Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

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ORIGINAL/ORIGINAL

CMD: 18-H6

Date signed/Signé le : 5 MARCH 2018

A Licence Renewal

Un renouvellement de permis

Ontario Power Generation Inc.

Ontario Power Generation Inc.

Pickering Nuclear Generating Station

Centrale nucléaire Pickering

Commission Public Hearing – Part 1

Audience publique de la Commission – Partie 1

Scheduled for:

4 April 2018

Prévue pour :

4 avril 2018

Submitted by:

CNSC Staff

Soumise par :

Le personnel de la CCSN

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Summary

This CMD presents information about the following matters of regulatory interest with respect to Ontario Power Generation Incorporated:

- Renewal of the Power Reactor Operating Licence (PROL) for Pickering Nuclear Generating Station (NGS)
- Periodic Safety Review conducted in support of licence renewal
- Planned end of commercial operation of the Pickering NGS
- Compliance with the safety and control areas for the safe operating of the facility

The following actions are requested of the Commission:

- Issue, pursuant to section 24 of the *Nuclear Safety and Control Act*, a Pickering NGS PROL authorizing OPG to carry out the activities listed in Part IV of the proposed licence from September 1, 2018 to August 31, 2028.
- Accept the following new station-specific conditions included in the proposed licence requiring OPG to:
    - implement the results of the Periodic Safety Review;
    - maintain Units 2 and 3 in the safe storage phase;
    - maintain pressure tube fracture toughness sufficient for safe operation;
    - implement and maintain plans for the end of commercial operations of all Pickering units;
- Authorize OPG to operate the Pickering NGS Units 5-8 fuel channels up to a

Résumé

Le présent CMD présente de l’information sur un ensemble de questions d’ordre réglementaire concernant Ontario Power Generation Incorporated:

- Renouvellement du permis d’exploitation d’un réacteur de puissance (PERP) pour la centrale nucléaire de Pickering
- Bilan périodique que la sûreté effectué à l’appui du renouvellement de permis
- Fin planifiée de l’exploitation commerciale de la centrale de Pickering
- Conformité aux domaines de sûreté et de réglementation concernant l’exploitation sûre de l’installation

La Commission pourrait considérer prendre les mesures suivantes :

- Conformément à l’article 24 de la *Loi sur la sûreté et la réglementation nucléaires*, délivrer un PERP pour la centrale de Pickering qui autorisera OPG à réaliser les activités énumérées à la Partie IV du permis proposé, du 1er septembre 2018 au 31 août 2028.
- Accepter les conditions suivantes propres à la centrale incluses dans le permis proposé et qui obligent OPG à :
    - mettre en œuvre les résultats du Bilan périodique de sûreté
    - maintenir les tranches 2 et 3 en état de stockage sûr
    - maintenir une résistance suffisante des tubes de force aux fractures pour assurer une exploitation sûre
    - mettre en œuvre et tenir à jour des plans pour la fin de l’exploitation commerciale

maximum of 295,000 EFPH for the lead unit.

- Authorize the delegation of authority as set out in section 6.11 of this CMD.

The following items are attached:

- The proposed PROL 48.00/2028
- The draft Licence Conditions Handbook
- The current PROL 48.04/2018
- The 2017 Environmental Assessment Report

de toutes les tranches de Pickering

- Autoriser OPG à exploiter les canaux de combustible des tranches 5-8 de la centrale de Pickering jusqu’à un maximum de 295 000 HEPP pour la tranche principale.
- Autoriser la délégation des pouvoirs indiquée à la section 6.11 du présent CMD.

Les pièces suivantes sont jointes :

- Le PERP proposé 48.00/2028
- L’ébauche du Manuel des conditions de permis
- Le PERP actuel 48.04/2018
- Le rapport d’évaluation environnementale de 2017

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Signed/signé le

March 5, 2018

Gerry Frappier, P. Eng.

Director General / Director General (Acting)

Directorate of Power Reactor Regulation

Directeur général / Directrice générale / Directeur général (Intérimaire) / Directrice générale (Intérimaire) de la

Direction de la réglementation des centrales nucléaires

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EXECUTIVE SUMMARY

Pickering Nuclear Generating Station (NGS) is located on the North shore of Lake Ontario, in the city of Pickering in the regional municipality of Durham, Ontario. The facility lies 32 km northeast of downtown Toronto and 21 km southwest of Oshawa. The facility is owned and operated by Ontario Power Generation Incorporated (OPG).

Pickering NGS consists of eight CANDU pressurized heavy water reactors and their associated equipment, which are designed, constructed, and operated to produce electrical power. Units 2 and 3 are in a safe storage state and will remain so until the eventual decommissioning of the station. Each operating reactor has a nominal electrical output of 515 MWe (megawatt-electric) for Pickering Units 1, 4 and 516 MWe for Pickering Units 5-8. The Pickering nuclear site also contains the Pickering Waste Management Facility which is licensed separately under a Class 1B waste facility operating licence.

In 2010, OPG announced that Pickering NGS would continue operation until 2020, at which time the station would shut down. In January 2016, OPG was requested by the Province of Ontario to plan for safe and reliable continued operation beyond 2020. In response, on June 28, 2017, OPG informed the CNSC that all Pickering units would cease commercial operation on December 31, 2024. Following the permanent shutdown of the units, the station will be transitioned to a safe storage state.

The current power reactor operating licence for Pickering NGS expires on August 31, 2018. OPG has requested the licence to be renewed for a period of 10 years. As OPG intends to cease commercial operation of Pickering NGS on December 31, 2024, this licence period will cover three phases of operational activities: continued commercial operation until December 31, 2024; a stabilization phase (post-shutdown defueling and dewatering) lasting approximately 3-4 years; and the beginning of safe storage for Units 1, 4 and 5-8. The proposed licence and accompanying Licence Conditions Handbook capture CNSC requirements and expectations for the transition from operating units to the safe storage state as well as confirmation from OPG, by December 31, 2022, of the final shut down date for each unit.

In support of its application for a 10-year operating licence, OPG performed a periodic safety review (PSR), in accordance with CNSC regulatory document REGDOC-2.3.3 *Periodic Safety Reviews*. The purpose of the PSR is to confirm and enhance the safety case for continued operation of Pickering NGS. A PSR allows a licensee to identify practicable safety enhancements to the plant to bring its overall performance to a level commensurate with that of modern requirements and practices. CNSC staff have included a licence condition in the proposed operating licence requiring OPG to implement the Integrated Implementation Plan (IIP) resulting from the PSR.

In April 2017, OPG submitted an updated Environmental Risk Assessment (ERA) report for the Pickering site based on effluent and environmental monitoring data for the five-year period between 2011and 2015. CNSC staff completed a detailed technical review of the 2017 ERA and found it to be consistent with the methodology of CSA standard N288.6-12, *Environmental Risk Assessments at Class I Nuclear Facilities and Uranium Mines and Mills*. Overall, the meaningful adverse ecological and human health effects due to releases to air and water from Pickering NGS are found to be unlikely. CNSC staff's assessment of the 2017 ERA was also provided to the Commission in CMD 17-HB.5, during the licence renewal hearing for the Pickering Waste Management Facility (PWMF) in 2017. Intervenors were also given an opportunity to review the ERA during the PWMF licence renewal hearing process.

An Environmental Assessment (EA) under the *Canadian Environmental Assessment Act* (CEAA) 2012, was not required for this licence renewal application. Similarly, section 67 of CEAA 2012 does not apply as no new projects (defined under section 66 of CEAA 2012) or new physical activities on federal lands are being authorized under the proposed licence. However, CNSC staff did conduct an EA under the *Nuclear Safety and Control Act* (NSCA) and its regulations. CNSC staff concluded that the licensee will make adequate provision for the protection of the environment.

The public, Indigenous groups and other stakeholders were invited to participate in the relicensing process, and up to $100,000 was made available to enable their participation through the CNSC's Participant Funding Program (PFP). Nine (9) applicants were awarded PFP funds for the Pickering licence renewal application to the amount of $97,632.97.

The current licence authorizes OPG to operate Pickering NGS fuel channels up to 247,000 Equivalent Full Power Hours (EFPH). OPG is seeking Commission approval to operate Pickering Units 5-8 up to 295,000 EFPH. This is the maximum operating time expected for the lead unit (Unit 6) before the end of commercial operation on December 31, 2024. To assess the risk of pressure tube failure from postulated flaws in the reactor core, OPG uses a fracture toughness model that has been developed for use up to a maximum pressure tube hydrogen equivalent concentration ([Heq]) of 120 ppm. Based on current [Heq] predictions, the lead Pickering fuel channels are not expected to reach 120 ppm before the end of their target commercial service life. Therefore, CNSC staff recommend that the Commission approve operation of Pickering NGS Unit 5-8 fuel channels up to a maximum of 295,000 EFPH for the lead unit.

CNSC staff recommend a specific licence condition (LC 15.3) requiring OPG to maintain pressure tube fracture toughness sufficient for safe operation. This LC will assure presence of adequate compliance verification criteria should the projected [Heq] predictions exceed 120 ppm before the end of Pickering pressure tube target service life. Should OPG seek CNSC approval to operate fuel channels above the predicted [Heq] of 120 ppm, specific acceptance criteria for the demonstration of adequate fracture toughness at [Heq] in excess of 120 ppm are defined in the accompanying Licence Conditions Handbook.

In this Commission Member Document (CMD), CNSC staff present the assessments of the licence application and the documents submitted in support of the application, as well as OPG's performance to date (2013-2017) for the licence period. CNSC's regulatory oversight of the Pickering NGS also included assessments of OPG's efforts in continuous safety enhancements.

In addition to the assessments, this CMD also provides comprehensive information on the issues on which CNSC staff have been focusing, the current status of these issues, and CNSC staff's future expectations of OPG.

This CMD provides information in all CNSC safety and control areas (SCAs) with focused highlights on:

- CNSC staff's environmental assessment under the NSCA
- PSR, including the Global Assessment Report and Integrated Implementation Plan (IIP);
- end of commercial operation of Pickering NGS;
- fitness-for-service strategy for fuel channels for operation up to 295,000 EFPH;
- update on Fukushima Action Items; and
- engagement with Indigenous communities

Table 1 lists CNSC staff's rating for OPG's safety performance in each SCA to the end of 2016. Note that preliminary ratings for 2017 show the same trend; however, they are not finalized and will be presented in the CNSC staff's *Regulatory Oversight Report for Canadian Nuclear Power Plants,* later in 2018.

Table 1 shows that OPG met or exceeded regulatory requirements in all SCAs and that OPG has operated Pickering NGS safely during the current licence period.

Table 1: Pickering NGS safety performance ratings 2013-2016

Safety and Control Area	2013	2014	2015	2016
Management System	SA	SA	SA	SA
Human Performance Management	SA	SA	SA	SA
Operating Performance	SA	SA	FS	FS
Safety Analysis	SA	SA	FS	FS
Physical Design	SA	SA	SA	SA
Fitness for Service	SA	SA	SA	SA
Radiation Protection	FS	FS	FS	SA
Conventional Health and Safety	SA	SA	FS	FS
Environmental Protection	SA	SA	SA	SA
Emergency Management and Fire Protection	SA	SA	SA	SA
Waste Management	SA	SA	FS	FS
Security	FS	FS	SA	SA
Safeguards and Non-Proliferation	SA	SA	SA	SA
Packaging and Transport	SA	SA	SA	SA

SA = Satisfactory; FS = Fully Satisfactory

Based on CNSC staff’s assessment of OPG’s past performance and of the licence application, CNSC staff conclude that OPG will:

- continue to operate Pickering NGS safely
- continue to maintain and implement adequate programs within the 14 SCAs
- fulfill commitments made in the licence renewal applications and complete the planned safety enhancements (such as those found in the IIP) during the proposed licence period

During the current licence period, there were no serious process system failures, the availability of special safety systems was acceptable, and doses to workers and the public were well below regulatory limits. Risk to the public and workers have been kept low, and in CNSC staff’s view, should remain low over the proposed licence period.

CNSC staff conclude that OPG is qualified to carry out the activities listed in the proposed licence, and has made and will continue to adequately provide 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.

CNSC staff recommend the Commission to:

1. Renew the Pickering NGS PROL, and associated LCH, authorizing OPG to carry out the activities listed in Part IV of the licence from September 1, 2018 to August 31, 2028.
2. Accept the station-specific conditions included in the proposed licence requiring OPG to:
    - implement the Integrated Implementation Plan;
    - maintain Units 2 and 3 in the safe storage phase;
    - maintain pressure tube fracture toughness sufficient for safe operation;
    - implement and maintain plans for the end of commercial operations of all Pickering units;
    - implement and maintain a Cobalt-60 program for activities described under Part IV of the licence; and
    - limit the activities of import and export to the nuclear substances occurring as contaminants in laundry, packaging, shielding or equipment.
3. Authorize OPG to operate the Pickering NGS Units 5-8 fuel channels up to a maximum of 295,000 EFPH for the lead unit.
4. Authorize the delegation of authority as set out in section 6.11 of this CMD.

The proposed PROL and draft LCH are presented in Part 2 of this CMD.

PART ONE

This Commission Member Document (CMD) is presented in two parts.

Part One includes:

1. An overview of the matter being presented;
2. Overall conclusions and overall recommendations;
3. General discussion pertaining to the safety and control areas that are relevant to this submission;
4. Discussion about other matters of regulatory interest; and
5. Addenda material that complements items 1 through 4.

Part Two provides all available information pertaining directly to the current and proposed licence.

1. OVERVIEW

1.1 Background

Pickering Nuclear Generating Station (NGS) is located in the Province of Ontario on the North shore of Lake Ontario, in the city of Pickering and the regional municipality of Durham. The facility lies 32 km northeast of downtown Toronto and 21 km southwest of Oshawa. The facility is owned by Ontario Power Generation Incorporated (OPG), a Canadian corporation, whose head office is located at 700 University Avenue, Toronto, Ontario, M5G 1X6.

Pickering NGS consists of eight CANDU pressurized heavy water reactors and their associated equipment, which are designed, constructed, and operated to produce electrical power. Units 2 and 3 are in a safe storage state and will remain so until the eventual decommissioning of the station. Each operating reactor has a nominal electrical output of 515 MWe (megawatt-electric) for Pickering Units 1, 4, and 516 MWe for Pickering Units 5-8. Construction of the facility started in 1966 for Units 1 to 4 (formerly referred to as Pickering NGS A) and in 1974 for Units 5-8 (formerly referred to as Pickering NGS B). First criticality for reactor Unit 1was on February 25, 1971, and for Unit 5 was on October 23, 1982. The in-service dates for Units 1-4 ranged from 1971 to 1973, and for Units 5-8 ranged from 1983 to 1986. Figure 1 shows an aerial shot of Pickering NGS.

In addition to the Pickering NGS, the Pickering Waste Management Facility (PWMF) is also located on the Pickering nuclear site and is separately licensed under a Class 1B Waste Facility Operating Licence. It consists of several installations at three different locations. The PWMF handles and stores used nuclear fuel from Pickering NGS that has cooled in the irradiated fuel bays of the station for several years. The PWMF also has a facility for the storage of components from past retubing activities from Pickering Units 1-4. The PWMF licence was renewed in February 2018.

In April 2017, OPG submitted an updated Environmental Risk Assessment (ERA) report for the Pickering site based on effluent and environmental monitoring data for the five-year period between 2011and 2015. CNSC staff’s assessment of the 2017 ERA was provided to the Commission in CMD 17-HB.5, which was presented during the licence renewal hearing for the PWMF. Intervenors were also given an opportunity to review the ERA during the PWMF hearing process.

Pickering NGS also produces a radioactive isotope cobalt-60 (Co-60), used for sterilization of medical equipment and food products. Co-60 is harvested from the irradiated reactor components (adjuster rods) that are removed from the reactors during planned outages.

Figure 1- Pickering NGS

1.2 Highlights

In 2017, OPG submitted an application, including supplemental information [1-9], for the renewal of its Pickering NGS Power Reactor Operating Licence (PROL). The current PROL expires on August 31, 2018. OPG has requested the licence to be renewed for a period of 10 years. As OPG intends to cease commercial operation of Pickering NGS on December 31, 2024 [10], this licence period will cover three phases of operational activities: continued commercial operation until December 31, 2024; a stabilization phase (post-shutdown defueling and dewatering) lasting approximately 3 to 4 years; and the beginning of safe storage for Units 1, 4 and 5-8. The safe storage phase marks the beginning of station decommissioning.

The proposed licence includes the following activities:

(i) operate the Pickering NGS;

(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) import and export the nuclear substances, except controlled nuclear substances, that are required for, associated with, or arise from the activities described in (i);

(iv) possess, transfer, produce, package, manage, and store Cobalt-60;

(v) possess, transfer, manage and store heavy water from other nuclear facilities;

(vi) transport Category II nuclear material by road vehicle from the nuclear facility spent fuel bay to the onsite waste storage facility;

(vii) possess, transfer, export, package, manage and store nuclear substances from the Western Waste Management Facility;

(viii) possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in (i); and

(ix) possess, use, manage and store enriched uranium as required for fission chambers for the Pickering NGS Units 1, 4 Shutdown System Enhancement, including spares.

In support of its application for a 10-year operating licence, OPG has performed a periodic safety review (PSR), in accordance with CNSC regulatory document REGDOC-2.3.3 *Periodic Safety Reviews*. The purpose of the PSR is to confirm and enhance the safety case for continued operation of Pickering NGS. A PSR allows a licensee to identify practicable safety enhancements to the plant to bring its overall performance to a level commensurate with that of modern requirements and practices.

The reasons for recommending this licence term are also based on criteria set out in CMD 02-M12, *New Staff Approach to Recommending Licence Periods*. Based on the submitted application and CNSC staff's evaluation of OPG's programs, CNSC staff determined that the criteria in CMD 02-M12 have been met and that OPG will make reasonable and practical physical and programmatic enhancements to ensure safety over the next 10 years.

The purpose of this CMD is to provide CNSC staff's conclusions and recommendations to support the Commission's decision on the licence renewal application.

This CMD provides information in all the CNSC safety and control areas (SCAs) with focused highlights on the:

- CNSC staff environmental assessment under the *Nuclear Safety and Control Act* (NSCA);
- PSR, including the Global Assessment Report and Integrated Implementation Plan;
- end of commercial operation of Pickering NGS;
- fitness-for-service strategy for fuel channels for operation up to 295,000 Equivalent Full Power Hours (EFPH);
- update on Fukushima Action Items (FAIs); and
- engagement with Indigenous communities

Commission requests arising from the previous Pickering NGS licence renewal in 2013 [11], and the Commission Hearing in 2014 for the removal of the Pickering hold point [12] are summarized in Table 2. Details on these items are provided in section 6.10 of this CMD.

Table 2: Summary of Commission requests

Item	Action	Description	Status
1	Provide the revised Probabilistic Safety Assessment (PSA) for Pickering A that meets the requirements of CNSC Regulatory Standard S-294	OPG to provide the revised Pickering A PSA assessments before the removal of the hold point can be approved.	PSA submitted. See CMD 14-H2 [13]. **Action complete**
2	Provide an updated PSA for both Pickering A and Pickering B that takes into account the enhancements required under the Fukushima Action Plan	OPG to provide submission before the removal of the hold point can be approved.	Updated PSAs submitted. See CMD 14-H2. **Action complete**
3	Provide a whole-site PSA or methodology for a whole site PSA, specific to the Pickering NGS site.	OPG to provide submission before the removal of the hold point can be approved. CNSC staff to review the Pickering PSA methodology, and provide its recommendation for the Commission's consideration at the time of OPG's request for the release of the hold point.	Conceptual whole site PSA methodology submitted by OPG in February 2014 and accepted by CNSC staff. See CMD 14-H2. Whole site Pickering PSA submitted in December 2017. See CMD 17-M64 [14] **Action complete**
4	Provide an action plan to address any identified issues should OPG exceed its targeted safety goals [in	OPG to provide an action plan depending on outcome of Pickering A PSA. If PSA values are between the limits and the targets, then safety	Risk improvement plan updates are submitted annually. CNSC staff

	the Pickering A PSA]	improvements should be put in place if practicable. If the PSA values are above acceptable limits then safety improvements are mandatory.	reports on OPG's implementation of the plan in the *Regulatory Oversight Report for Canadian Nuclear Power Plants* **Action complete**
5	A report on OPG's analysis and way for future enhancements to protect containment under the FAI	OPG will be considering filtered containment as part of its analysis of future enhancements to protect containment through its Fukushima Action Items. OPG to report on this issue at the time of its request to remove the hold point.	Report provided. See CMD 14-H2. **Action complete**
6	OPG to produce and distribute to all households in the Pickering area an emergency management public information document summarizing the integrated emergency response plan of all involved organizations, including all key roles and responsibilities and include information on potassium iodide (KI) tablet distribution	The document is to be produced by the end of June 2014.	Document produced and distributed. See CMD 14-H2 **Action complete**
7	OPG to clarify its long-term plan for waste management, by June 30, 2017, at the time of OPG's notification to the Commission of the end date of commercial operations of all Pickering NGS units.		Long term waste management plan provided in OPG letter dated June 28, 2017 [10] **Action complete**

8	OPG to provide a report on the detailed risk improvement plan for Pickering NGS	Follow up Commission request as detailed in the Record of Proceedings for the Removal of the Pickering Hold Point Commission Hearing, May 7-8, 2014.	Risk improvement plan updates are submitted annually. CNSC staff reports on OPG's implementation of the plan in the *Regulatory Oversight Report for Canadian Nuclear Power Plants* **Action complete**
9	Increase monitoring, inspection and reporting on the operation of the Pickering reactor units.	Action on CNSC and OPG. Provide annual updates to the Commission regarding increased monitoring, inspection and reporting on major components.	CNSC staff reports on this in the *Regulatory Oversight Report for Canadian Nuclear Power Plants* **Action complete**

1.3 Overall Conclusions

CNSC staff have concluded the following with respect to paragraphs 24(4)(*a*) and (*b*) of the NSCA, in that the licensee:

1. Is qualified to carry on the activity authorized by the licence.
2. Will, in carrying out 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.

