LX110 bottle	Used as required	Liquid	Corrosive

Report

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 13 of 14

Title:

PICKERING NGS HAZARDOUS SUBSTANCES

Chemical	Where Used (System)	Purpose	Storage	Disposal	Inventory	In system	Form	Characteristics
Solvent, Degreaser	Varies	Cleaning compound, for parts washer	Flammable storage cabinet	Industrial waste disposal	45 GAL DRUM	Used as required	Liquid	Flammable

In addition to above chemicals, Designated Substance Assessments were conducted as per Ontario Regulation. The Ontario Occupational Health and Safety Act defines a designated substance as a biological, chemical or physical agent, or combination of agents to which the exposure of a worker is prohibited, regulated, restricted, limited, or controlled by a specific regulation.

Designated Substances	Assessment #	Form	Comments
Asbestos	P-REP-08965-0413252	Other than asbestos on plant system components (e.g., pipe insulation) there are gaskets in station as well.	A program is in place under direction of the Asbestos Program Administrator (APA) to control asbestos-containing materials.
Silica	P-REP-08965-0333820	Products containing crystalline silica ingredients can be classified as follows: Painting and coating materials, caulking products, sealants, cements, concrete and grouting products, sand, hardener, joint Treatment, adhesive, and construction activities (modification projects) such as drilling, grinding and chipping concrete.	
Lead	P-REP-08965-0412357	Lead could be found in product categorised below: Lead Sheets, Lead blankets, Lead wool, Hilti categories, Lead shot, Solders alloy, Lead wire, Lead batteries, Abrasive shot (copper slag with minor lead contamination), lab standards.	In addition lead also is in structural material such as lead bricks, radiation shielding and some paints.

Report

Internal Use Only		
Document Number: P-REP-08965-0633695	Usage Classification: N/A	
Retention: P	Revision Number: R001	Page: 14 of 14

Title:
PICKERING NGS HAZARDOUS SUBSTANCES

Isocyanates	P-REP-08965-0333818	Products are: DECOTHANE SP, SIKAFLEX PRIMER 429/202, BELZONA 2911 (ELASTOMER QD CON), 2000.35952 359B9500 DEVTHANE 3 (Two parts MSDS), STONFLEX MP7, SIKAFLEX-221	These products are Largely used by the contractor.
Arsenic	P-REP-08963.21.DSA-0463389	Most products are batteries and one Lead Alloy and one Ebony Grit.	Concentration of Arsenic in these products was very low. The highest was .2%.
Mercury	P-REP-08963.21.DSA-0468663	Mercury-containing components and equipment on site are switches, relays, manometers, hygrometers, thermometers, lighting lamps and tubes, dry-cell batteries and a blood-pressure gauge.	Since the assessment blood pressure gage has been removed from site.
Benzene	P-REP-08963.21.DSA-0466050	3 gasoline products plus paints and primers(, Loctite 7649 Primer, 4020.01000 DEVFLEX DTM INEX, 4020.07100 DVFLX DTM FLA RD 4020-710 ER, and 4308-9020H DEVGUARD 4308H (also Carbopol 941 Polymer which has not been used for years).	Regulation 490/09 does not apply to delivery of gasoline to vehicles by gasoline pump.
Acrylonitrile	P-CORR-08963.21-0461966	No product containing Acrylonitrile	
Coke Oven Emissions	P-CORR-08963.21-0461479	No Metallurgical Coke-Oven at Pickering	
Ethylene Oxide	P-CORR-08963.21-0461995	No product was found.	This search yielded no results. There was no use of Ethylene oxide or Ethylene oxide-Containing products.
Vinyl Chloride	P-CORR-08963.21.DSA-0462279	No product was found.	