1.4 Overall Recommendations

CNSC staff recommend to the Commission the following:

1. Renew the Pickering NGS PROL, and associated Licence Conditions Handbook (LCH), authorizing OPG to carry out the activities listed in Part IV of the licence from September 1, 2018 to August 31, 2028.
2. Accept the station-specific conditions included in the proposed licence requiring OPG to:

- implement the Integrated Implementation Plan;
- maintain Units 2 and 3 in the safe storage phase;
- maintain pressure tube fracture toughness sufficient for safe operation;
- implement and maintain plans for the end of commercial operations of all Pickering units;
- implement and maintain a Cobalt-60 program for activities described under Part IV of the licence;
- limit the activities of import and export to the nuclear substances occurring as contaminants in laundry, packaging, shielding or equipment.

3. Authorize OPG to operate the Pickering NGS Units 5-8 fuel channels up to a maximum of 295,000 EFPH for the lead unit.
4. Authorize the delegation of authority as set out in section 6.11 of this CMD.

The proposed PROL and LCH are presented in Part 2 of this CMD.

2. MATTERS FOR CONSIDERATION

2.1 Environmental Assessment

An Environmental Assessment (EA) under the *Canadian Environmental Assessment Act* (CEAA) 2012, was not required for this licence renewal application. Similarly, section 67 of CEAA 2012 does not apply as no new projects (defined under section 66 of CEAA 2012) or new physical activities on federal lands are being authorized under the proposed licence.

However, CNSC staff did conduct an EA under the NSCA and its regulations. More information can be found in Appendix F. CNSC staff conclude that the licensee will make adequate provision for the protection of the environment.

2.2 Periodic Safety Review

In support of its application for a 10-year operating licence, OPG has performed a periodic safety review, in accordance with CNSC regulatory document REGDOC-2.3.3 *Periodic Safety Reviews*. Further information is provided in section 3.

2.3 End of Commercial Operation

In 2010, OPG announced that Pickering NGS would continue operation until 2020, at which time the station would shut down. During the previous licence renewal in 2013, Licence Condition 16.2 was added to the Pickering PROL, requiring OPG to confirm to the Commission, in writing and no later than June 30, 2017, the end date of commercial operation of all Pickering units.

In January 2016, OPG was requested by the Province of Ontario to plan for safe and reliable continued operation beyond 2020. In response, on June 28, 2017, OPG informed the CNSC that all Pickering units would cease commercial operation on December 31, 2024 [10]. Following the permanent shutdown of the units, the station will be transitioned to a safe storage state.

Further information is provided in section 4.

2.4 Safety and Control Areas (SCAs)

The functional areas of any facility or activity licensed by the CNSC consist of a standard set of 14 safety and control areas (SCAs). Each SCA is comprised of several “specific areas” of regulatory interest. See Appendix D, “Safety and Control Framework”, for further information about SCAs.

The CNSC has applied a risk-informed regulatory approach to determine the relative risk rankings of each SCA when applied to NPPs. An overview of the risk ranking, and the management and monitoring approach associated with the various degrees of risk, can be found in Appendix A “Risk Ranking”.

Each year, CNSC staff evaluate the licensee’s performance rating within each SCA. The safety performance rating for each SCA indicates the level of overall compliance with regulatory requirements within the evaluation period. Information and definitions can be found in Appendix B “Rating Levels”.

Table 3 summarizes the Pickering NGS safety performance ratings for each SCA during the period from 2013 to 2016. Ratings for 2017 will be available at a later date through the *Regulatory Oversight Report for Canadian Nuclear Power Plants* (the “NPP Regulatory Oversight Report”).

Table 3: Pickering NGS safety performance ratings 2013-2016

Safety and Control Area	2013	2014	2015	2016
Management System	SA	SA	SA	SA
Human Performance Management	SA	SA	SA	SA
Operating Performance	SA	SA	FS	FS
Safety Analysis	SA	SA	FS	FS
Physical Design	SA	SA	SA	SA
Fitness for Service	SA	SA	SA	SA
Radiation Protection	FS	FS	FS	SA
Conventional Health and Safety	SA	SA	FS	FS
Environmental Protection	SA	SA	SA	SA
Emergency Management and Fire Protection	SA	SA	SA	SA
Waste Management	SA	SA	FS	FS
Security	FS	FS	SA	SA
Safeguards and Non-Proliferation	SA	SA	SA	SA
Packaging and Transport	SA	SA	SA	SA

SA = Satisfactory; FS = Fully Satisfactory

2.5 Other Matters of Regulatory Interest

The following table identifies other matters that are relevant to this CMD. These are describes in section 6.

Table 4: Other matters of regulatory interest

OTHER MATTERS OF REGULATORY INTEREST
Indigenous Engagement
Other Consultation
Cost Recovery
Financial Guarantees
Licensee’s Public Information Program
Nuclear Liability Insurance
Fukushima Action Items
OSART mission
Fisheries Act Authorization
Follow up Requests from the Commission
Delegation of Authority

2.6 Regulatory and Technical Bases

The regulatory and technical bases for the matters discussed in this CMD are provided in Appendix C of this document.

3. PICKERING PERIODIC SAFETY REVIEW

3.1 Background

Pickering NGS Units 1-4 came into service between 1971 and 1973. The pressure tubes in Pickering Units 1-4 were replaced in the mid to late 1980s. In 1997, the station was shut down and placed in a lay-up state. Following safety upgrades in the early 2000s, OPG returned Units 1, 4 to service in 2005 and 2003, respectively. Due to economic reasons, OPG decided not to return to service Units 2 and 3 and placed them in a safe storage state.

Pickering NGS Units 5-8 came into service between 1982 and 1985. In 2009, OPG completed an Integrated Safety Review to assess options for Units 5-8 continued operation. In 2010, OPG decided that an incremental operating extension of the entire Pickering NGS until 2020, rather than refurbishment, was the preferred option. CNSC staff advised OPG that should OPG decide to operate Pickering NGS beyond 2020, a Periodic Safety Review (PSR) should be performed to support such a decision [15].

Accordingly, to assure continued safe operation of the NGS, and in support of its application for renewal of the Pickering NGS PROL, OPG has performed a PSR in accordance with the requirements of REGDOC-2.3.3 *Periodic Safety Reviews*.

3.2 Periodic Safety Review — Overview

A PSR is a systematic and comprehensive assessment performed by the licensee typically every 10 years. The PSR is complementary to, but does not replace, compliance and verification activities. It takes into account evolving national requirements and international safety practices; considers worldwide operating experience; and, in particular, undertakes an assessment of the impact of plant aging on safety.

The objectives of Pickering PSR are to determine:

1. The extent of conformance of the Pickering NGS to applicable modern codes, standards and practices ;
2. The extent of continued validity of the Pickering NGS licensing basis for the next licence period;
3. The adequacy and effectiveness of programs as well as structures, systems and components (SSCs) for continued safe commercial operation of Pickering NGS to the end of 2024;
4. The opportunities to enhance Pickering NGS safety through the implementation of specific actions that disposition identified PSR findings at specific and agreed scheduled target completion dates.

REGDOC-2.3.3 requires that OPG submits to the CNSC:

1. Details on the conduct of the PSR (the PSR basis document)

   A typical PSR basis document contains fundamental elements related to the conduct of the PSR. Examples of such elements include the operating strategy of the station, the current licensing basis; the scope of the PSR; applicable codes, standards and practices; the methodology used in conducting the PSR, the methodologies for evaluating the global risk and for prioritizing and ranking the findings; recording and tracking the results, and the management of the PSR as a project. REGDOC-2.3.3 requires that the PSR basis document be accepted by CNSC staff. CNSC staff have accepted the Pickering PSR Basis Document.

2. Results of the review of established and agreed safety factors (safety factor reports)

   The safety factor reports include the results of the review of 15 safety factors. Details regarding the 15 safety factors and the associated review tasks are found in REGDOC-2.3.3 and IAEA SSG-25 *Periodic Safety Review for Nuclear Power Plants*. Each safety factor report includes assessment against relevant modern codes, standards and industry practice; as well as systematic and detailed assessment of pre-specified and agreed review tasks. REGDOC-2.3.3 requires the submission of the safety factor reports to CNSC staff for review. CNSC staff have completed the review of all 15 Pickering PSR safety factor reports.

3. Results of global risk assessment of operation to 2024 (Global Assessment Report)

   The Global Assessment Report (GAR) includes a statement by the licensee on the overall acceptability of continued safe and reliable operation of the plant. The global assessment process consolidates the findings documented in the safety factor reports into risk-ranked global issues, supplemented by residual actions from previous systematic reviews of safety, emerging issues or events, and findings from CNSC compliance activities. Plans are then developed to resolve these global issues. An assessment of defence-in-depth is then completed to assess the acceptability of plant operation for the period covered by the PSR. The GAR is submitted for review by CNSC staff. CNSC staff have completed the review of Pickering PSR GAR.

4. A plan to execute actions to disposition identified findings at specific and agreed target completion dates (Integrated Implementation Plan)

   The Integrated Implementation Plan (IIP) identifies practicable actions and corresponding timelines for executing such actions. The IIP includes a well-defined schedule for implementing the resulting PSR actions based on their safety significance and availability of station outages where necessary. The IIP includes a process that refers to a PSR database for tracking successful completion of actions, and describes how the progressive implementation of actions will be managed, controlled and reported. REGDOC-2.3.3 requires that the licensee's IIP be accepted by CNSC staff. CNSC staff accepted the Pickering PSR IIP on March 2, 2018.

The IIP forms part of the licensing basis. Therefore, completing the IIP will become a licensing requirement for OPG as stated in LC 15.1, and will be subject to close regulatory scrutiny by way of compliance verification criteria detailed in the LCH.

3.3 Regulatory Oversight of Pickering PSR Project

In April 2016, a protocol [16] was established and then revised in January 2017, detailing the interaction between the CNSC and OPG for the conduct of a PSR in support of Pickering NGS PROL renewal.

CNSC staff acceptance of PSR basis document

On January 29 2016, OPG submitted Revision 000 of its PSR Basis Document for CNSC acceptance. CNSC staff performed a sufficiency assessment and requested clarification by OPG on, along with other matters, the applicability of previous systematic safety reviews performed for any reactor units of Pickering NGS. CNSC staff also recommended that the PSR freeze date for codes and standards be aligned with the submission date of the Basis Document.

Revision 002 of the Pickering NGS PSR Basis Document was accepted on July 6, 2016 [17] without conditions by CNSC staff.

CNSC staff review of safety factor reports and complementary reviews

OPG completed 15 safety factor reports, including the review of 74 modern codes and standards, which identified 93 gaps. CSA Standard N290.18 *Periodic Safety Review for Nuclear Reactor Facilities* defines a gap as "a determination of non-conformance with modern requirements documents or practices, nonfulfillment of a review task requirement or lack of information concerning the current condition of a structure, system or component important to safety."

At the request of CNSC staff, OPG also performed two complementary reviews. The first was to reassess the Fukushima Action Items (FAIs), and the second was to re-evaluate the Pickering B Continued Operations Plan actions[1]. These complementary reviews identified an additional 26 gaps.

CNSC staff reviews further identified 78 gaps; 23 of which were considered within the PSR process. The remaining 55 CNSC staff additional gaps were addressed and dispositioned by OPG as part of the regulatory compliance process, in parallel with the PSR process [18, 19].

In total, 143 gaps were identified for progression to the GAR phase.

CNSC staff reviewed the Pickering NGS 15 safety factor reports as they were progressively being submitted by OPG starting in July 2016. CNSC staff completed the review of the last safety factor report on July 26, 2017.

[1] The Pickering B Continued Operations Plan actions were developed based on the results of the Integrated Safety review and the Environmental Assessment (EA) conducted in 2009.

CNSC staff review of the GAR

In the GAR, OPG demonstrated how outputs from the safety factor reports and other sources — such as findings from previous assessments, existing licensing commitments, and comments by CNSC staff — were consolidated into global issues that were then prioritized based on their safety significance. Also, OPG formulated resolution plans for each global issue and developed corresponding resolution statements that were then ranked to determine the activities that will be most effective in enhancing safety (for example, time of implementation and the practical safety enhancement gained) giving the limited extended operation period of the plant to the end of 2024. Furthermore, OPG performed a comprehensive defence-in-depth analysis to document the overall risk judgment on acceptability of continued safe and reliable operation of Pickering NGS, assuming that actions will have been developed and implemented to resolve the findings as would be listed and scheduled in the IIP. Throughout this process, CNSC staff provided regulatory clarification and regulatory interpretation of the requirements in CNSC REGDOC-2.3.3, and guidance of IAEA SSG-25, and CSA N290.18.

Through the global assessment process, the 143 gaps initially identified during the safety factor reviews and the 2 complementary reassessments were consolidated into 51 global issues with 117 proposed resolution plans. After a defence-in-depth analysis, 23 of the global issues along with 35 proposed resolution plans representing 71 gaps were progressed for developing actions in the IIP. The remaining 28 global issues and corresponding 82 resolution plans which comprise 72 gaps were categorized by OPG and agreed by CNSC staff as follows:

1. 35 *acceptable deviations* for which OPG demonstrated that they were of very low safety significance or their implementation measures are not practicable
2. 22 *No further action* for which OPG indicated that Pickering NGS operations programs and execution plans already exist, enabling their successful completion under regulatory compliance activities,
3. 25 *Cross-referenced* that OPG proposed to amalgamate into other resolutions plans that were similar in scope.

OPG submitted Revision 000 of the GAR in October 2017, and Revision 001 on February 12, 2018 [20], which was determined by CNSC staff to be satisfactory [21].

CNSC staff acceptance of the IIP

The IIP is the last PSR deliverable submitted by OPG for acceptance by CNSC staff. OPG submitted Revision 0 of the IIP on November 30, 2017 [22]. From the 23 global issues and 35 proposed resolutions statements carried forward from the GAR, OPG has developed 63 IIP actions with completion criteria and target completion dates. The IIP is based on current Canadian experience and reflects the requirements of CNSC REGDOC-2.3.3 and guidance of IAEA SSG-25 and CSA N290.18-17. CNSC staff reviewed this submission and determined that it reflects the work done under the Pickering PSR [23] and forms basis for actions to support safe operation. However, OPG was requested to address and resolve few remaining issues and comments. OPG then submitted Revision 1 of the IIP [24], which was reviewed and accepted by CNSC staff on March 2, 2018 [25].

In parallel, OPG initiated and developed a PSR database to record and track all PSR information from the identified gaps to the closure of the IIP actions. As well, OPG drafted an IIP administrative instruction on how OPG intends to manage the IIP execution. CNSC staff reviewed this instruction and determined that it meets the regulatory expectations. OPG IIP administrative instruction is included in the LCH as a written notification document.

CNSC staff oversight of the effective implementation of the IIP

Upon the Commission renewing the Pickering NGS licence, by August 2018, CNSC staff will formalize an approach for the regulatory oversight of the effective implementation by OPG of the IIP. The CNSC approach will define the roles and responsibilities of involved CNSC staff, the means of formal and informal communication with OPG, and the means for the regulatory oversight of OPG's execution of the IIP actions. CNSC staff will perform inspections and assessments of key IIP actions to confirm that the corresponding completion and closure criteria detailed in the IIP are satisfied.

OPG will notify the CNSC of changes to the IIP for CNSC staff acceptance.

OPG will report the status of IIP actions quarterly and annually starting in the 4th quarter of 2018, with the annual report submitted on February 28 of the following calendar year. OPG will use the quarterly and annual reports to summarize changes to the IIP. CNSC staff will update the Commission on the status of the IIP actions as part of the annual NPP Regulatory Oversight Report.

3.4 PSR Results

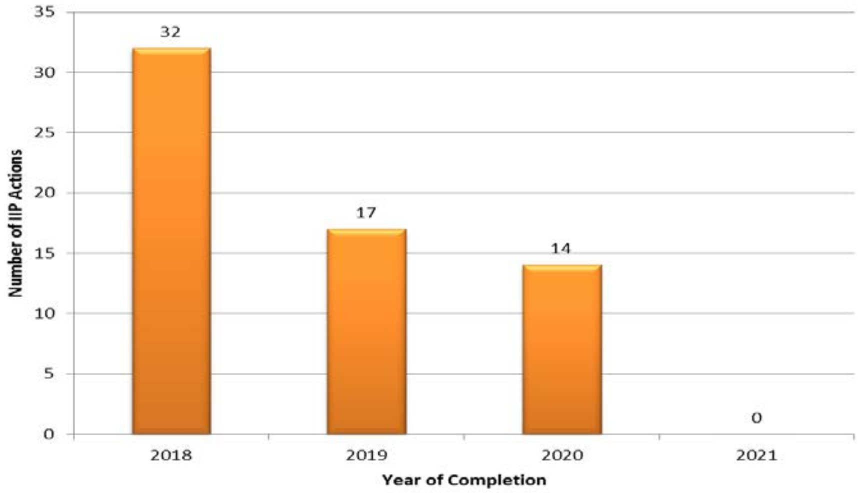
The Pickering NGS PSR resulted in 23 global issues, 35 resolution statements and 63 IIP actions. All IIP actions are targeted to be completed by December 31, 2020.

Based on CNSC staff's review of the GAR and IIP, CNSC staff conclude that:

1. The GAR and IIP meet CNSC regulatory requirements and expectations of REGDOC-2.3.3, and the guidance in IAEA SSG-25 and CSA N290.18-17;
2. Pickering NGS design, operation, processes and management system will ensure continued safe operation of Units 1, 4 and 5-8, for the operation to the end of 2024;
3. The actions in the IIP along with the commitment of OPG to invest in the plant will enhance the safe operation of Pickering NGS reactor units; and
4. Pickering NGS reactor units will be operated only if fitness for service of the structures, systems and components (SSCs) important to safety is assured.

Figure 2 shows how many of the 63 actions included in the IIP [24] will be completed by OPG in 2018, 2019 and 2020, considering that some of the actions will be implemented during outages.

Figure 2: OPG IIP actions completion from 2018 to 2020



CNSC staff also concur with OPG that among the highest-ranked PSR safety-enhancements are those related to:

1. Updating the life cycle management plans (LCMPs) for the major components (steam generators, feeders, calandria internals, and fuel channels);
2. Updating the safety analyses impacted by aging;
3. Implementing upgrades to ensure the containment integrity under beyond design basis accidents (BDBA), including severe accidents; and
4. Updating the condition assessments for piping systems and components with similar functions (e.g. valves) for the extended period of operation. This includes the development and implementation of a database with an action tracking and reporting tool for reporting internally within OPG and externally to the CNSC.

The following table shows the distribution of the global issues, resolution statements and IIP actions by CNSC SCA.

Table 5: Distribution of global issues, resolution statements and IIP actions by SCA

SCA	Number of Global Issues	Number of Resolution Statements	Number of IIP Actions
Safety Analysis	5	8	18
Physical Design	4	4	4
Fitness for Service	12	21	37
Emergency Preparedness and Fire Protection	2	2	4[1]
Total	23	35	63

[1]Includes actions related to progression and consequences of severe accidents

Additional details highlighting specific IIP actions are provided in section 5 of this CMD.

3.5 Conclusion

OPG has performed a PSR in accordance with CNSC regulatory document REGDOC-2.3.3, in support of its licence application and plan to extend commercial operation to December 31, 2024. Pickering PSR results are the output of the detailed review and systematic assessment by OPG that required more than 2 years of effort, from January 2016 to March 2018. CNSC staff accepted the PSR Basis Document and IIP, and agreed with the methods used by OPG in the GAR and the results of the defence-in-depth analysis.

CNSC staff note that all actions included in the IIP will be implemented by December 31, 2020.

CNSC staff will update the Commission on the status of the Pickering NGS IIP actions as part of the annual NPP Regulatory Oversight Report. The public will have a chance to participate in the proceedings when this report is presented to the Commission each year.

3.6 Recommendation

CNSC staff recommend the following licence condition be included the proposed PROL:

- LC 15.1: The licensee shall implement the Integrated Implementation Plan.

This licence condition will support safety enhancements across all applicable SCA. Compliance verification criteria are detailed in the proposed LCH.

4. END OF COMMERCIAL OPERATION

On June 28, 2017, OPG informed the CNSC that all Pickering units would cease commercial operation on December 31, 2024.

4.1 OPG Strategy for Pickering End of Commercial Operation

The OPG document entitled *Pickering Site Strategic Plan* [26] provides an overview of the site strategy for Pickering as it approaches the end of commercial operation. The end of commercial operation signifies the permanent shutdown of nuclear reactors and the end of generation of electric power. The strategy consists of the following stages:

- continued commercial operation until December 31, 2024,
- stabilization activities from 2025 to 2028,
- safe storage with surveillance from 2028 to 2050,
- dismantling and demolition from 2051 to 2061,
- site restoration from 2061 to 2065

Following the permanent shutdown of all units by December 31, 2024, OPG will undertake stabilization activities to transition the station to a safe storage state. During the stabilization activity stage, the reactors will be defueled, systems containing heavy water will be drained, and systems no longer required for maintaining the safe condition of the station will be removed from service. The stabilization activity stage is expected to last from 3 to 4years.

The safe storage stage is a period of storage with surveillance to allow for the decay of radioactivity prior to dismantling the reactors. OPG will continue to operate the systems necessary to meet the regulatory and operational demands of the safe storage state. During the first 10 years of safe storage, used fuel will be transferred from the irradiated fuel bays to dry storage at the Pickering Waste Management Facility on site. The safe storage stage is nominally planned to last 22 years.

The station dismantling and demolition stage is expected to begin around 2051 and take approximately 10 years to complete. This will be followed by site restoration, which is targeted for completion by 2065. OPG will retain ownership of the site throughout the course of the decommissioning activities and subsequent restoration of the site.

4.2 Licensing Strategy

OPG has chosen a deferred decommissioning strategy for Pickering, meaning that the station will be placed in a safe storage state to allow for radiation levels to decay prior to dismantling and demolition.

CSA standard N294-09 *Decommissioning of Facilities Containing Nuclear Substances,* identifies 4 phases to decommissioning:

Phase 1, Planning for Decommissioning

This phase generally begins at the design phase (or as early as possible) and continues throughout the life cycle of the facility. A decommissioning strategy and a preliminary decommissioning plan are developed in this phase.

Phase 2, Preparation for Decommissioning

This phase begins with the decision to cease operations and begin decommissioning. Pickering entered into this phase in February 2010 when OPG announced its decision not to refurbish the nuclear facility, but to extend its operations up to 2020 (now 2024). During the preparation phase, the licensee should prepare a detailed decommissioning plan and submit it to the CNSC in support of its application to request authorization to decommission. This phase also includes the stabilization activities required to place the station in a safe storage state.

Phase 3, Execution of Decommissioning

This phase begins with the implementation of the decommissioning plan after all necessary regulatory approvals have been obtained. The activities under this phase include those associated with the period of storage with surveillance as well as the execution of physical works (i.e., decontamination, dismantling and demolition of the facility).

Phase 4, Completion of Decommissioning

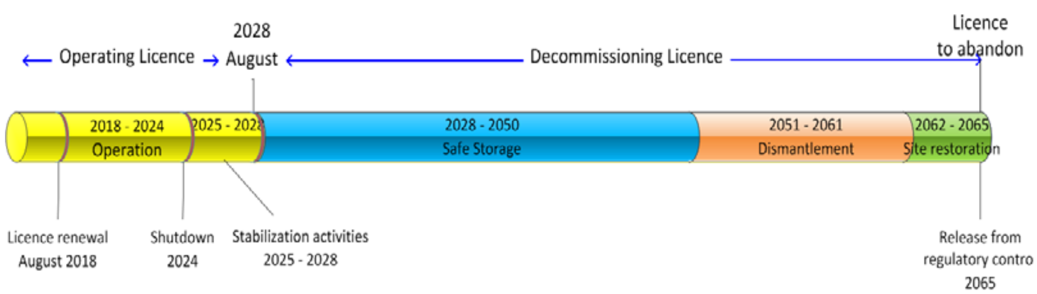
This phase involves verifying that all decommissioning activities have been completed satisfactorily and the final end state has been reached, including restoration of the site.

OPG is requesting a 10-year operating licence, from September 1, 2018 to August 31, 2028. This operating licence will include continued on-power operation until December 31, 2024, as well as the stabilization activities stage and the start of the safe storage stage (which are Phases 1 and 2 of decommissioning).

For the safe storage with surveillance, dismantling and site restoration stages (Phases 3 and 4), OPG would apply for a decommissioning licence.

Figure 3 illustrates the projected timeline for OPG activities and the applicable NPP licence for each stage of the station life going forward.

Figure 3: Pickering NGS timeline for activities for each stage of station life



4.3 Regulatory Oversight for Pickering End of Commercial Operation

In preparation for the permanent shutdown of the Pickering NGS and its subsequent transition to a safe storage state, the proposed PROL contains licence condition (LC) 15.4 to oversee the activities specific to the end of commercial operation.

The LC requires OPG to implement and maintain plans for the end of commercial operation of all Pickering units. The proposed LCH provides details regarding the type, timing and scope of these plans, specifically for:

- a sustainable operations plan (SOP) for the safe operation until the final permanent shutdown of each reactor unit, and
- a stabilization activity plan (SAP) for transitioning the shutdown reactors to the safe storage state.

CNSC requirements and expectations for the SOP and SAP were communicated to OPG in August 2017 [27]. These updated regulatory requirements and expectations are based on elements of draft CNSC regulatory document RD/GD-360 version 2, *Life Management of Nuclear Power Plants*, the IAEA Specific Safety Guide SSG-25 *Periodic Safety Review for Nuclear Power Plants*, as well as previous CNSC correspondence to OPG [28-30].

It is anticipated that the approach to permanent reactor shutdown may pose unique challenges which will require incremental activities that are not covered by existing regular programs. The purpose of the SOP is to identify challenges within the 14 SCAs while approaching the end of commercial operation of any reactor and to devise and implement the resolutions for such challenges to support the safe and reliable operation of the station.

The SOP is to be developed and implemented at least 5 years prior to the permanent shutdown of any reactor unit and updated annually.

The purpose of the SAP is to identify the unique challenges that could be faced by the station as the permanently shut down units of the station are transitioned to the safe storage state, and to devise and implement appropriate arrangements, activities, and actions. The SAP is to be developed at least 3 years prior to the permanent shut down of any reactor unit and implemented immediately after the unit is shut down.

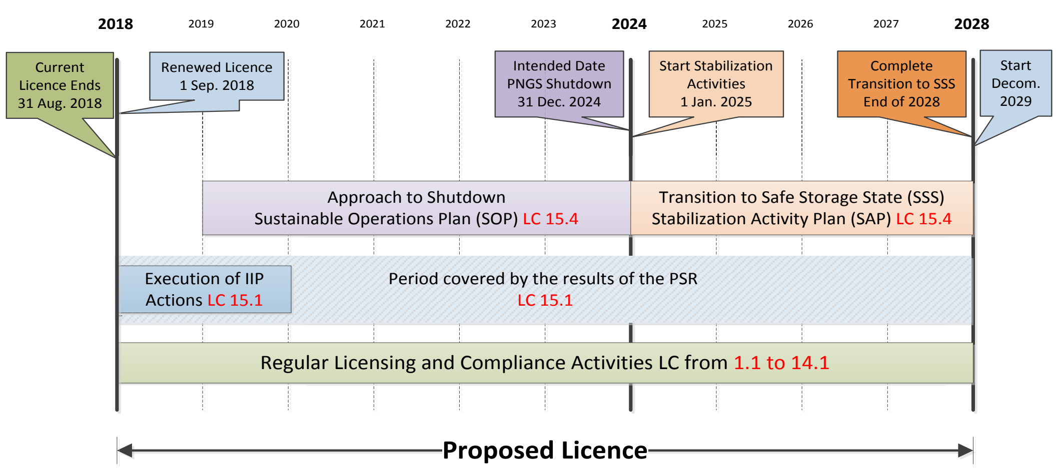
In addition to the SOP and SAP, OPG is required to submit a decommissioning plan every 5 years or when required by the Commission. The decommissioning plan is developed and updated progressively over the life cycle of the facility to reflect the appropriate level of detail required for the respective licensed activities. OPG submitted the most recent Preliminary Decommissioning Plan (PDP) for Pickering in January 2017. The next PDP is expected by January 2022. A Detailed Decommissioning Plan (DDP) for Pickering will be required for a Licence to Decommission. The DDP should be supported by a safety case and other licensing documentation reflecting OPG's plans and programs for managing the facility while in a safe storage state.

Should OPG be asked by the Province to investigate operating any unit beyond December 31, 2024, the compliance verification criteria specified under LC 15.4, require that OPG shall notify the CNSC in writing and no later than December 31, 2022, of its consideration to operate any unit of the Pickering NGS beyond December 31, 2024. Upon receipt of such a notice, CNSC staff will assess the impact on the licensing basis, PSR results, SOP and SAP and report its assessment findings and conclusions to the Commission.

4.4 Relationship of Compliance Oversight Activities and Plans for the End of Commercial Operation

Figure 4 shows the relationship between the regular programs and activities required by the PROL and the additional plans overseeing the end of commercial operation for Pickering NGS.

Figure 4: Relationship of regular programs and supplementary activities (PSR, SOP, SAP)



CNSC staff conduct regular compliance oversight activities to ensure licensees implement and maintain the programs required by the PROL in accordance with the compliance verification criteria in the LCH. The CNSC compliance verification program includes surveillance and monitoring, inspections and desktop reviews. These activities are performed in a risk-informed manner across all 14 SCAs.

The PSR and resulting IIP identify safety enhancements for the continued safe operation of Pickering NGS until the end of commercial operation in December 2024. CNSC staff will assess OPG's effective implementation of the IIP through additional compliance verification activities as described in section 3.3.

Similarly, the SOP and SAP identify unique incremental activities within each SCA that are not covered by existing programs. CNSC staff will assess the SOP and SAP submissions and follow up with OPG as required.

Staff will report to the Commission on all these activities through the annual NPP Regulatory Oversight Report.

4.5 Recommendation

CNSC staff recommend the following licence condition pertaining to the end of commercial operation:

- LC 15.4 The licensee shall implement and maintain plans for the end of commercial operations of all Pickering units.

Compliance verification criteria are detailed in the proposed LCH.

5. GENERAL ASSESSMENT OF SCAs

The specific areas that comprise the SCAs for this facility are identified in Appendix D, section D.2. Supporting details for some SCAs are provided in Appendix E.

5.1 Management System

The Management System SCA covers the framework that establishes the processes and programs required to ensure an organization achieves its safety objectives, continuously monitors its performance against these objectives, and fosters a health safety culture.

This CMD covers the following specific areas of the Management System SCA:

- Management system
- Organization
- Performance assessment, improvement and management review
- Problem identification and operating experience (OPEX)
- Change management
- Safety culture
- Configuration management
- Records management
- Management of contractors
- Business continuity

5.1.1 Trends

The following table indicates the overall performance ratings for the Management System SCA over the current licence period:

TRENDS FOR MANAGEMENT SYSTEM			
Performance Ratings			
2013	2014	2015	2016
SA	SA	SA	SA
Comments			
Pickering received a “Satisfactory” rating throughout the licence period.			

SA = Satisfactory

5.1.2 Discussion

OPG has a management system at Pickering NGS that is maintained and improved in accordance with the requirements of CSA N286 *Management System Requirements for Nuclear Facilities*.

OPG meets the principles and regulatory requirements for the Management System SCA at Pickering NGS. The station was given a “Satisfactory” rating throughout the licence period.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Management System

The OPG management system is defined in a charter that takes authority from a nuclear safety policy. The OPG charter provides a framework for the programs and governance that make up the OPG nuclear management system and the organizational structure under which they are implemented. The Chief Nuclear Officer is accountable for the implementation and the effectiveness of the nuclear management system.

During the licence period, OPG transitioned from CSA N286 edition 2005 to the 2012 edition. The 2012 edition of CSA N286 does not represent fundamental changes to the previous edition. To demonstrate compliance with the new edition, OPG provided a matrix identifying the OPG management system documents which address the CSA N286-12 requirements. CNSC staff have reviewed this matrix. CNSC staff also regularly assess the compliance of OPG programs with CSA N286-12, through planned and reactive compliance verification activities.

Organization

During the current licence period, CNSC staff performed desktop reviews of OPG’s organizational and program structure resulting from the OPG Business Transformation Initiative (BTI). In 2012, OPG initiated the BTI to implement a new organizational model. The resulting center-led matrix organization is composed of business lines (i.e., Nuclear, Hydro, Thermal) having common services (i.e., Finances, Human Resources) provided by corporate service organizations.

As a result of the BTI, the ownership of some programs was transferred from the nuclear business unit to corporate business units. Currently, seven programs are owned by corporate business units: Training, Environmental Management, Information Management, Items and Services Management, Health and Safety Management System, Business Continuity and Project Management. Oversight and review of these programs continues to be part of the nuclear management system and the Chief Nuclear Officer remains accountable for the implementation and effectiveness of the programs.

In January 2017, CNSC staff conducted an inspection to assess the implementation of the OPG organization, roles and responsibilities and interfaces related to the documentation and corporate business units [31].

CNSC staff were satisfied with the definition of roles and responsibilities and interfaces in the OPG documentation. However, minor non-compliances were identified with OPG's internal governance in the areas of records management, organization and procedural adequacy. CNSC staff is reviewing the OPG corrective action plan and will continue to monitor OPG's implementation of these actions as part of ongoing compliance verification activities.

Performance Assessment, Improvement and Management Review

OPG has a nuclear oversight program to periodically assess the effectiveness of their management system. This program encompasses the independent (audit) and self-assessment programs and the management review process conducted by OPG senior management.

In 2015, CNSC staff conducted an inspection of the OPG management review process and concluded that OPG was in compliance with the regulatory requirements. However, CNSC staff identified certain deficiencies with OPG internal governance with respect to the identification of inputs, definition of metrics and the completeness of OPG's review of their management system [32]. Regulatory actions were initiated and CNSC staff are following up with OPG on closure of these actions.

The OPG audit program includes the review of all of the programs in their management system, including programs that are maintained and implemented by corporate business units. The OPG audit program frequency is based on program risk analysis. Some programs are audited annually, others on a three-year and five-year audit frequency. The selection of program elements to be assessed is also based on a risk assessment. The structure of this process promotes early detection of minor issues before they become major.

In 2017, CNSC staff conducted an inspection of OPG's audit and self-assessments programs. Both the audit and self-assessment programs are in compliance with the requirements of CSA N286-12 and CNSC staff were satisfied with the implementation of the programs. CNSC staff identified areas for improvement mainly with the control of documentation and records [33]. CNSC staff have received OPG's corrective action plan and will continue to follow up with OPG as part of ongoing compliance verification activities.

Problem Identification and Resolution and Operating Experience

In 2014 and 2017, CNSC staff conducted inspections to assess the implementation of the OPG problem identification and resolution program. CNSC staff were satisfied with the implementation process for reporting and correcting problems. In the 2017 inspection, CNSC staff identified areas for improvement with the documentation and records [34]. CNSC staff will review the OPG corrective action plan and monitor OPG's implementation of the corrective actions.

OPG has a program to share lessons learned from internal and external events and take action when appropriate through their problem identification and resolution program. The OPG Operating Experience program is in compliance with the standard CSA N286-12. CNSC staff regularly verify compliance with this program during their ongoing compliance verification activities.

Change Management

OPG manages organizational changes and changes to processes, programs, designs, structures, systems, components, equipment, materials, software and documents in accordance with approved change processes. Changes are tested, reviewed and approved before they are implemented.

During compliance activities, CNSC staff verified that changes are controlled and carried out as per OPG governance documentation and CNSC staff will continue to oversee the implementation of OPG changes on a risk informed basis.

Safety Culture

OPG's most recent safety culture self-assessment was a fleet-wide assessment at Pickering, Darlington and OPG waste management facilities in 2015.

OPG procedure N-PROC-AS-0077 *Nuclear Safety Culture Assessment*, describes the OPG process for safety culture self-assessments. This process includes several methods to collect data. For the 2015 self-assessment, a survey comprised of 81 questions based on the Institute of Nuclear Power Operations (INPO) "10 Traits of a Healthy Nuclear Safety Culture", was sent to all employees at Pickering and semi-structured interviews were conducted to supplement the survey. The results of the assessment were categorized as positive/negative observations (if seen locally) and strengths/weaknesses (if seen systemically).

CNSC staff reviewed the methodology and assessment results and determined that OPG's assessment process was consistent with their procedure and that actions were taken towards further improving the safety culture. OPG's next safety culture self-assessment is scheduled for 2018.

OPG has implemented a Nuclear Safety Culture Monitoring Panel (NSCMP) which follows guidance in the Nuclear Energy Institute 09-07 Rev 1 "Fostering a Healthy Nuclear Safety Culture". The purpose of the NSCMP is to track action items emanating from the self-assessments, as well as monitoring various metrics (e.g. OPEX, Performance trends, Station Condition Reports, CNSC inspections) that could reveal aspects of safety culture. NSCMP are held once per quarter and provide the opportunity to monitor changes in the nuclear safety culture traits between assessments to identify and take actions if necessary. CNSC staff support such monitoring activities and promote the use of self-assessments and monitoring activities for continual improvement.

Configuration Management

The OPG configuration management is an integrated management process that ensures that the physical and operational configuration and the documentation conform to the design and licensing basis requirements.

In March 2016, CNSC staff conducted an inspection of the OPG configuration management program and concluded that OPG was in compliance with all the regulatory requirements. CNSC staff also identified areas for improvement with regards to OPG's internal governance related to the documentation of temporary configuration change [35]. CNSC staff will continue to monitor OPG corrective actions through ongoing compliance verification activities.

Records Management

The OPG records management encompasses the control of documents and records. The OPG process for the control of documents includes the development, validation and approval of safety related documents. Documents are available for use at the location where the work is to be performed. Changes to documents are documented and tracked. The OPG process for the control of records ensures that records are readable, complete, identifiable, traceable, retrievable, preserved and retained as specified.

The OPG record management performance was satisfactory during the licence period. Implementation of records management was effective and continues to be monitored by CNSC staff as part of compliance verification activities.

OPG is planning to have a new records repository by the end of 2020. CNSC staff will review this upgrade to ensure it meets and the requirements of the standard CSA N286-12.

Management of Contractors

The OPG supply chain services are responsible for establishing and maintaining the OPG nuclear approved supplier list. The OPG process describes methods used to originate, request, evaluate, qualify, and maintain the qualification of suppliers of items and services required for Quality Assurance (QA) programs or other OPG nuclear quality requirements.

In 2014, CNSC staff conducted an inspection on the OPG supply management program and identified minor deficiencies with the qualification of suppliers. OPG implemented corrective actions to ensure that the qualification of contractors is appropriate for the scope of work in a contract to be awarded. CNSC staff were satisfied with OPG corrective actions and closed the action item.

In 2017, CNSC staff conducted another supply management inspection and concluded that OPG was in compliance with regulatory requirements. CNSC staff identified minor deficiencies with respect to the identification of technical requirements in OPG documentation and with the OPG review of the qualification of contractors and audit reports submitted by contractors [36]. CNSC staff will monitor the implementation of OPG's corrective actions through ongoing compliance verification activities.

Business Continuity

OPG has developed adequate contingency plans to maintain or restore critical safety and business functions in the event of disabling circumstances such as a pandemic, severe weather, or labour actions.

5.1.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.1.3.1 Past Performance

During the current license period, CNSC staff concluded that OPG's Management System met applicable regulatory requirements and CNSC performance objectives. OPG has made adequate provision to monitor and improve its management system and promote a healthy safety culture. On the basis of compliance oversight results and existing OPG commitments, CNSC staff are satisfied that OPG will continue to operate in a safe manner.

5.1.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's performance in this area through regulatory oversight activities, including follow up on open action items, onsite inspections and reviews of compliance reporting and of revisions to relevant OPG program documents. Staff will also monitor OPG's management of the increase in critical component inspections, maintenance and safety enhancements resulting from the IIP.

5.1.3.3 Proposed Improvements

OPG is planning to have a new records repository by the end of 2020. Once implemented, CNSC staff will review this upgrade to ensure it complies with CSA N286-12 requirements.

5.1.4 Conclusion

Based on CNSC staff assessments of the licence renewal application, supporting documents and past performance, CNSC staff conclude that OPG continues to maintain and implement a management system in accordance with CNSC regulatory requirements. OPG regularly assesses its management system to ensure the adequacy and effectiveness of its programs. OPG promotes a healthy safety culture and controls changes and documentation.

5.1.5 Recommendation

The following standard licence condition is included the proposed PROL:

- LC 1.1: The licensee shall implement and maintain a management system.

Compliance verification criteria are detailed in the proposed LCH.

5.2 Human Performance Management

The Human Performance Management SCA covers activities that enable effective human performance through the development and implementation of processes that ensure that a sufficient number of workers are in all relevant job areas and have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

The specific areas that comprise this SCA include:

- Human performance program
- Personnel training
- Personnel certification
- Initial certification examinations and requalification tests
- Work organization and job design
- Fitness for duty

5.2.1 Trends

The following table indicates the overall performance ratings for the Human Performance Management SCA over the current licence period:

TRENDS FOR HUMAN PERFORMANCE MANAGEMENT			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	SA	SA
Comments			
Pickering received a "Satisfactory" rating in this SCA throughout the licence period.			

SA = Satisfactory

5.2.2 Discussion

OPG has a sufficient number of qualified workers available in all relevant job areas and ensures that they have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties. OPG programs in the areas of human performance, personnel training, personnel certification, initial certification examination and requalification testing, work organization and job design and fitness for duty demonstrated continued satisfactory performance throughout the licence period.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Human Performance Program

A human performance program contains an organization's processes and procedures that support workers in carrying out their tasks to the desired levels of performance. The program considers and manages the factors that can influence human performance, such as the fitness for duty of workers (workers are physically and mentally capable of performing their duties competently and safely), training, staffing, procedures, processes and the design of equipment. A human performance program addresses the need for specific training, practice and rehearsal of emergency tasks, and gives consideration to how extreme conditions may influence human performance.

OPG's human performance program follows the INPO program process that relies on Event-Free Tools. During the license period, CNSC staff conducted a Type II inspection of the Pickering human performance program and concluded that Pickering has a human performance program that complies with the applicable requirements of CSA N286-05, *Management System Requirements for Nuclear Power Plants*. Recommendations were made with respect to how human performance implementation at Pickering could be improved. CNSC staff found that OPG is continuously making improvements to the program to ensure that the human performance program equips workers to conduct their activities safely.

Personnel Training

OPG has a well-documented and robust fleet-wide training system based on a systematic approach to training (SAT) that is compliant with CNSC requirements in REGDOC 2.2.2 *Personnel Training*.

Over the licence period, CNSC staff conducted four inspections and five desktop reviews of OPG training programs for different job families to verify that the SAT-based training system was adequately implemented at Pickering NGS. These compliance verification activities were performed for the following training programs:

- OPG Authorized Nuclear Operator;
- Pickering Radiation Protection Technician;
- OPG Engineering
- OPG Health Physicist/Responsible Health Physicist;
- OPG Maintenance;
- OPG Emergency Response Organization;
- OPG Shift Manager and Control Room Shift Supervisor;
- OPG Train-the-Trainer;
- OPG Non-Licensed Operators;

In all cases, CNSC staff concluded that the various training programs at Pickering were defined, designed, developed, evaluated and managed in accordance with the many processes and procedures that constitute the OPG SAT-based training system and that OPG met regulatory requirements. CNSC staff continue to closely monitor the performance of the licensee in this area through ongoing compliance activities.

Personnel Certification

The positions at the Pickering NGS that require certification by the CNSC are:

- The responsible health physicist;
- The authorized nuclear operator;
- The control room shift supervisor; and
- The shift manager.

To become a certified worker, a candidate must successfully complete the training program and certification examinations described in CNSC regulatory document RD-204 *Certification of Persons Working at Nuclear Power Plants*. The CNSC then certifies the candidates who meet these regulatory requirements and who have demonstrated their competence to safely perform the duties of a certified position. Once certified by the CNSC, certified staff undergoes continued training and requalification testing to ensure that they maintain the knowledge and skills to safely perform their duties.

Over the current licence period, CNSC staff's review of staffing reports for certified personnel and review of applications for initial certification and renewal of certification confirmed that certified workers possess the knowledge and skills required to perform their duties safely.

Initial Certification Examinations and Requalification Tests

The initial certification examination and requalification testing program for certified staff at Pickering NGS meets all regulatory requirements. As part of the personnel certification program to become a certified worker, trainees are required to complete initial certification examinations. OPG staff that are currently certified are required to complete requalification tests as part of the requirements to renew their certification.

CNSC staff administer the initial certification examinations and requalification tests for responsible health physicists and OPG is responsible for the administration of the certification examinations and requalification tests for all other certified staff.

Two compliance inspections of simulator-based certification examinations and one compliance inspection of simulator-based requalification testing were performed during the current licence period. These compliance verification activities concluded that the initial certification examination and requalification testing programs for all certified positions at Pickering 1-4 and 5-8 met the regulatory requirements.

Work Organization and Job Design

Minimum shift complement

Minimum Shift Complement (MSC) is a well-established concept that ensures that there is a sufficient minimum number of qualified staff, including certified staff, at the station at all times in case of a resource-intensive event.

In 2014, CNSC staff monitored an operations training exercise which was aimed at demonstrating the site's response to an event in which the main control room was uninhabitable. CNSC staff concluded that the response was satisfactory.

In August of 2014, OPG informed the CNSC that they intended to revise P-INS-09100-00003 *Pickering Minimum Shift Complement* to remove the position of stock keeper from the minimum shift complement. This decision was based on a human factors assessment of the shift complement stock keeper personnel required to respond to the most resource-limiting design basis accident scenario at Pickering. The assessment concluded that there is no requirement for specialized equipment for which a stock keeper has specialist knowledge or skills that cannot be transferred to other workgroups, and that needed equipment could be located outside of stores in cabinets or toolboxes. CNSC staff evaluated the human factors assessment and other documents provided by OPG and concluded that OPG's measures to ensure materials and tools remain accessible in the absence of the stock keeper are acceptable. The Pickering NGS LCH was revised to reflect the new minimum shift complement.

In May 2017, CNSC staff conducted a Type II inspection of the Pickering MSC program. The scope of the inspection encompassed all aspects of the MSC to verify availability of sufficient qualified staff at Pickering NGS. CNSC staff confirmed that OPG was in compliance with licence requirements and has processes and procedures in place to ensure the availability of a sufficient number of qualified staff. Opportunities for improvement were identified in the areas of accurate record-keeping, training qualifications for all staff in their work group and emergency response roles and reinforcing consistent behaviors in the use of the Minimum Complement Compliance Program electronic record [37]. OPG has provided a corrective action plan to address CNSC findings and staff are following up on its completion.

Fitness for Duty

Hours of work

As part of the strategy for managing worker fatigue, OPG has procedures that control the number of hours worked by workers who perform safety-sensitive work at Pickering NGS. Many of these workers are part of the minimum shift complement.

OPG has an hours of work process that ensures that workers don't work over 16 hours in a shift, have adequate time off to rest, and are monitored for signs of fatigue and other impairments. REGDOC 2.2.4 *Human Performance Management – Fitness for Duty: Managing Worker Fatigue*, was published in March 2017. The REGDOC establishes fatigue management programmatic measures applicable to a broad worker population as well as hours of work limits and shift schedules for safety-sensitive positions. OPG has committed to full implementation of the REGDOC by January 1, 2019 [38].

Staff performed a desk-top review in July 2017, to verify whether Pickering NGS complied with the requirements of REGDOC 3.1.1 *Reporting requirements for Nuclear Power Plants*, section 3.3 (5), which addresses non-compliances with the limits of hours of work by certified staff performing safety-related tasks or working on safety-related systems, for the year 2016. There were no non-compliances identified for Pickering NGS, however inaccuracies were found in OPG's reporting system [39]. For example, OPG does not have an auditable system in place to confirm compliance with the limits of hours of work as required by OPG internal governance. These findings were communicated to OPG and CNSC staff will monitor OPG's progress with resolution of this issue.

Fitness for duty

Pickering NGS currently has measures that address fitness for duty requirements for workers, including certified staff and nuclear security officers, as required under RD-204 *Certification of Persons Working at Nuclear Power Plants* and RD-363 *Nuclear Security Officer Medical, Physical, and Psychological Fitness,* respectively.

REGDOC 2.2.4 *Fitness for Duty Volume II: Managing Alcohol and Drug Use,* was approved by the Commission on November 9, 2017. This document sets out requirements and guidance for managing fitness for duty of workers in relation to alcohol and drug use at all high security sites. OPG has been requested to provide to CNSC staff with an implementation plan for REGDOC-2.2.4 Volume II, by March 31, 2018 [40].

5.2.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.2.3.1 Past Performance

OPG maintains programs in the area of human performance, personnel training, personnel certification, initial certification examination and requalification testing, work organization and job design and fitness for duty that meet regulatory requirements. These programs ensure that Pickering NGS has a sufficient number of qualified workers available in all relevant job areas and who have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

Pickering's performance in this SCA met requirements and regulatory expectations during the current licence period.

5.2.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's performance in this area through regulatory oversight activities, including follow up on open action items, onsite inspections and reviews of compliance reporting and revisions to relevant OPG program documents.

5.2.3.3 Proposed Improvements

OPG has committed to implement the following new standard:

- REGDOC-2.2.4 *Fitness for Duty: Managing Worker Fatigue*, by January 1, 2019

This standard has been included in the proposed LCH. CNSC staff will also include the implementation date for REGDOC-2.2.4 *Fitness for Duty Volume II: Managing Alcohol and Drug Use,* once OPG's implementation plan has been received.

CNSC staff will monitor OPG's progress in implementing these new standards.

5.2.4 Conclusion

Based on the CNSC staff's review of the licence renewal application, supporting documentation and past performance, CNSC staff conclude that OPG has implemented and maintains effective programs within the Human Performance Management SCA.

5.2.5 Recommendation

The following standard licence conditions are included the proposed PROL:

- LC 2.1: The licensee shall implement and maintain a human performance program
- LC 2.2: The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facility
- LC 2.3: The licensee shall implement and maintain training programs
- LC 2.4: The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document RD-204 *Certification of Persons Working a Nuclear Power Plants*

  Persons appointed to the following positions require certifications:

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

Compliance verification criteria are detailed in the proposed LCH.

5.3 Operating Performance

The Operating Performance SCA includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.

The specific areas that comprise this SCA include:

- Conduct of licensed activity;
- Procedures;
- Reporting and trending;
- Outage management performance;
- Safe operating envelope;
- Severe accident management and recovery; and
- Accident management and recovery.

5.3.1 Trends

The following table indicates the overall performance ratings for the Operating Performance SCA over the current licence period:

TRENDS FOR OPERATING PERFORMANCE			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	FS	FS
Comments			
OPG's performance was "Satisfactory" to "Fully Satisfactory" during the licence period.			

SA = Satisfactory, FS= Fully Satisfactory

5.3.2 Discussion

OPG maintains an effective operations program at Pickering NGS in accordance with regulatory requirements. OPG operates Pickering NGS in a safe and secure manner, with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Conduct of Licensed Activities

Operational activities at Pickering NGS are governed by the Operating Policies and Principles (OP&Ps), as referenced in the current licence and LCH. The OP&Ps state the operating boundaries within which the station may be operated safely and specify how OPG will operate, maintain and modify station systems while controlling risk to the public. CNSC staff conduct inspections and assessments of Pickering operations against the requirements of the OP&Ps and other applicable requirements and has concluded that the licensed activities are conducted safely at Pickering NGS.

One of the significant indicators pertinent to the conduct of licensed activities is the number of unplanned reactor transients and their causes and consequences. An unexpected transient or power change may indicate problems within the plant equipment and can place undesired strain on the plant process systems while responding to the transient. Unplanned transients include stepbacks (Pickering 5-8 only), setbacks and automatic reactor. CNSC staff assess OPG response to transients and the root cause investigations of events.

The number of unplanned transients from 2013 to 2017 is shown below.

Table 6: Unplanned transients reported for Pickering Units 1, 4 and 5-8

	2013		2014		2015		2016		2017[1]	
	Units 1,4	Units 5-8	Units 1,4	Units 5-8	Units 1,4	Units 5-8	Units 1,4	Units 5-8	Units 1,4	Units 5-8
Unplanned reactor trips	1	2	1	0	0	1	1	1	1	0
Stepbacks[2]	n/a	1	n/a	1	n/a	1	n/a	1	n/a	0
Setbacks	2	1	1	0	2	1	2	0	0	4
Total	3	4	2	1	2	3	3	2	1	4

[1] 2017 data is current to September 2017.
[2] Pickering Units 1, 4 do not have stepbacks as part of their design

CNSC staff followed up on all the licensee's assessments of the transients and concluded that OPG adhered to approved procedures, investigated or evaluated the root causes of the events and took appropriate corrective actions. Although unplanned transients place a burden on the plant and its operating staff, none of these resulted in an elevated risk.

As part of CNSC compliance and verification activities, field inspections are conducted on a routine basis and their findings are provided as quarterly compliance inspection reports to the licensee. CNSC staff have seen an improvement in OPG performance regarding the timely resolution of preliminary facts identified by CNSC during the field inspections. As a result, fewer enforcement actions have been necessary overall. Plant status control continues to be an area of focus for CNSC site inspectors, as a number of temporary changes (identified by status control tags) have been identified in recent field inspection reports. The most frequent findings were tags that had no or cancelled conditions for removal, and tags with missing, incorrect or out of date information. CNSC inspectors are following up through routine compliance verification activities.

Procedures

Procedures are essential for safe execution of authorized activities because they support and guide workers' interactions among themselves, with systems and responses to safety-related events. CNSC staff oversight in this Specific Area focuses on ensuring that the licensee has an adequate process for the development, verification, validation, implementation, modification and use of procedures, which takes into account human performance considerations, and that there are demonstrated mechanisms for ensuring and, where necessary, improving procedural adherence.

CNSC staff compliance verification activities have confirmed that OPG has mature and efficient governance in place to ensure that procedures are written in a consistent and usable manner. Pickering has clearly documented expectations for procedural use and adherence, and a process to manage procedural change.

In 2015, as part of an integrated evaluation of the Pickering severe accident management (SAM) program, CNSC staff performed an extensive desktop review of Pickering SAM documentation, including the SAM guidelines (SAMG) and guidelines for the use of emergency mitigating equipment (EME). While some recommendations for continuous improvement were identified, staff concluded that OPG has adequately developed and implemented a SAM program at Pickering. The Pickering emergency procedures including SAM and EME guidelines, have been verified and validated through large scale exercises, table top exercises and drills and demonstrated to be effective.

Reporting and Trending

During the licence period, OPG submitted reports for Pickering NGS in accordance with CNSC regulatory document S-99 *Reporting Requirements for Operating Nuclear Power Plants* and its successor, REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants*. REGDOC-3.1.1 superseded S-99 on January 1, 2015.

OPG followed up on all reportable events with corrective actions and root cause analyses when appropriate. CNSC staff informed the Commission of significant reportable events through event initial reports (see Appendix E.1 for additional information) or through the regular status updates on power reactors. For the 33 reportable events that required a detailed event report in 2017, 22 such reports were submitted on time. OPG issued 11 deferral notices to the CNSC since development and approval of corrective actions required additional time. These were events which required Apparent Cause Analysis or Root Cause Analysis and approval of the corrective action plan by the OPG Corrective Action Review Board. OPG has initiated effort to enhance the Corrective Action Review Board process to improve timeliness.

Outage Management Performance

In order to ensure that Pickering NGS remains fit for service, planned outages are planned and undertaken by the licensee to conduct maintenance, testing or inspections that cannot be performed when the reactor is at power.

The table below provides the number of planned maintenance outages at Pickering occurring between 2013 and 2017.

Table 7: Number of planned maintenance outages

Unit	2013	2014	2015	2016	2017
1	0	0	1	0	1
4	0	1	0	1	1
5	1	0	1	0	1
6	1	0	1	0	0
7	0	1	0	1	0
8	0	1	1	1	0

CNSC verification activities during planned maintenance outages include field inspections, interviewing licensee staff, observing licensee meetings, reviewing station condition records, assessment of relevant technical reports and participating in discussions of preliminary periodic inspection results. CNSC staff also verify that adequate provisions are established for reactivity control, heat sinks and radiation protection and that all work committed to the regulator is completed.

Overall, based on the CNSC staff oversight results, OPG executed planned outages safely and met regulatory requirements.

In addition to planned outages, OPG also undertook forced unplanned outages as required to fix or replace equipment. These outages and their outcomes were communicated to the Commission via Event Initial Reports (EIRs), status report on power reactors or the annual NPP Regulatory Oversight Report. Evidence indicates that OPG conducted these outages safely.

<u>Safe Operating Envelope</u>

A licensed NPP must be controlled in accordance with a set of operational safety requirements, supported by the safety analysis, within the boundaries of the “safe operating envelope” (SOE). The SOE is the set of limits and conditions within which the nuclear generating station must be operated, and which is monitored and controlled by the operator. The objective of the SOE is to ensure conformance with the safety analyses assumptions and results. OPG’s implementation of the SOE maintained the reactors operating in their analyzed states thereby ensuring adequate safety at all times.

OPG has implemented an SOE program at Pickering NGS in accordance with CSA standard N290.15, *Requirements for the Safe Operating Envelope of Nuclear*

Power Plants. The limits and conditions defined by the SOE are documented in Operational Safety Requirements (OSR) documents, including the associated Instrument Uncertainty Calculations (IUC) documents.

During the licence period, the Pickering's performance related to this area was satisfactory. CNSC staff will continue monitoring the licensee performance through regular compliance verification activities.

Severe Accident Management and Recovery

In 2015, as a follow up to the closure of FAIs 3.1.1 to 3.1.4 (related to finalization and implementation of SAMGs and demonstration of the effectiveness of SAMGs via table top exercise and drills), CNSC staff conducted an integrated evaluation of the Pickering SAM program, including a desktop review of the Pickering SAM documentation, interviews with site staff responsible for SAM, and observations of drills/exercises involving the use of SAM activities and EME. This regulatory evaluation concluded that OPG has implemented a robust SAM program in Pickering and continue to demonstrate the effectiveness of the SAM through regular drills and exercises.

The 2015 evaluation also identified a few areas that needed to be followed up as areas for improvement of the Pickering SAM program. In 2017, CNSC staff revisited some of these follow-up items, including a review of the computational aid for hydrogen source term estimation and a review of the Pickering filtered venting strategy in a severe accident. CNSC staff made recommendations for further strengthening of hydrogen monitoring provisions [41] and will continue to follow up with OPG through on-going compliance verification activities.

CNSC staff's review of COG report COG-JP-4534-02 *Final Report on CANDU Post-Fukushima Questions*, also identified a few areas for enhancement of SAM, including in-vessel retention, which is a key strategy for SAM for CANDU reactors. A letter was sent to OPG with the results of the CNSC review. In response to the CNSC letter, Industry provided a high level overview document describing COG research and development (R&D) work performed to date, as well as work in progress and work planned to specifically address the topics described in the CNSC letter. CNSC staff will continue to track and report, if necessary, on progress relevant to those topics.

While the ongoing R&D is important to reduce uncertainty, OPG has:

1. Installed hydrogen Passive Autocatalytic Recombiners (PARS) in all Pickering NGS units,
2. Completed Phase 1 EME to supply emergency make-up water to the steam generators, heat transport systems and calandria vessels, thus ensuring continuous fuel cooling and monitoring, and
3. Implemented SAMGs to guide plant staff on preventing and mitigating a beyond design basis accident (BDBA) progression to a severe accident.

In addition, as committed in the PSR IIP [24], OPG has scheduled to implement safety-enhancement modifications and design changes that ensure additional barriers exist to prevent a BDBA progressing to a severe accident and to mitigate the consequences if a severe accident occurs, specifically:

1. Completion of actions and modifications to make fire protection system water available to the steam generators, heat transport system and calandria,
2. Completion of actions to facilitate providing emergency power and cooling water to the air conditioning units in all reactor units, as well as emergency power to the hydrogen igniters, Filtered Air Discharge System (FADS); and
3. Completion of necessary power and support service connections required to restore the functionality of a main volume vacuum pump.

The IIP-committed modifications and provisions related to protecting the integrity of the containment to ensure controlled filtered venting are being implemented by OPG by June 2018 for physical changes and December 2018 for programmatic changes. However, emergency fire water cooling piping connection to Pickering Unit 1 will be completed during a planned 2020 outage, and the restoration of emergency power to one main volume vacuum pump will be completed by June 2019.

CNSC staff concur with OPG that the already implemented PARS, Phase 1 EME, and SAMGs; as well as the IIP scheduled actions and the provision of fire water to Pickering Units 1, 4 will further enhance safety by ensuring the existence of barriers to prevent a BDBA progression to a severe accident and to ensure the availability of options for controlled filtered post-accident venting.

Accident Management and Recovery

Licensees must have procedures capable of dealing with abnormal incidents as well as design basis accidents. CNSC staff is satisfied that OPG has a series of abnormal incident manual (AIMs) and emergency operating procedures (EOPs) at the Pickering NGS to detect abnormal conditions, mitigate causes of the incidents and accidents, return the plant to a safe and controlled state, and to prevent further escalation into a more serious accident. CNSC staff routinely perform verifications to ensure that up-to-date AIMs and EOPs are available to the operators, should they be required and that operators are trained in their use. CNSC staff are satisfied with the licensee's performance in this specific area.

5.3.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.3.3.1 Past Performance

During the licence period, OPG continued to implement and maintain an effective operations program at Pickering NGS in accordance with regulatory requirements. OPG operates Pickering NGS in a safe and secure manner, with adequate regard for health, safety, security, radiation and environmental protection and international obligations.

5.3.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's performance in this SCA through regulatory oversight activities including inspections and reviews of compliance reports and other licensee submissions.

5.3.3.3 Proposed Improvements

The PSR undertaken by OPG identifies scheduled modifications to ensure additional barriers exist to prevent a BDBA progressing to a severe accident. These include the provision of emergency cooling water to the steam generators, heat transport system and calandria; electric power and water to the reactor air cooling units and power to the hydrogen igniters and the Filtered Air Discharge System (FADS). Specific activities are documented in the PSR IIP. CNSC staff will maintain close oversight through review of completion of actions in the IIP.

5.3.4 Conclusion

Based on CNSC staff's assessments of OPG's licence application, supporting documents and past performance, CNSC staff conclude that OPG continues to implement and maintain an effective operations program at Pickering NGS in accordance with regulatory requirements of the Operating Performance SCA.

5.3.5 Recommendation

The following standard licence conditions are included the proposed PROL:

- LC 3.1: The licensee shall implement and maintain an operations program, which includes a set of operating limits.
- LC 3.2: The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or prior written consent of a person authorized by the Commission.
- LC 3.3: The licensee shall notify and report in accordance with CNSC regulatory document REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants*.

Compliance verification criteria are detailed in the proposed LCH.

5.4 Safety Analysis

The Safety Analysis SCA covers maintenance of the safety analyses that support the overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activities or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.

This CMD covers the following specific areas of the Safety Analysis SCA:

- Deterministic safety analysis;
- Probabilistic safety analysis;
- Hazard analysis;
- Criticality safety;
- Severe accident analysis; and
- Management of safety issues (including R&D programs).

5.4.1 Trends

The following table indicates the overall performance ratings for the Safety Analysis SCA during the current licence period:

TRENDS FOR SAFETY ANALYSIS			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	FS	FS
Comments			
Pickering received “Satisfactory” to “Fully Satisfactory” ratings.			

SA = Satisfactory, FS= Fully Satisfactory

5.4.2 Discussion

OPG has implemented and maintains safety analysis programs at Pickering NGS in accordance with regulatory requirements. The CNSC requires OPG to conduct safety analyses for the Pickering NGS to demonstrate that the station meets relevant safety requirements and the design continues to provide adequate prevention and mitigation to protect against accidents. CNSC staff reviewed a number of submissions related to the different aspects of safety analysis during the current licence period and no issues of major concern were identified.

Details pertaining to the most significant reviews within the specific areas in this SCA are presented in the following subsections.

Deterministic Safety Analysis

Pickering NGS has an effective, well-managed program for performing deterministic safety analysis. CNSC staff determined that the Pickering safety analysis predicts adequate safety margins and meets the CNSC acceptance criteria for safe operation. Overall, performance by OPG has been acceptable and a high level of safety has been demonstrated.

Implementation of REGDOC-2.4.1 Deterministic Safety Analysis

In October 2014, OPG submitted its implementation plan for REGDOC-2.4.1 *Deterministic Safety Analysis,* which identified the REGDOC-2.4.1 compliant analyses that would be undertaken in the 2014-2017 timeframe. The plan included the methodology development and conduct of analysis for common mode events (CME), as this represented the single largest gap in the Pickering Safety Reports with respect to REGDOC-2.4.1.

In August of 2016, OPG submitted the Pickering CME identification and classification report and the technical basis document for CME analysis. CNSC staff have reviewed this submission and provided comments. OPG completed the CME analysis and submitted the results in December of 2017.

OPG has provided a revised REGDOC-2.4.1 implementation plan for work to be undertaken from 2018-2021, based on a risk informed approach. CNSC staff have determined that the existing deterministic safety analyses remain adequate during the continued implementation of REGDOC-2.4.1.

Safety report update

The Pickering NGS Safety Report was revised to include the CME analysis and submitted to the CNSC in December 2017. CNSC staff will review the CME analysis results in 2018. OPG is expected to address CNSC staff comments on the CME analysis through the Safety Report update process.

Impact of standing flame in containment

The impact of a standing flame in containment has been recognized as a potential safety concern. During a postulated loss of coolant accident (LOCA) with impairment of the emergency core cooling system in a CANDU reactor, a break in the primary heat transport system can cause the release of hydrogen-steam mixtures into containment. The hydrogen-steam mixture can ignite at the break if its temperature is sufficiently high or if there is an ignition source in the vicinity, and create a standing flame.

In 2016, OPG submitted their assessment of the impact of standing flames on critical equipment at Pickering NGS. In February 2017, CNSC staff determined that OPG adequately addressed issues related to hydrogen behaviour in containment and that the impact of standing flames and multiple hydrogen burns on equipment is inconsequential for design basis accident. CNSC staff recommended that OPG incorporate this assessment in the next safety report update.

Neutron overpower protection trip setpoints

Neutron overpower protection (NOP) trips are designed to protect against a loss of reactor power regulation in a CANDU reactor by tripping (shutting down) the reactor. The design basis accident used to derive the NOP trip setpoint is a slow loss of regulation event.

In 2015, OPG submitted NOP trip setpoints based on a new Enhanced NOP (E-NOP) Extreme Value Statistics methodology.

E-NOP was developed to address the impact of aging (which was not covered in the original design analysis), to demonstrate that the installed trip setpoints remain adequate under aging conditions and, therefore, no physical corrective measures, are necessary.

In 2016, CNSC accepted the use of the new methodology for compliance purpose [42]. CNSC staff agree with OPG that the NOP system safeguards Pickering 1, 4 and 5-8 units against all power transients, including the most limiting slow loss of regulation events.

Impact of aging on the safety analysis margins

As the reactor core ages, aging of various structures, systems and components (SSCs) have an impact on the overall safety case of the NPPs. OPG has an aging management program in place that includes systematic monitoring of aging-related parameters important to safety analysis and assessment of the impact of the change in core conditions on existing safety margins.

Presently, Pickering 1, 4 and 5-8 units operate at full power with adequate safety margins. In 2015, OPG submitted the safety analysis for the impact of aging on safety margins for small LOCA, Loss of Regulation and Loss of Flow for reactor operation until January 2019 for Pickering 1, 4 and until June 2019 for Pickering 5-8, demonstrating that the safety systems remain effective with adequate margins. CNSC staff were satisfied with OPG’s safety case and agreed that there is an adequate safety margin. To reflect the changing conditions of the plant systems, OPG will perform and submit updated safety analyses to support continued operation to 2024 as part of the IIP resulting from the PSR.

Large LOCA safety margins

For addressing the large LOCA safety analysis margin issue, OPG has initiated a two-step plan: application of a “more realistic implementation of the limit of operating envelope (LOE) methodology” for the short term and the use of a Composite Analytical Approach (CAA) for the long term.

In July 2016, OPG submitted a work plan to complete a large LOCA licensing analysis for Darlington reactors using the newly proposed more realistic LOE methodology to demonstrate quantitatively that the large LOCA safety analysis margins are greater than represented in the current analysis of record. Upon completion of the analysis for Darlington, OPG will utilize the same approach for updating the large LOCA analysis for Pickering units.

CNSC staff review found that at the conceptual level, the proposed methodology is compliant with REGDOC-2.4.1 requirements [43]. Staff identified several areas in which further clarification is needed, including the derived acceptance criteria, analysis scope, and analysis methodology and assumptions. OPG provided responses to CNSC questions and comments and these responses are currently under CNSC review.

The CAA is a new analytical approach and its development is an industry-wide effort. CNSC staff will review OPG's application of the CAA once OPG submits its proposal.

CNSC staff continue to review all OPG large LOCA submissions through normal compliance activities. The licensing basis of the Pickering operating reactors for large LOCA scenarios will continue to be based on the traditional conservative safety analysis until the more realistic implementation of the LOE methodology and the CAA are accepted by CNSC staff.

OPG currently complies with CSA N286.7-99 *Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants* (reaffirmed 2012), and will fully implement the 2016 edition of this standard (N286.7-16) by September 1, 2018.

Probabilistic Safety Assessment

Probabilistic safety analysis (PSA) provides a comprehensive, structured approach to identifying accident scenarios and deriving numerical estimates of the likelihood of various scenarios and their consequences. The main benefit of PSA is to provide insights into plant design and operation, including the identification of dominant risk contributors and safety improvement opportunities, and the comparison of options for reducing risk. PSA is used in a complementary manner to the traditional deterministic safety analysis and defence-in-depth considerations.

CNSC found that OPG's performance in the PSA area at Pickering met regulatory requirements during the current licence period.

Compliance with S-294Probabilistic Safety Assessment for Nuclear Power Plants

In the previous licence periods for Pickering NGS 1, 4 (2010 – 2013) and Pickering NGS 5-8 (2008-2013).[2], OPG was required to implement CNSC Regulatory Standard S-294 *Probabilistic Safety Assessment for Nuclear Power Plants*.

OPG completed S-294-compliant full scope PSAs for Pickering NGS 1, 4 and Pickering NGS 5-8 by 2014 and 2012 respectively, using the CNSC staff accepted PSA methodologies. The Pickering 1, 4 and Pickering 5-8 PSAs included Level 1 and Level 2 PSAs for internal and external events (seismic, high winds, internal fires, internal floods and other hazards) for both at-power and shutdown states.

[2] Prior to 2013, Pickering NGS 1, 4 and Pickering NGS 5-8 had separate operating licences.

PSA updates

As requested by the Commission after the Part 2 Hearing for the Pickering NGS licence renewal in 2013, OPG updated both the Pickering NGS 1, 4 and Pickering NGS 5-8 PSAs to account for the enhancements required under the Fukushima Action Plan (see [13] for additional details). OPG has used the results and insights of the updated PSAs to identify and optimize risk improvement tasks.

In 2017, OPG submitted a S-294-compliant full scope PSA update for Pickering NGS 5-8, and will submit a S-294-compliant full scope PSA update for Pickering NGS 1, 4 by the end of 2018.

REGDOC 2.4.2 implementation

In 2015, OPG provided a plan for PSA updates to meet the requirements established by REGDOC-2.4.2 *Probabilistic Safety Assessment (PSA) for Nuclear Power Plants.* REGDOC-2.4.2 introduces new requirements (i.e. considerations of other radioactive sources, including the irradiated fuel bay and multi-unit impacts). OPG plans to fully implement REGDOC-2.4.2 at Pickering NGS by the end of 2020. CNSC staff are satisfied with OPG’s transition plan and will continue to monitor the implementation of REGDOC-2.4.2.

Hazard Analysis:

Hazard Analysis is used to demonstrate the adequacy of the facility design to withstand external and internal hazards. It is usually performed during the site selection and the design stage of the plant. The reassessment of hazard is also conducted either through PSR or through a specific situation (e.g. as part of the Fukushima Action Plan).

In 2012, OPG conducted a reassessment of internal and external hazards for both Pickering Unit 1, 4 and Pickering 5-8 through the S-294 compliance project. The project included the internal and external hazard screening analysis, PSA for seismic events, internal fires, internal floods and high winds.

During the current licence period, OPG addressed CNSC FAI 2.1.1 and FAI 2.1.2, which required the re-assessment of site-specific extreme external hazards and the assessment of plant capability to withstand the challenges posed by extreme external hazards. In 2014, OPG completed FAI actions 2.1.1 and 2.1.2, including the completion of separate assessments for seismically-induced fires and floods for Pickering Unit 1, 4 and for Pickering Unit 5-8.

OPG also updated the Internal Screening Analysis methodology in 2016, which was accepted by CNSC staff. In 2017, OPG submitted the PSA update for Pickering Unit 5-8. This submission includes the hazard screening analysis, PSA updates for internal fires, internal floods, seismic events and high winds. CNSC staff review of OPG’s 2017 Pickering Unit 5-8 PSA is in progress and will be completed in Q2 of 2018.

CNSC staff are satisfied with OPG’s activities during the current licence period, within the hazard analysis specific area.

In the next licence period, as part of the 5-year PSA update for Pickering Units 1, 4, OPG will submit the hazard analysis, screening analysis and PSA updates for internal fires, internal floods, seismic events and high winds.

Fire safety assessment

During the licence period, OPG revised its fire safety assessment which includes a Fire Hazard Assessment (FHA) and Fire Safe Shutdown Analysis (FSSA) to reflect the current plant configuration. The updated fire safety assessments were performed in accordance with CSA N293-12 *Fire Protection for Nuclear Power Plants*, and industry best practices.

The FHA concludes that the station is provided with effective measures to mitigate the fire hazards present and maintain the fire, life and nuclear safety objectives. The FSSA concluded that the station has the capability to safely shutdown in the event of a fire.

CNSC staff's review concluded that OPG's FHA and FSSA for the Pickering NGS complied with the fire safety assessment requirements of CSA N293-12.

Criticality Safety

Criticality safety focuses on the prevention of the criticality of fuel outside of the core, for both new and irradiated fuel. Pickering NGS reactors use natural uranium fuel which cannot achieve a criticality in air or in light water. New fuel is stored in such a manner that it 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 of Pickering NGS.

Severe Accident Analysis

REGDOC-2.4.1 requires performance of deterministic BDBA/severe accident analysis to support the evaluation of safety goals (Level 2 PSA) and demonstrate that the procedures/guidelines and equipment put in place can handle the severe accident management needs.

REGDOC-2.4.2 requires that assessments of severe accidents be included as part of the Level 2 PSA.

All SAMG-related FAI for Pickering are now closed. See section 6.7 for additional details regarding FAI. See also section 5.3 for discussion about severe accident management and recovery and section 6.10.6 for discussion on enhancements to protect containment during postulated progression of severe accidents.

In 2015, OPG in cooperation with Bruce Power successfully completed a severe accident software simulator solution (SASS) project to verify the multi-unit severe accident modeling methodology of the MAAP-CANDU severe accident computer code used in the current severe accident analyses. CNSC staff have reviewed the reports from the SASS project and have provided recommendations to the Industry.

Management of Safety Issues (including R&D programs)

Research and development programs

During the current licence period, CNSC staff continued to undertake systematic evaluations of the OPG R&D program activities, as submitted to CNSC staff through annual reporting in accordance with REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants*. These evaluations confirm that OPG maintains or has access to a robust R&D capability to address any emerging issues.

The following are highlights of two R&D projects that are currently ongoing.

- Moderator subcooling requirements methodology

  OPG submitted the conclusion of the review by a Safety Analysis Issue Review Panel of experimental results from the CNSC-sponsored Calandria-Tube Strain Contact Boiling project. CNSC staff issued an interim report summarizing the results of the experiments and an evaluation of the results [44, 45]. OPG plans to address the outstanding issues over the next licence period. This issue is considered to be of low safety significance as it only affects safety margins during postulated accidents of a low probability of occurrence.

- Moderator temperature predictions

  The accurate prediction of the moderator temperature is important for several design basis accident analyses. The original work completed on moderator temperature predictions did not consider in detail the moderator nozzle configuration specific for Pickering Units 1, 4. OPG recently completed several initiatives to address CNSC staff's concerns including the conduct of analyses and experiments representing the specific geometries of the moderator inlet nozzles for Pickering Units 1, 4. Further experimental work is currently underway at McMaster University. CNSC staff will review the experimental results when they become available. This issue is considered to be of low safety significance as the issue deals with the uncertainties in analyses using the overall robust models.

CANDU safety issues

OPG has been participating in the resolution of CANDU Safety Issues (CSIs). These issues are categorized according to their safety significance categories as Category 1, 2 or 3, as shown in the table below. The categories reflect the degree of uncertainty associated with the issue.

Category	Meaning
1	The issue has been satisfactorily addressed in Canada.
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.
3	The issue is a concern in Canada. Measures are in place to maintain safety margins, but further experiments and/or analyses are required to improve knowledge and understanding of the issue, and to confirm the adequacy of the measures.

In August 2016, CNSC staff presented in CMD 16-M34, a technical briefing to the Commission describing the approach taken to assess the current status of design and analysis of safety improvement initiatives [46]. Following this presentation, several intervenors questioned the basis for categorization and re-categorization of CSIs and provided detailed comments on topics such as total loss of alternating current power, fire protection, fuel channels, hydrogen control and HTS relief capacity.

In March 2017, CNSC staff provided the basis for re-categorization of Category 3 CSIs in CMD 17-M12 [47]. CNSC staff also described the systematic and rigorous process that was followed for the re-categorization of the Category 3 CSIs.

After examining the contents regarding the CSIs and with consideration to the information provided by licensees and CNSC staff, the Commission confirmed CNSC staff’s categorization of the CSIs.

The CNSC continues to monitor OPG’s management of CSIs to ensure timely and effective implementation of plant specific safety improvement initiatives and risk control measures. There are currently four Category 3 CSI that remain open for Pickering NGS. These are:

- AA9 - analysis for void reactivity coefficient;
- PF9 - fuel behaviour in high temperature transients;
- PF10 - fuel behaviour in power pulse transients; and
- IH6 - need for systematic assessment of high energy line break effects.

The first three are interconnected and related to the adequacy of the knowledge base to support the evaluation of Large LOCA safety margins. Control measures are in place to maintain safety margins, but further experiments and/or analysis are required to improve knowledge and understanding of the issues and to confirm the adequacy of the safety margins. The licensees proposed an approach to address the Large LOCA-related issues (see discussion above under “Deterministic safety analysis”) and a pilot project demonstrated that this approach is a viable solution to realistically predict Large LOCA safety margins. Further confirmatory research and analysis are ongoing.

The fourth Category 3 issue for Pickering is related to systematic assessment of dynamic and environmental effects in the event of high energy pipeline breaks inside containment and the consequences to plant safety. These pipes contain fluids operating at high temperature and pressure. In the event of a high energy pipe break, energy is released which, if unmitigated, could lead to damage of safety systems, equipment and structures. This issue for Pickering Units 1, 4 remains as Category 3 pending completion by OPG of a leak-before-break analysis, which is expected in Q3 of 2018. CNSC staff are satisfied with this timeline. For Pickering Units 5-8 OPG has requested re-categorization to Category 2 based on an assessment, which is currently under review by CNSC staff. CNSC staff plan to undertake an inspection on site to support regulatory evaluation of the safety provisions in place. CNSC staff target completion of the review by Q3 of 2018.

CNSC staff are satisfied with the OPG’s progress on Category 3 CSIs. There is no safety concerns related to their status and the progress made to address them. The regulatory position and path forward for addressing these Category 3 CANDU Safety Issues are well established. The safety case for facilities remains valid and adequate provisions for safety are in place.

Work is ongoing for Category 2 issue AA3, “Computer Code and Plant Model Validation”. OPG submitted COG guidelines on code validation and code accuracy assessment, which CNSC staff reviewed and concluded that the code validation process adheres to the majority of the requirements in REGDOC-2.4.1. However, CNSC staff identified minor deficiencies in the submitted guidelines which require clarification or modification [48]. CNSC staff will continue to follow up on OPG’s progress on this issue through normal compliance verification activities.

With regards to issue PF12 “Channel Voiding during a Large Loss of Coolant Accident”, significant work was completed, supported by an extensive experimental program in the RD14M facility at Whiteshell Nuclear Laboratories. This work was complemented by demonstration of relevance of the facility to CANDU geometry via performing a complex scaling analysis. CNSC staff reviewed all submitted information and concluded that there was sufficient information to close the GAI and to re-categorize PF12 to Category 1.

CNSC staff will continue to provide the Commission with the status of Category 3 CSI issues in the annual NPP Regulatory Oversight Report.

5.4.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.4.3.1 Past Performance

OPG has implemented and maintains safety analysis programs at Pickering NGS in accordance with regulatory requirements. CNSC staff reviewed a number of safety analysis-related submissions during the current licence period and no issues of major concern were identified. OPG's performance within the specific areas of this SCA met or exceeded requirements and CNSC expectations during the licence period.

5.4.3.2 Regulatory Focus

OPG's revised REGDOC-2.4.1 implementation plan identifies additional practical activities to be undertaken from 2018-2021, to foster compliance with the requirements of REGDOC-2.4.1. CNSC staff will continue to review all related submissions to verify compliance with REGDOC-2.4.1 requirements.

In addition, OPG will continue implementing REGDOC-2.4.2, and plans to fully implement the REGDOC by the end of 2020. CNSC staff will continue to monitor OPG's progress transitioning from S-294 to REGDOC-2.4.2.

5.4.3.3 Proposed Improvements

OPG currently complies with CSA N286.7-99 *Quality Assurance of Analytical, Scientific and Design Computer Programs for Nuclear Power Plants* (reaffirmed 2012), and will fully implement the 2016 edition of this standard (N286.7-16) by September 1, 2018.

Major safety analysis activities committed in the PSR IIP include the following:

- Completing the safety analyses of Small Break Loss of Coolant Accident (SBLOCA), Loss of Flow and Neutron Overpower (NOP) to account for the impact of fuel channel aging and submit for CNSC staff review.
- Connecting the Pickering NGS firewater system to the Pickering Unit 1, 4 steam generators, heat transport system and calandria, to achieve further risk reduction as predicted by PSA.

CNSC staff concur with OPG that these upgrades for Pickering Units 1, 4 would ensure continuous post-severe accident fuel cooling and will reduce the estimated frequency of large release to be closer to OPG PSA Administrative Safety Goals (1.00E-06/year) – which is equal to the safety goal for new builds described in REGDOC-2.5.2 *Design of Reactor Facilities: Nuclear Power Plants*. CNSC staff will maintain close oversight through review of completion of IIP actions.

5.4.4 Conclusion

OPG maintains an effective safety analysis program at Pickering NGS that meets or exceeds regulatory requirements and expectations and supports the overall safety case for the facility.

5.4.5 Recommendation

The following standard licence condition is included the proposed PROL:

- LC 4.1: The licensee shall implement and maintain a safety analysis program.

Compliance verification criteria are detailed in the proposed LCH.

5.5 Physical Design

The Physical Design SCA relates to activities that impact the ability of structures, systems and components to meet and maintain their design basis given new information arising over time and taking changes in the external environment into account.

The specific areas that comprise this SCA include:

- Design governance;
- Site characterization;
- Facility design;
- Structure design;
- System design; and
- Component design.

5.5.1 Trends

The following table indicates the overall performance rations for the Physical Design SCA over the current licence period:

TRENDS FOR PHYSICAL DESIGN			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	SA	SA
Comments			
Pickering received a “Satisfactory” rating throughout the licence period.			

SA = Satisfactory

5.5.2 Discussion

OPG maintains design programs under the Physical Design SCA in accordance with applicable standards.

Over the current licence period, OPG met the regulatory requirements and performance objectives. There are no safety significant outstanding issues within this SCA for Pickering.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Design Governance

Design program

OPG has a design management program that covers changes to systems, structures, components, software and engineering tools. This program describes the interrelationship between interfacing engineering program and documentation.

CNSC staff monitor the design management program through regular compliance verification activities and desktop reviews.

Pressure boundary program

OPG has a mature, well-developed pressure boundary program that is comprised of many sub-programs, processes and procedures to ensure compliance with the requirements of CSA N285.0 *General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants*, as well as other relevant requirements. As required by the PROL, OPG has a formal service agreement with the Technical Standards and Safety Authority (TSSA) as the Authorized Inspection Agency (AIA).

CNSC staff conducted a Type II pressure boundary inspection in 2014 to verify compliance with the PROL on the implementation of the pressure boundary program processes for system code classification, reconciliation and registration, as well as the AIA service agreement. The inspection team identified good practices as well as some non-compliances related to the identification of legacy pressure boundary systems, timely completion of tests and adherence to the AIA service agreement [49]. These issues were assessed to be of low risk significance. CNSC staff are satisfied with OPG's progress in addressing these issues and will continue to follow up with OPG on the remaining corrective actions.

On the basis of regulatory oversight activities including inspections and document reviews, CNSC staff concluded that OPG's pressure boundary program is in compliance with the regulatory requirements. OPG continues to implement a comprehensive pressure boundary program and maintains a formal agreement with an AIA.

Human factors in design

OPG's Engineering Change Control process is well-established and ensures that human factors are considered in design.

The design process incorporates human factors principles and practices to ensure that installed structures, systems and components (SSCs) meet the design and licensing basis, as well as remain within the safe operating envelope. In December 2014, CSA standard, N290.12-14, *Human Factors in Design for Nuclear Power Plants*, was published. This standard is intended to work in conjunction with N286-12 *Management System Requirements for Nuclear Power Plants*, and reflects the operating experience of Canadian NPPs. As part of their licence application, OPG determined they would be in compliance with N290.12-14 by the end of 2017. This standard has been added as compliance verification criteria in the proposed LCH.

Environmental qualification

Pickering NGS's environmental qualification program ensures all required SSC are capable of performing designated safety functions in a harsh environment that could result from design basis accidents.

OPG is required to maintain an environmental qualification program in accordance with CSA N290.13 *Environmental Qualification of Equipment for CANDU Nuclear Power Plants*, and OPG's own governing documents to ensure equipment remains qualified for the life of the station. During the licence period, CNSC staff conducted two Type II inspections of the environmental qualification program at Pickering NGS. In both cases, staff concluded that the program met regulatory requirements.

To support operation beyond 2020, OPG is conducting under one action of the IIP, an evaluation of existing environmental qualification assessments for life-limited components. The results of this evaluation will be documented and addressed by OPG through their environmental qualification program. This information will be submitted to the CNSC no later than December 2019, for staff evaluation and assessment.

Site Characterization

There are currently no ongoing actions identified as a result of regulatory oversight activities or requests from the Commission in this specific area.

Facility Design and Structure Design

Facility design and structure design pertains to the overall adequacy of the design of the facility and structures. The licensee must ensure that changes to any aspects of design do not lead to non-conformance with the licensing basis. CNSC staff review changes against established criteria to ensure that they do not invalidate the limits or introduce hazards that are different in nature from those previously considered. CNSC staff conclude the Pickering NGS facility design and structure design meet regulatory requirements.

System Design

Conclusions from several regulatory evaluations undertaken during the licence period are provided below.

Electrical power systems

During the licence period, CNSC staff performed electrical power system inspections at both Pickering 1, 4 and 5-8 and concluded that OPG is maintaining the health of the electrical power systems at Pickering NGS. There are no significant safety concerns with the electrical power systems at Pickering NGS.

Instrumentation and control

In response to CNSC staff requests, OPG provided information regarding the aging management of instrumentation and control (I&C) equipment at Pickering NGS. OPG has addressed aging management through the execution of the Pickering NGS Instrumentation and Control Obsolescence Project. The intent of the project was to provide recommendations for a cost effective strategy for dealing with the risks associated with obsolete I&C equipment. The OPG report provides a summary of recommended replacement components and replacement engineering change strategies for controllers in Pickering.

In addition, all digital controllers in OPG's Master Equipment List (MEL) are subject to the Aging Management scoping and screening process. For each digital controller in the MEL, this process determines whether a Detailed Condition Assessment report will be developed. Any equipment with identified obsolescence recommendations is managed through OPG's Obsolescence Management Process, N-STD-MA-0024. For equipment for which a Detailed Condition Assessment report was not prepared, a Screening Condition Assessment report has been issued to document the rationale for exclusion.

For example, to support the station to the end of Extended Operating Life, a number of projects were completed or are underway to deal with the obsolescence and aging of digital control computer (DCC) equipment such as:

- Replacement of DCC power supplies;
- Refurbishment of display system computer;
- Replacement of DCC core memory boards; and
- Replacement of DCC output cards.

OPG has recently initiated a DCC modernization project and working with CANDU Owners Group (COG) has selected a suitable replacement for the DCC computers.

CNSC staff will continue to review this information and follow up with OPG as required as part of ongoing compliance verification activities.

Instrument air system

Based on the results of compliance activities, CNSC staff determined there are no major issues with the Instrument Air System at Pickering NGS.

Fire protection design

OPG has carried out a code compliance review of the Pickering NGS for compliance with CSA N293-07 *Fire Protection for Nuclear Power Plants,* as well as key standards referenced therein such as the *National Building Code of Canada*, *National Fire Code of Canada,* and associated National Fire Protection Association standards. CNSC staff concluded that the code compliance review performed for Pickering NGS demonstrated that Pickering NGS is in compliance with the requirements of CSA N293-07.

OPG continue to submit third party reviews of proposed modifications with the potential to impact protection from fire. The submission of the third party reviews provides evidence to CNSC staff that the compliance criteria for modifications are being met. CNSC staff have performed desktop reviews of the third party reviews and found that they meet regulatory requirements.

During the current licence period CNSC staff also performed a Type II inspection of the Pickering fire water and fire alarm systems monitoring program. The inspection team concluded that OPG met regulatory requirements with the exception of a minor non-compliance with an OPG governing document. OPG has addressed this finding to the satisfaction of CNSC staff.

Component Design

Cables

As a result of a Type II inspection performed at Pickering Units 5-8 in 2015, CNSC staff concluded that the cable management program at Pickering met the applicable regulatory requirements.

Fuel design

OPG has a well-developed fuel inspection and monitoring program. Fuel performance at Pickering has been acceptable over the existing licence period, with the fuel defect rate being below the target of one bundle per unit per year. Although Pickering Unit 1 experienced a higher than normal rate of oxide formation on the fuel during the current licence period, OPG's fuel program was able to safely manage the issue and implement corrective actions that appear to have been successful. Therefore, CNSC staff considers that the OPG fuel program is satisfactory and that OPG is able to adequately manage fuel performance issues while maintaining safe operations.

5.5.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.5.3.1 Past Performance

Over the current licence period, OPG met the regulatory requirements and performance objectives within the Physical Design SCA. CNSC staff found the implementation of the design programs to be satisfactory. Fuel usage remained safe for all units and fuel performance met requirements.

5.5.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's compliance with regulatory requirements through regulatory oversight activities including onsite inspections and reviews of compliance reports and of revisions to relevant program documentation. CNSC staff will, in particular, monitor design modifications done to address effects of ageing and to implement risk improvement measures.

5.5.3.3 Proposed Improvements

OPG has committed to implement the following new and updated standards:

- CSA N290.12-14 *Human Factors in Design for Nuclear Power Plants*, by September 1, 2018.
- CSA N285.0-12 (Annex N) *General Requirements for Pressure-Retaining Systems and Components in CANDU Nuclear Power Plants*, by September 1, 2018

CNSC staff will confirm OPG compliance with these standards through compliance verification activities.

A relevant IIP activity is to confirm that the seismic capacity of the fuel basket staking arrangement in the irradiated fuel bays will be maintained for the extended period of operation. CNSC staff will maintain oversight through review of completion of IIP actions.

5.5.4 Conclusion

Based on the CNSC staff's review of the licence renewal application, supporting documentation and past performance, CNSC staff conclude that OPG's design programs are effectively implemented and comply with regulatory requirements.

5.5.5 Recommendation

The following standard licence conditions are included the proposed PROL:

- LC 5.1: The licensee shall implement and maintain a design program.
- LC 5.2: The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency
- LC 5.3: The licensee shall implement and maintain an equipment and structure qualification program.

Compliance verification criteria are detailed in the proposed LCH.

5.6 Fitness for Service

The Fitness for Service SCA covers activities that impact the physical condition of structures, systems and components to ensure that they remain effective over time. This area includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.

The specific areas that comprise this SCA include:

- Equipment fitness for service / equipment performance (reliability);
- Maintenance;
- Structural integrity;
- Aging management;
- Chemistry control; and
- Periodic inspection and testing.

5.6.1 Trends

The following table indicates the overall performance ratings for the Fitness for Service SCA during the current licence period:

TRENDS FOR FITNESS FOR SERVICE			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	SA	SA
Comments			
Pickering received “Satisfactory” ratings throughout the licence period			

SA = Satisfactory

5.6.2 Discussion

OPG implements and maintains programs for the fitness for service of structures, systems, and components (SSCs) at Pickering, in accordance with the regulatory requirements contained in the PROL and LCH. Details pertaining to the specific areas within this SCA are presented in the following subsections.

Equipment Fitness for Service / Equipment Performance (Reliability)

CNSC staff have determined that the overall equipment fitness for service and performance at Pickering NGS is satisfactory and meets regulatory requirements. OPG has programs in place to manage the impact of aging on equipment and provide condition monitoring of systems through safety systems tests, inspections, assessments and review of operating experience (OPEX). System and component health reports are produced quarterly and include items such as equipment function failures, maintenance backlogs, as well as aging and obsolescence issues.

During the licence period, the Service Water System for Pickering Units 1, 4 experienced performance issues. Over the years, OPG has issued several Station Condition Records documenting the unavailability of Units 1, 4 Emergency Low Pressure Service Water (ELPSW) and Emergency High Pressure Service Water (EHPSW) pumps. These pumps are part of the Systems Important to Safety. The unavailability was caused by clogging of the strainers in the lube water supply line to the bearings and mechanical seal of the pumps. OPG evaluated several options to resolve these issues and improve the availability of ELPSW and EHPSW pumps. If both ELPSW pumps lubricating water supply strainers are clogged then the ELPSW system does not meet the design intent. The same is applicable to EHPSW system.

The option chosen was a modification to the design of the ELPSW and EHPSW pumps to eliminate the external water supply requirements for the bearing and seals, similar to the existing pumps in Units 5-8. In the modified configuration, the pumps have no mechanical seal and gland packing is installed. The modified pumps were tested at the Original Equipment Manufacturer (OEM) facility and the test run was successful.

The modified pumps were installed in Unit 1-4. However, the pumps failed again due to insufficient gland leakage. Minimal gland leakage ensures sufficient flow of water for the bearing lubrication and gland cooling. At the OEM facility the pump test run was successful because filtered water was used instead of lake water. OPG’s investigation also found additional issues requiring corrective actions. In order to have high confidence that these modified pumps are fully operable, one of the EHPSW pump was test run for 72 hours at Pickering NGS in lake water conditions. The pump test run was successful and the pumps were declared fully available for service. CNSC staff witnessed the test run and are satisfied that no further regulatory follow-up is required.

Reliability

In accordance with CNSC regulatory standard RD/GD-98 *Reliability Program for Nuclear Power Plants*, OPG maintains a reliability program for Units 1, 4 and 5-8. This program includes setting reliability targets, performing reliability assessments, testing and monitoring, and reporting for plant systems whose failure increases the likelihood of a release of radioactive or hazardous material.

OPG’s governance document N-PROG-RA-0016 *Risk and Reliability Program* references lower tiered documentation describing the detailed processes for the development and implementation of the reliability program.

OPG has identified the Systems Important to Safety (SIS) and established reliability targets for these systems. In the next licence period, it is expected that OPG will update the SIS lists based on the new results of the Pickering 1, 4 and Pickering 5-8 PSA updates which are scheduled to be completed by the end of 2018 and 2017, respectively.

The Pickering Annual Reliability Report, required under REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants*, provides detailed yearly reliability performance for SIS. Two major indicators reported on are those used by the licensee to evaluate the overall reliability performance of a SIS: the predicted future unavailability (PFU) and the actual past unavailability (APU). The PFU estimates the probability that the system will be found in the future in a state in which component faults prevent it from operating with acceptable effectiveness. The APU represents the fraction of time in a specified interval, usually a year, when a system was inoperable or operable at significantly reduced effectiveness.

CNSC staff reviewed the reliability performance of SIS each year and concluded that all special safety systems for Pickering Units 1, 4 and 5-8 met their unavailability targets during the licence period. The reliability performance of the SIS, other than special safety systems, was also found satisfactory except for the emergency power system for Unit 5-8. The Unit 5-8 Emergency Power System PFU has been above the unavailability target since 2012, due to longer than expected durations of the maintenance activities for Emergency Power Generator (EPG) 1 and EPG 2. OPG has indicated that the major maintenance activities, including overhauls for the emergency power generators, have been completed and in the next licence period the duration of the maintenance activities for emergency power generators will be reduced significantly and bring the PFU of the emergency power system below the unavailability target.

Although the PFU of the emergency power system exceeded the unavailability target, the actual performance of system was always below the unavailability target for the previous years. In addition, when one emergency power generator was out of service for the maintenance, OPG always put EPG 3 in standby state to improve the reliability of the emergency power system if called upon. Therefore, CNSC staff conclude that the reactor safety was not challenged due to PFU exceeding the unavailability target. The additional EPG 3 will also enhance the performance of the system.

As a follow up, in 2017 CNSC staff performed a review of OPG's maintenance strategy to improve the system availability/reliability CNSC staff determined that the existing maintenance and reliability programs meet regulatory requirements. CNSC staff identified areas for improvement regarding the adequacy of qualified maintenance resources; the consideration of the ALARA principle in component categorization; and long hours of component unavailability (outages, impairments) causing loss of redundancy of certain system important to safety [50]. CNSC staff will assess OPG's response to these findings through ongoing compliance verification activities.In addition, CNSC staff will continue monitoring the effectiveness of OPG's existing system health and reliability improvement actions in order to confirm that such actions are effective in reducing the number of component failures and deficiencies.

Pickering NGS performance within this specific area was satisfactory during the current licence period.

Maintenance

OPG maintains a maintenance program at Pickering NGS in accordance with CNSC regulatory document S-210 *Maintenance Programs at Nuclear Power Plants*. CNSC staff determined that the Pickering maintenance program met regulatory requirements and performance objectives during the current licence period.

The average preventive maintenance completion ratio during the licence period for the six units at Pickering was 88 percent. The other key maintenance performance indicators are listed in the table below.

Table 8: Maintenance backlogs and deferrals for critical components

Performance indicator	Average work orders 2015	Average work orders 2016	Average work orders 2017 Q1-Q2	Trend	Industry average 2016
Corrective maintenance backlog	26	19	10	down	8
Deficient maintenance backlog	96	109	127	up	111
Deferrals of preventive maintenance	120	110	92	down	38

Trending data for these performance indicators is not applicable prior to implementation of REGDOC-3.1.1 in 2015

The corrective critical maintenance backlog is continuously being reduced and is currently close to the industry's average range. The number of deferrals of critical preventive maintenance was higher than the industry average but has also been reduced. The deficient critical maintenance backlog increased to above the industry's average range. A CNSC staff focused desktop review [50] was undertaken in 2017 to determine if there is any the relation between the safety performance indicators and the performance of components important to safety for several selected systems (low pressure service water system, vault vapour recovery system and emergency service water system). The review revealed that "lack of adequate resources" was one of the major contributing factors to preventive maintenance deferrals being above industry average. The review also confirmed that OPG is implementing corrective actions to address the repeated failures of a number of components for the three selected systems, and the effectiveness of existing corrective actions has been gradually demonstrated. Although some failed or deficient components led to reduced system redundancy, the safety significance of the findings was determined to be low since the system safety functions have been continuously maintained.

Measures to reduce the maintenance backlogs are monitored by CNSC staff through maintenance-related desktop reviews and inspections. CNSC staff will continue to assess the trends in these indicators and any maintenance-related events.

As part of the licence renewal, OPG confirmed it has implemented CNSC regulatory document RD/GD-210 *Maintenance Programs for Nuclear Power Plants*, which supersedes S-210. This standard has been added as compliance verification criteria in the proposed LCH.

Structural Integrity

OPG verifies the structural integrity of pressure boundary components, containment components and structures, and safety related civil structures to demonstrate that the margins are not reduced below acceptable levels due to various degradation mechanisms.

Based on the results of the Pickering inspection program outcomes, quarterly operations reports, pressure boundary reports, and event reports, CNSC staff concluded that during the licence period, SSC required for safe operation continued to meet the structural integrity requirements established in the design basis or in CNSC-accepted standards and guidelines.

OPG follows approximately a two-year outage cycle for each reactor, whereby the reactor is shut down for regular major maintenance activities. Since 2013, OPG has undertaken numerous inspections under the Periodic Inspection Programs (PIPs) and in-service inspection programs of Units 1, 4 and 5-8 for:

- pressure boundary components under CSA N285.4
- containment components under CSA N285.5

OPG evaluated all inspection findings to confirm that structural integrity margins are maintained and to confirm the fitness for service of the inspected SSCs. Where results indicated that margins were reducing, appropriate corrective actions (such as repairs, replacement of components, or operation with restrictions) were implemented to restore adequate margins.

CNSC staff review the results from reactor building, vacuum building and the pressure relief duct inspections including leak rate tests. Such tests occur routinely during outages in accordance with the requirements of CSA N287.7, to confirm fitness for service of these concrete containment structures. The test and inspection results indicated that the concrete structures are in good condition. Minor deteriorations detected as a result of inspections have been repaired by OPG using approved methods.

Fuel channels are a key pressure boundary component in the Pickering reactors and are subject to several degradation mechanisms. Appendix E.2 provides a description of the degradation mechanisms that affect Pickering fuel channels. Each of these degradation mechanisms is monitored through either in-service inspections or material property testing of tubes removed from the reactor core.

CNSC staff review all in-service inspection reports, as well as OPG evaluations of the current and future predicted state of pressure tube material.

During the licence period, OPG continued to execute in-service inspections of select pressure tubes during each planned inspection outage. CNSC staff confirm that the inspection results to date have satisfied all structural integrity requirements.

Pressure tube flaw assessments

One important factor to infer the structural integrity of pressure tube material is to determine the hydrogen equivalent concentration ([Heq]) present in the pressure tube. Deuterium (hydrogen) ingress is not a life-limiting mechanism on its own; however, it affects the pressure tube material property over time. Licensees rely on Heq measurements (and predictions) to demonstrate that inspected flaws are able to maintain structural integrity margin during design basis transients. In cases where a flaw evaluation does not meet the acceptance criteria of the relevant standards, this finding would trigger a fitness for service assessment and a disposition acceptable to the CNSC. The disposition may include mitigation measures like repair, operation with restrictions or replacement of the pressure tube containing the flaw. To-date, no detected pressure tube flaw has revealed evidence of growth. There have also not been any flaws that would necessitate mitigating measures.

In 2016, CNSC staff requested OPG to assess its pressure tube flaws for crack initiation due to hydrided region overload (HROL). At the time, OPG started assessing risks posed by HROL in its probabilistic core and leak-before-break evaluations. However, OPG could not deterministically assess inspected flaws against HROL as a suitable deterministic methodology was not available. CNSC staff raised an enforcement action on OPG to develop a method to perform deterministic assessments on inspected flaws, and set expectations by when all inspected pressure tube flaws are to be assessed against the degradation mechanism. OPG has developed a short term and long term plan to perform such assessments. For the interim, OPG has provided a risk-based assessment of the most limiting flaw susceptible to HROL, which confirms that adequate safety margin is maintained. CNSC staff continue to monitor OPG's progress in implementing the short and long term plan through regular compliance activities.

Pressure tube fracture toughness

Increasing [Heq] reduces ductility and fracture toughness of the pressure tube material. Fracture toughness is one of the critical properties required to demonstrate leak-before-break; it also requires imposing restrictions on the pressure-temperature operating envelope.

In the past, licensees utilized a fracture toughness model that was supported up to [Heq] levels of 30 ppm. The Industry carried out a Fuel Channel Life Cycle Management Project to produce a new model that would support operation of pressure tubes with higher [Heq] levels (between 40 and 120 ppm). The 2015 edition of CSA N285.8 adopted a new model, which allows predicting reductions in pressure tube fracture toughness for the transition temperature region, up to 250°C, and which is used to evaluation of pressure tube fracture toughness during reactor heat-up and cool-down.

To validate the new fracture toughness model, the Industry set up a burst test program. In early 2017, the Industry reported one validation test result that revealed a potential weakness in the existing model. The Industry revised the test program to address this finding by conducting tests in the range of conditions of interest, as well as proposing a plan for an improved fracture toughness model that would incorporate the latest research results. To track the issue, CNSC staff initiated an enforcement action on OPG and continues to monitor the progress of model validation and research activities. The Industry has recently demonstrated progress in addressing this issue through the execution of two additional burst tests to date. The results of the two burst tests fall within the range that supports the existing model.

Pressure tube – calandria tube contact for Pickering Units 5-8

Loose-fitting spacers can shift under normal operating conditions and OPG has observed spacer movement in select fuel channels. To ensure that spacers continue to maintain a gap between pressure tubes and calandria tubes, the spacers need to be inspected and periodically repositioned. OPG maintains a program to predict which channels are more susceptible to spacer movement, and this removes the burden of having to inspect all channels in the core during each planned inspection outage.

For Pickering, Units 5-8 have loose-fitting spacers; therefore pressure tube – calandria tube (PT-CT) contact assessments are necessary to ensure that pressure tubes do not come into contact with the calandria tube during the evaluation period (at least) or up to the next planned outage.

Accordingly, OPG has developed a methodology to identify the channels at high risk for spacer movement and has incorporated targeted mitigation strategies to reposition the spacers to reduce the spacer mobility. Additionally, OPG has incorporated these strategies into their aging management programs to monitor the position of the spacers through scheduled inspection campaigns. Through normal compliance activities, CNSC is continuously monitoring the effectiveness of the mitigation strategies and the assessment results. The likelihood of a PT-CT contact is assessed to be acceptably low.

Irradiation-induced material property changes in tight-fitting spacers

Tight-fitting spacers are predicted to maintain their position, and do not face the same challenges as loose-fitting spacers. However, as the tight-fitting Inconel X-750 spacers age, their ability to maintain structural integrity diminishes, which may lead to PT-CT contact.

Pickering Units 1, 4 and a small subset of fuel channels in Units 6, 7 and 8, are equipped with X-750 spacers, OPG, along with its industry partners, routinely perform material surveillance tests on spacers removed from the core. This is accomplished when an entire pressure tube is periodically removed for destructive testing. In the case of the X-750 spacers, destructive tests are performed to measure the remaining mechanical strength of the spacer material, as over time, the irradiated X-750 spacers can become brittle and fail. A failed spacer could result in a pressure tube becoming in contact with a calandria tube. Such a condition can lead to pressure tube blister formation and crack growth.

Based on OPG's current assessments, spacer material degradation is not considered life-limiting for Pickering Units 1, 4. CNSC continues to monitor OPG assessments and periodic material surveillance tests results.

Calandria tube – liquid injection shutdown system nozzle contact for Pickering Units 5-8

OPG's current assessments predict that calandria tube and liquid injection shutdown system (CT-LISS) nozzle contact could occur before the end of commercial operation in some of the units. However, OPG has plans in place to collect additional CT-LISS gap data, whereby repeat channel measurements will result in refined gap closure rates and allow for more accurate prediction of CT-LISS nozzle contact time. This is expected to extend the predicted first time to CT-LISS nozzle contact beyond 2024.

Pressure tube leak-before-break

Leak-before-break (LBB) assessments are used to demonstrate that in the unlikely event of a leak from a pressure tube, the consequential leak will be detected in time to shut down the reactor and cool and depressurize the primary heat transport system before the pressure tube ruptures. This evaluation produces an estimated conditional probability of LBB given a through-wall crack, and is compared against the acceptance criteria (expressed as an allowable conditional probability of ruptures per through wall crack over the evaluation period).

CSA N285.8-15 requires an evaluation of LBB of a CANDU reactor core when the bulk hydrogen concentration in the pressure tube is at, exceeds, or is expected to exceed, before the end of the evaluation period, the threshold level at which the materials is susceptible to delayed hydride cracking under any sustained hot condition. As only a small number of pressure tubes are inspected in any given outage to detect susceptible flaws that could initiate delayed hydride cracking, a probabilistic evaluation of pressure tubes in the entire reactor core is required. These core assessments are reviewed by OPG on a three year cycle to evaluate their validity. A re-assessment is needed when new inspection data statistically changes the input distributions used in a previous assessment and/or when a methodology and assumptions used in a previous assessment are no longer valid.

Despite a fair amount of safety margin when compared against the acceptance criteria, OPG is working to better support the uncertainty of pressure tube fracture toughness predictions. CNSC will continue to review all key inputs, methodologies and assumptions to evaluate their validity.

Aging Management

Pickering NGS has an Integrated Aging Management program to ensure that the degradation mechanisms of SSCs important to safety are well understood and that the required processes and activities are in place to assure their health as the plant ages. Under the Integrated Aging Management program, OPG has implemented Life Cycle Management Plans (LCMP) for major components, which specify specific activities undertaken to continuously assess the component conditions and their fitness for service.

In July 2015, CNSC staff conducted a Type II inspection of OPG's Integrated Aging Management Program and identified some deficiencies within OPG's governance relating to the implementation of this program and its interfaces with other programs [51]. OPG responded with a corrective action plan that CNSC staff found acceptable. Staff will continue to monitor the implementation of OPG corrective actions through on-going compliance verification activities.

OPG informed CNSC staff that it had updated its aging management governance and processes for Pickering NGS to meet the requirements of REGDOC-2.6.3 *Aging Management,* and had fully implemented the standard as of December 14, 2017 [4]. CNSC staff will evaluate the effective implementation of this REGDOC through regular compliance activities in the next licensing period.

Fuel channels

In January 2018, CNSC staff provided a technical update to the Commission [52] on fuel channel evaluations for Canadian NPPs, specifically addressing the pressure tube fitness-for-service requirements and evaluation methodologies that are established in CSA N285.4 and N285.8.

The ability to safely operate pressure tubes is demonstrated through assessments of the current and expected conditions of the pressure tubes based on an understanding of relevant degradation mechanisms. Research activities as well as inspection and maintenance programs provide data to periodically validate the input parameters for these assessments.

CNSC staff continue to review the results from fuel channel inspections that occur routinely during planned inspection outages as well as encourage R&D activities for topics relating to emerging issues. Inspection results to-date confirm that the safety margins are being maintained. OPG's Fuel Channel Life Cycle Management Plan identifies mitigating strategies should fitness for service assessments not be able to meet acceptance criteria up to the end of the evaluation period.

Currently, Pickering NGS is approved to operate to 247,000 Effective Full Power Hour (EFPH) for Pickering Units 5-8 fuel channels. In the licence application, OPG is seeking Commission approval to operate Pickering Unit 5-8 fuel channels up to 295,000 EFPH [1]. This is the maximum operating time expected for the lead unit (Unit 6) before the end of commercial operation on December 31, 2024. Units 1, 4 had their pressure tubes replaced in the mid- to late-1980s, therefore their accumulated EFPH values are significantly lower.

OPG continues to submit to CNSC staff the assessments for fuel channel components in order to support safe operation. OPG is required to demonstrate that the requirements in CSA N285.4-05 and N285.8-15 are met. These assessments rely on models that represent the current and predicted conditions of fuel channel components. As stated earlier, the fracture toughness model is used to assess the risk of pressure tube failure from postulated flaws in the reactor core. The current model for fracture toughness has been incorporated into CSA Standard N285.8, for use up to a maximum pressure tube [Heq] of 120 ppm.

OPG and industry partners continue R&D activities to enhance the current understanding of all aging-related degradation mechanisms. OPG will document these activities in a Pickering NGS Fuel Channel Readiness Plan, an IIP deliverable**.** The Readiness Plan will establish a roadmap, with associated tasks and corresponding timelines, to demonstrate compliance with the 9 attributes of an effective integrated aging management program (Appendix A of REGDOC-2.6.3). The Readiness Plan will also identify the assessment methodologies that require revisions or updates, and will provide information about the R&D activities that are required to enhance the assessment models and methodologies, as required, to support the evaluation of safety margins of the fuel channels for operation to the end of 2024.

Based on current [Heq] predictions, the lead Pickering channels are not expected to reach 120 ppm before the end of their target service life at any unit. Therefore, CNSC staff recommend that the Commission approve the operating of Pickering NGS Unit 5-8 fuel channels up to a maximum of 295,000 EFPH for the lead unit (Unit 6).

CNSC staff recommend a specific licence condition (LC 15.3) requiring OPG to maintain pressure tube fracture toughness sufficient for safe operation. This LC will assure presence of adequate compliance verification criteria should the projected [Heq] predictions exceed 120 ppm before the end of Pickering pressure tube target service life.

Under LC 15.3, prior to operating pressure tubes with [Heq] in excess of 120 ppm, OPG must seek CNSC acceptance of a model used for predicting pressure tube fracture toughness for the bounding [Heq] concentrations. The associated compliance verification criteria for LC 15.3 require that OPG submit to CNSC staff:

- a technical basis document to support the revised Model;
- a quantitative assessment of uncertainties for the revised Model; and
- a test plan, including the results of fracture toughness tests, the status of findings and test outcomes, additions and changes to the test plan and changes to the test strategy

If the [Heq] at a point along the length of a pressure tube is predicted to exceed the limits specified in CSA N285.8-15, the periodic inspection program will be expected to incorporate the selection of pressure tubes with the highest expected

[Heq] and highest potential for service induced flaws for volumetric examination and Heq measurement.

Feeders

OPG annually updates the Pickering NGS feeder LCMP, which contains the management strategies for feeder degradation from wall thinning due to flow accelerated corrosion and other mechanisms. OPG manages feeder wall thinning through scheduled wall thickness measurements, and stress analysis to determine the required wall thickness in accordance with the feeder fitness for service guidelines. OPG completed the baseline inspection for feeder thickness measurements at the limiting locations including tight-radius bends and regions adjacent to the Grayloc welds. Currently, OPG focuses the repeat thickness measurements on the limiting feeders identified by the baseline inspection. If a section of a feeder can no longer meet the required structural margins, OPG has the capability to replace the section during a maintenance outage. It is worth noting that no feeders were replaced during the current licence period. CNSC staff conclude that OPG's strategies outlined in the LCMP are appropriate to manage the expected aging of the Pickering feeders over the proposed operation period.

Steam generators

The LCMP for steam generators defines, integrates, and schedules actions to be performed in order to achieve safe and reliable steam generator operation. A new tube degradation mechanism was identified during the Unit 4 steam generator inspections completed in 2016. CNSC staff determined that OPG took appropriate actions, including pulling tubes for metallurgical examination to characterize the degradation mechanism and assessing changes required for aging management strategies. Regulatory oversight activities related to this inspection program finding will continue. Based on OPG's current estimates, adequate margins remain such that operation will not be impacted by the expected numbers of steam generator tubes that may require removal from service prior to the proposed end of commercial operation. CNSC staff conclude the strategies outlined in the LCMP are appropriate to manage the expected aging of the steam generators over the proposed commercial operation period.

Reactor components and structures

The reactor components and structures LCMP defines the aging management strategies for the calandria vessel, its internal components, the moderator system and other components in the calandria vault. The LCMP provides an overview of potential aging-related degradation mechanisms and activities, including inspections and surveillance activities. There were no findings of aging related degradation over the course of the current licence period that impacted safe operation. CNSC staff will continue to monitor the implementation of the LCMP activities with particular attention paid to:

- the sagging of calandria tubes and Liquid Injection Shutdown System (LISS) nozzles due to irradiation induced creep, to evaluate the potential for contact between the calandira tubes and LISS nozzles.

- the potential for calandria tube cracking due to fuel channel garter spring vibration for Units 5-8.
- the demonstration of adequate structural integrity margins for calandria tube and LISS nozzles for continued operation up to the end of 2024.

Containment concrete structures

OPG's aging management plan for concrete containment structures defines the activities required to address aging related degradation. Periodic inspection and testing of the concrete containment structures are conducted in accordance with the requirements of CSA N287.7 *In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plants* and the approved station periodic inspection programs. During the current licensing period, CNSC staff did not identify regulatory compliance issues affecting safe operation. CNSC staff continue monitoring this area as part of the compliance program.

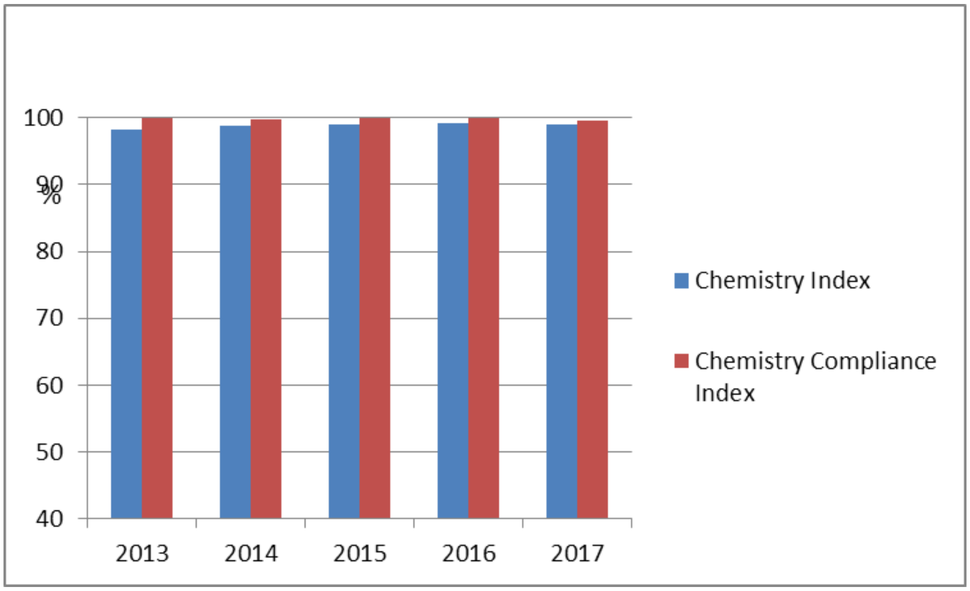
Chemistry Control

During the licence period, CNSC staff did not identify any significant chemistry control related issues that may affect the safety of the station.

CSA standard N286-12 contains requirements for system chemistry control. OPG's program document N-PROG-OP-0004, *Chemistry*, specifies processes, overall requirements, and licensee accountabilities to ensure effective control of plant chemistry during operational and lay-up conditions, control of laboratory methods, sampling and analyses, process chemicals, chemistry control performance monitoring, and reporting. These activities are performed in order to ensure critical plant equipment performs safely and reliably over the life of the station.

Pickering NGS maintained acceptable performance during the licence period as demonstrated from the Quarterly Safety Performance Indicators Chemistry Index and Chemistry Compliance Index, which are reported to the CNSC as per REGDOC 3.1.1, *Reporting Requirements for Nuclear Power Plants*, and presented to the Commission in the annual NPP Regulatory Oversight Report.

Figure 5: Chemistry index and chemistry compliance index for Pickering NGS



In 2017, CNSC staff conducted a Type II inspection of the Pickering chemistry program and concluded that OPG's chemistry control program is in compliance with regulatory requirements and industry best practices.

Periodic Inspection and Testing

CNSC staff have determined that OPG has adequate and well maintained periodic inspection programs (PIPs) for pressure boundary systems, containment components and containment structures that comply with CSA Standards N285.4 *Periodic inspection of CANDU nuclear power plant components*, N285.5 *Periodic inspection of CANDU nuclear power plant containment components* and N287.7 *In-service examination and testing requirements for concrete containment structures*.

CNSC staff assess PIP compliance with regulatory requirements through three primary activities:

- PIP governing documents are reviewed to assess compliance with the applicable CSA standards when such documents are revised to reflect updates to the standards;
- Unit outage inspection reports are reviewed to assess compliance with the processes described in the PIP documents;
- Compliance verification inspections are periodically carried out to confirm compliance with requirements that are difficult to verify through document reviews.

Pickering's pressure boundary component PIPs currently comply with the 2005 edition of CSA standard N285.4. CNSC staff reviewed and accepted the PIP documents and OPG has carried out inspection activities in accordance with the program documents. OPG assesses the PIP inspection results in accordance with the applicable standards and guidelines.

In 2016, CNSC staff completed a Type II compliance inspection related to the implementation of the CSA N285.4 PIP for the Pickering steam generators. Staff concluded that the program activities were implemented in accordance with regulatory requirements. OPG implemented corrective actions to address inspection findings related to OPG staff non-compliance with OPG internal governance.

With regard to Pickering fuel channels, CNSC staff conducted a multi-phase Type II compliance inspection. This was undertaken in response to the 2013 Commission Directive in the *Record of Proceedings* [12] for the Pickering Hold Point, in which OPG and CNSC staff were directed to increase fuel channel inspections and verifications accordinglly. CNSC completed the Phase 1 of the inspection in early 2015, Phase 2 in Fall 2015 and Phase 3 in Summer 2017, focusing on OPG’s compliance with the requirements of CSA N285.4-05, CSA N286 and CSA N285.8. In particular, these inspections assessed OPG compliance with the requirements for pressure tube-to-calandria tube contact, scrape sampling for deuterium ingress and hydrogen measurement, and calculation of Annulus Gas System response times.

Phase 1 of the inspection concluded that OPG met the regulatory requirements regarding the selection of fuel channels for the required inspections in accordance with Clause 12 of CSA N285.4-05 standard. A weakness was identified regarding the clarity of the governing procedure, which could have challenged adherence to the procedure in performing specific tasks. Consequently, OPG updated the procedures in accordance with CNSC recommendations.

Phase 2 of the inspection identified areas of weakness with respect to the conduct of pressure tube inspections [53]. Deficiencies were identified in procedures, trending of aging effects and the identification of QA requirements when procuring contract services. Non-compliances with the CSA standards were identified pertaining to the submission of procedures, performance demonstrations, technical justifications and calibration specimens. OPG has satisfactorily addressed the majority of these findings. CNSC staff will continue to follow up with OPG on the remaining issues.

Phase 3 of the inspection focused on the methodologies and codes used for

- evaluation, disposition and fitness for service assessment of pressure tube using the OPG inspection data as related to pressure tube to calandria tube gap,
- the estimates of dew point alarm times and beetle alarm times in the leak detection systems, and
- pressure tube material property testing.

CNSC staff concluded that OPG meets the intent of the regulatory requirements for periodic inspection of fuel channels; however deficiencies were identified that represent an aggregate low risk that the program could ultimately fail to achieve expectations. The deficiencies were identified within OPG governance and practices related to description of licensee governing processes, QA and control of calibration laboratory activities, identification of technical requirements for service procurement, availability of procedures, and computer code validation [54]. OPG has provided a corrective action plan to address these findings. CNSC staff will continue to monitor OPG's corrective actions through on-going compliance verification activities.

Balance of plant

The current LCH requires that OPG implement inspection programs to monitor the effects of potential aging related degradation of balance of plant pressure boundary components and civil structures that could impact safe operation. OPG has implemented specific inspection programs to address aging related degradation mechanisms for balance of plant SSCs important for safe operation, for example programs that target pressure boundary components affected by flow accelerated corrosion and microbially influenced corrosion.

During the licence period, CNSC staff did not identify compliance issues or reports of degradation that would affect safe operation. CNSC staff continued regulatory oversight in this area to ensure that OPG's implementation of inspection activities of safety-related balance of plant pressure boundary components and civil structures meet regulatory requirements.

5.6.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.6.3.1 Past Performance

OPG has well developed programs, processes and procedures to meet the performance objectives and applicable regulatory requirements of the Fitness for-Service SCA.

During the licence period, SSCs required for safe operation continued to meet the structural integrity requirements established in the design basis or in CNSC-accepted standards and guidelines. OPG has an Integrated Aging Management program to ensure that the degradation mechanisms of SSCs important to safety are well understood and that the required processes and activities are in place to assure their health as the plant ages. In addition, OPG continued to have adequate and well maintained PIPs for pressure boundary systems, containment components and containment structures that comply with applicable CSA standards.

5.6.3.2 Regulatory Focus

OPG will be required to augment the major components condition assessments, specifically for pressure tubes, through additional inspections, R&D and analysis to further understand and control the aging mechanisms affecting the pressure tubes. CNSC staff will maintain adequate compliance oversight to confirm the continued fitness for service up to the end of commercial operation.

5.6.3.3 Proposed Improvements

OPG has committed to implement the following updated/revised standards:

- RD/GD-210 *Maintenance Programs for Nuclear Power Plants* (2012), implementation by September 1, 2018
- REGDOC-2.6.3 *Aging Management*, as of December 14, 2017

CNSC staff will confirm OPG compliance with these standards through compliance verification activities.

In addition, staff have requested OPG to provide additional information regarding the implementation plans for CSA N285.4-14 *Periodic Inspection of CANDU Nuclear Power Plant Components*, and CSA N285-5-13 *Periodic Inspection of CANDU Nuclear Power Plant Containment Components*, and will revise the draft LCH as appropriate.

Major IIP actions include:

- Upgraded and updated fuel channel LCMP that will be submitted annually to CNSC with activities to demonstrate the fitness for service of fuel channels until 295,000 EFPH (which approximately corresponds to operation to December 31, 2024.)
- Submission of the results of measurements of gaps between calandria tube and the liquid injection shutdown system nozzle for Units 5 and 6, in support of operation to 2024.
- Completion of a risk-based approach to aging management, as well as an action tracking and reporting process including a database for condition assessment of all SSCs important to safety.
- Completion of the project related to mitigating leakage from the Pickering 5-8 Irradiated Fuel Bays to the supporting concrete structure.

Of special interest, Global Issue 1 (GI-01) in the IIP identifies the resolution plan and actions necessary to demonstrate the fitness for service of fuel channels until the end of commercial operation in 2024. Two key actions are as follows:

- The Fuel Channel Readiness Plan identifies gaps in the current knowledge on the condition of the fuel channels and the required enhancements in the inspection, assessment and mitigating strategies to address various CNSC concerns and action items. It is expected that this Readiness Plan will provide a roadmap to demonstrate compliance with the 9 attributes of an effective integrated aging management program (Appendix A of

REGDOC-2.6.3). The Readiness Plan will also document the status of the work required in support of Pickering NGS operation to 295,000 EFPH. The Readiness Plan will be updated annually based on results from ongoing relevant analytical and experimental work.

- In parallel, OPG will upgrade and submit annually the Fuel Channel LCMP for CNSC staff review. The upgraded LCMP will include the most up-to-date information and activities recommended in the Readiness Plan to demonstrate continued fitness for service of the fuel channels. The upgraded LCMP will include a table detailing the current status of each of the applicable aging degradation mechanisms (See Appendix E.2 for details) with elaboration on how they are detected, assessed, monitored, prevented, and mitigated using current industry practice. The table will also include the required enhancements, based on the knowledge gained, to determine current and projected conditions of the fuel channels to 2024. The table should address stressors such as deuterium / hydrogen ingress, changes in material properties, and dimensional changes, as well as their effect on the structural integrity of the fuel channels. CNSC staff expect that the activities and up-to-date knowledge in the upgraded LCMP will demonstrate that the fuel channel will be fit for service, considering all degradation mechanisms, to 295,000 EFPH.

5.6.4 Conclusion

CNSC staff are satisfied with the current status of fitness for service of major components at Pickering. By effectively implementing the existing fitness for service activities and the IIP actions, OPG will be able to demonstrate the fitness for service of major components as well as SSC important to safety.

5.6.5 Recommendation

The following standard licence condition is included in the proposed PROL:

- LC 6.1: The licensee shall implement and maintain a fitness for service program.

In addition, CNSC staff recommend the following LC to address FC FFS.

- LC 15.3: The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.

Compliance verification criteria are detailed in the proposed LCH.

5.7 Radiation Protection

The Radiation Protection SCA covers the implementation of a radiation protection program in accordance with the Radiation Protection Regulations. The program must ensure that contamination levels and radiation doses received by individuals are monitored, controlled and maintained As Low as Reasonably Achievable (ALARA).

The specific areas that comprise this SCA include:

- Application of ALARA
- Worker dose control
- Radiation protection program performance
- Radiological hazard control
- Estimated dose to public

5.7.1 Trends

The following table indicates the overall performance ratings for the Radiation Protection SCA during the current licence period:

RATING LEVEL TRENDS FOR RADIATION PROTECTION			
Performance Ratings			
2013	**2014**	**2015**	**2016**
FS	FS	FS	SA
Comments Pickering received “Satisfactory” to “Fully Satisfactory” ratings during the licence period.			

SA = Satisfactory, FS= Fully Satisfactory

5.7.2 Discussion

OPG’s Radiation Protection Program, captured in N-PROG-RA-0013, *Radiation Protection*, is supported by a series of lower-level OPG standards and procedures to be utilized for the conduct of all operational and maintenance activities within the nuclear facility. The implementation of this program ensures that:

- Public and occupational exposures to ionizing radiation are controlled such that individual doses are kept below regulatory dose limits and unplanned exposures are avoided.
- Individual and collective doses are maintained at levels ALARA, social and economic factors being taken into account.
- The movement of people and materials is done in a manner that prevents the uncontrolled release of contamination or radioactive materials from OPG facilities.

- High standards of radiation protection performance are achieved and confirmed through monitoring.
- All applicable regulatory requirements are met.

These objectives are achieved through the establishment and implementation of standards and processes for the conduct of licensed activities.

During the licence period, OPG implemented and maintained an effective radiation protection program at Pickering NGS in accordance with regulatory requirements. Pickering's rating in this SCA was reduced from "Fully Satisfactory" to "Satisfactory" in 2016 due to issues with the frequency of instrument calibrations and procedural non-compliances associated with the fixed and semi-portable area gamma monitors. Overall, CNSC staff are satisfied that the radiation protection program at Pickering NGS is effective in maintaining doses below regulatory limits and ALARA, and protecting the health and safety of persons.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Application of ALARA

OPG's commitment to the ALARA principle has been demonstrated through the radiation protection program implemented at the Pickering NGS. Part of their program includes the implementation of N-STD-RA-0018, *Controlling Exposures as Low as Reasonably Achievable*. OPG's radiation protection program was developed in accordance with CNSC regulatory guide G-129, *Keeping Radiation Exposures and Doses "As Low as Reasonably Achievable"*. OPG's program ensures that all levels of the organization, including upper management, are involved in ensuring that ALARA is integrated into planning, scheduling, and work control, and also requires the establishment and monitoring of ALARA performance targets for work conducted at the facility.

In 2017, CNSC staff conducted a Type II compliance inspection focused on the area of Application of ALARA. This inspection demonstrated that a mature ALARA program that meets CNSC expectations is in place to plan and control work activities. There were no regulatory non-compliances identified as a result of this inspection.

Pickering NGS has developed a 5-Year Collective Radiation Exposure dose reduction plan, which includes internally established collective dose[3] performance targets as well as approved current and planned ALARA initiatives that are expected to reduce collective dose. This plan tracks the performance of the dose reduction initiatives and collective dose performance on an on-going basis. The collective doses, as provided by OPG, are described in Appendix E.3.

[3] The collective dose is the addition of the doses for all workers. Collective dose is generally used as an instrument for optimization for radiation protection. There is no regulatory limit on the annual collective effective dose.

The plan is updated annually to reflect the results of benchmarking, self-assessments, corrective action plans and industry best practices.

Some examples of current and ongoing ALARA initiatives are:

- Dose goals to improve individual and station dose performance
- Use of robotics to perform tasks in radioactive work areas
- Dynamic learning activities in a simulated radioactive work environment
- Use of remote monitoring and real time data transmission
- Use of a gamma ray imaging spectrometer to provide mapping of isotopes and radiation dose rates in an area
- Improvement of vapour recovery dryer performance
- Implementation of a reactor face shielding cabinet and other innovative shielding designs to reduce radiation dose rates
- Continued improvements in the use of teledosimetry

CNSC staff confirm that Pickering NGS continued to implement a highly effective and well-documented ALARA program, based on industry best practices, to keep doses ALARA. CNSC staff conclude that the application of ALARA by OPG met regulatory requirements and achieved planned goals with a noted improved trend.

Worker Dose Control

The radiation protection program implemented at OPG is designed to ensure that doses to workers are controlled and do not exceed regulatory limits.

OPG uses a CNSC licensed dosimetry service to monitor, assess, record and report doses of ionizing radiation received by employees, visitors and contractors as a result of activities at the Pickering NGS site. Doses to individuals are reported to the National Dose Registry. The appropriate types of dosimetry, criteria and procedures are implemented through the radiation protection program.

OPG uses a combination of action levels, staff training and qualification, dose management tools (work planning and management oversight) and personal protective equipment as necessary to ensure radiation doses to workers are controlled and kept ALARA.

Action levels are established for unplanned dose in a single shift, as well as accumulated dose in a 1-year dose period. Action levels are not intended to remain static and are recommended to be reviewed at least once per licence period to ensure that they remain meaningful. During this licence period, OPG reassessed their current action levels pertaining to exposure control and confirmed that they remained relevant and appropriate.

During the licence period, radiation doses to workers were below the regulatory dose limits and action levels established in the OPG radiation protection program.

There were no adverse trends indicated or safety-significant unplanned exposures due to the licensed activities at Pickering NGS.

CNSC staff determined that during the licence period, OPG continued to effectively control radiation doses received by workers at Pickering NGS. CNSC staff conducted two inspections in the area of worker dose control in addition to the quarterly field inspections that also review aspects of this area. The inspections identified multiple areas of strength in the implementation of worker dose control measures. However, staff found that OPG did not comply with paragraph 7(1)(d) of the *Radiation Protection Regulations*, for failing to inform all Nuclear Energy Worker contractors in writing of the radiation doses they received at Pickering NGS [55]. Non-compliances with OPG internal governance were also observed. All the findings were assessed to be of low safety significance. OPG developed corrective action plans for each of the areas of non-compliance, which CNSC staff reviewed and found acceptable.

Worker dose information from this licence period can be found in Appendix E.3. Average and maximum dose results demonstrate that OPG is maintaining control over worker exposure. Approximately 81 percent of workers monitored received doses at or below 1 mSv. No regulatory limits were exceeded.

Radiation Protection Program Performance

OPG implemented the radiation protection program described in its program document N-PROG-RA-0013, *Radiation Protection Program* at Pickering NGS. A series of standards and procedures supporting this program provide the means by which radiation protection is integrated within the day-to-day operations of the facilities.

OPG's Radiation Protection Program, N-PROG-RA-0013 was revised during this licence period. The major program changes included updates to:

- Implementing procedures and related programs and references.
- Roles and responsibilities to align with the most current organizational structure.

CNSC staff reviewed and accepted the revision to the program and concluded that applicable regulatory requirements were met.

OPG continually measures the performance of its radiation protection program against industry established objectives, goals and targets.

CNSC compliance verification activities indicate that OPG is effective in the area of radiation protection program performance. Overall, CNSC staff are satisfied that OPG implemented and maintained a program which is effective in protecting workers at Pickering NGS.

Radiological Hazard Control

OPG ensures that there are adequate measures in place to monitor and control radiological hazards. This includes but is not limited to the monitoring and controlling of surface and airborne contamination and of radiation dose rates. The radiological hazards are either eliminated (if possible), or controlled with engineered barriers and signage identifying the level and extent of hazard areas. Shielding and other protective measures are used to reduce radiation exposures to workers during operational and maintenance activities.

The contamination control process at Pickering NGS is designed to ensure that radioactive contamination is controlled at the source to prevent contamination spread to the worker, equipment and areas between work locations in order to maintain exposures ALARA. This is achieved by establishing radiological zones, a routine hazard monitoring program, classifying areas according to their radiation hazard potential, posting signs identifying the radiation areas and potential radiation hazards and protective equipment requirements, restricting access and monitoring personnel and material prior to leaving contaminated or potentially contaminated areas. Loose contamination is not tolerated within the station with the exception of identified contamination control areas.

OPG has action levels for surface contamination levels in Zone 1, which is treated as an area equivalent to the public domain. There were no surface contamination action level exceedances reported to the CNSC during the licence period.

There were two inspections conducted at Pickering during the licence period related to radiological hazard control. These Type II inspections were complemented by routine field inspections. Based on the results of the inspections, CNSC staff concluded that OPG was in compliance with regulatory requirements, with some instances of non-compliances with OPG internal governance. CNSC staff are satisfied that OPG took appropriate corrective actions and these actions are now closed.

In 2015 CNSC staff identified that OPG was not compliant with section 20 of the *Nuclear Substances and Radiation Devices Regulations*, as it was using fixed (non-portable) and semi-portable area gamma monitors that had not been calibrated in the preceding twelve months. This equipment is used as a barrier to prevent workers within the station from receiving unnecessary exposures during low frequency events associated with rapidly changing radiological conditions. Commitments made by OPG to return to compliance were not met, resulting in a CNSC reactive inspection in 2016 [56]. The inspection identified that the number of uncalibrated gamma monitors was more extensive than previously reported by OPG. In addition, OPG was not meeting their own procedural requirements for placing approved back up gamma monitoring equipment in the field. Four enforcement actions were issued. The extent of the deficiency indicated poor performance by Pickering NGS in the management and timely resolution of the non-compliance. As a result of CNSC enforcement actions, OPG immediately took measures to return to regulatory compliance and meet their program requirements. OPG also developed and implemented a corrective action plan to prevent a recurrence of a similar situation. OPG continued to implement routine protective measures in accordance with their radiation protection program to ensure the protection of their workers such as routine surveys, work plans and dosimetry requirements. There have been no exceedances of action levels or dose limits.

CNSC staff determined that during this licence period, OPG continued to implement their radiological hazard controls to protect workers and ensure radioactive contamination is controlled within site boundaries.

Estimated Dose to Public

OPG continued to ensure the protection of members of the public in accordance with the *Radiation Protection Regulations*. The reported estimated dose to a member of the public from the Pickering NGS site during the licence period remained well below the annual public dose limit of 1 mSv (1000 μSv/year).

The following table presents annual effective doses to a member of the public from licensed activities conducted at the Pickering NGS during the current licence period:

Table 9: Maximum effective dose to member of the public 2013-2017

MAXIMUM EFFECTIVE DOSE TO A MEMBER OF THE PUBLIC						
Dose Statistic	**2013**	**2014**	**2015**	**2016**	**2017[1]**	**Regulatory Limit**
Maximum Effective Dose (μSv)	1.1	1.2	1.2	1.5	--	1000 μSv/year)

[1] 2017 data will be available by May 1, 2018

5.7.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.7.3.1 Past Performance

OPG continued to implement an effective radiation protection program to protect the health and safety of persons inside the facility and ensure occupational and public exposures are below regulatory dose limits and maintained ALARA during the licence period.

5.7.3.2 Regulatory Focus

CNSC staff will continue to monitor OPG's performance in the Radiation Protection SCA through regulatory oversight activities including onsite inspections, assessment of corrective actions, desktop reviews of quarterly compliance reports and reviews of revisions to relevant program documentation. This oversight will continue through ongoing commercial operation of all reactor units until the end of 2024 and will continue through post-shutdown activities associated with removal of fuel and water in preparation for the safe storage of all units.

5.7.3.3 Proposed Improvements

OPG continues to improve their radiation protection program through the implementation of several ongoing initiatives. These include process improvements, dose reduction initiatives, shielding improvements, innovative uses of technology and improvements in remote monitoring.

5.7.4 Conclusion

CNSC staff have assessed information related to the Radiation Protection SCA, including OPG's documentation submitted in support of the licence application for renewal and have found that Pickering NGS meets applicable CNSC requirements. Based on the available evidence, CNSC staff are also satisfied with OPG's efforts in applying the ALARA principle and conclude that OPG's overall performance for this SCA is satisfactory.

5.7.5 Recommendation

The following standard licence condition is included in the proposed PROL:

- LC 7.1: The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

Compliance verification criteria are detailed in the proposed LCH.

5.8 Conventional Health and Safety

The Conventional Health and Safety SCA covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.

The specific areas that comprise this SCA include:

- Performance;
- Practices; and
- Awareness.

5.8.1 Trends

The following table indicates the overall performance ratings for the Conventional Health and Safety SCA over the current licence period:

TRENDS FOR CONVENTIONAL HEALTH AND SAFETY			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	FS	FS
Comments			
Pickering received “Satisfactory” to “Fully Satisfactory” ratings during the licence period.			

SA = Satisfactory, FS= Fully Satisfactory

5.8.2 Discussion

The Pickering NGS PROL requires OPG to implement and maintain a conventional health and safety program to minimize the risk to the health and safety of workers posed by conventional (non-radiological) hazards in the workplace.

CNSC staff have assessed that OPG has a highly effective health and safety program that provides safe work practices and conditions to achieve a high level of personnel safety at the Pickering NGS. Over the licence period, OPG’s performance rating in this SCA went from Satisfactory to Fully Satisfactory as a result of improvements made in the area of scaffolding inspections and record keeping.

OPG’s conventional health and safety program is regulated by the Ontario *Occupational Health and Safety Act* (OHSA) and the Ontario *Labour Relations Act*. Related legislation includes the Ontario *Workplace Safety and Insurance Act* and the Ontario *Human Rights Code*.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Performance

The accident severity rate (ASR), accident frequency (AF) and industrial safety accident rate (ISAR) are parameters reported by NPP licensees that measure the effectiveness of the conventional health and safety program with respect to worker safety. The ASR measures the total number of days lost due to injury for every 200,000 person-hours (approximately 100 person-years) worked at an NPP. The AF is a measure of the number of fatalities and injuries (lost-time and medically treated) due to accidents for every 200,000 person-hours worked at an NPP. The ISAR is a measure of the number of lost-time injuries for every 200,000 hours worked by NPP personnel.

The table below shows the ASR, AF and ISAR reported by OPG for the Pickering NGS from 2013 to 2017.

Table 10: Accident frequency and severity rates and industrial safety accident rate for Pickering

Year	Accident Frequency	Accident Severity Rate	Industrial Safety Accident Rate[1]
2013	0.3	0.0	N/A
2014	0.3	1.0	N/A
2015	0.4	0.5	0.04
2016	0.5	0.5	0.03
2017	0.00 (Q1) 0.13 (Q2)	0.00 (Q1) 0.00 (Q2)	0.00 (Q1) 0.00 (Q2)

[1]Licensees began reporting ISAR in 2015 with the implementation of REGDOC-3.1.1

The results of these performance indicators are extremely low compared other industries and workplaces in Ontario and Canada, and are comparable to Canadian nuclear industry average. Performance indicators for the conventional health and safety SCA are reported annually to the Commission as part of the NPP Regulatory Oversight Report. Overall, CNSC staff are fully satisfied with OPG's performance in this area.

Practices

The CNSC has a Memorandum of Understanding with the Ontario Ministry of Labour (MOL) to cooperate and exchange information and technical expertise related to their respective areas of jurisdiction, such as occupational health and safety practices at nuclear facilities. There has been regular communication between CNSC staff and the MOL regional office regarding any conventional health and safety issues at site.

CNSC staff did not identify any significant issues with OPG's compliance against the Ontario OHSA and the *Labour Relations Act* (Ontario). OPG's conventional health and safety program covers all of the major activities on site under the OHSA.

During field inspections, CNSC staff identified minor issues, such as housekeeping deficiencies. However, these findings were promptly corrected by OPG. CNSC staff continue to monitor practices and conditions as part of the ongoing compliance verification program.

During the current licence period, OPG's performance in the practice specific area met or exceeded CNSC requirements.

Awareness

The conventional health and safety work practices and conditions at the Pickering NGS continued to achieve a high degree of personnel safety. OPG personnel at all levels exhibit proactive attitude towards anticipating work related hazards and preventing unsafe conditions. There continues to be a safe and efficient working environment where situational awareness and safe work practices are encouraged.

OPG met requirements in this specific area during the licence period at Pickering NGS. All deficiencies from on-site inspections were adequately addressed throughout the year.

5.8.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.8.3.1 Past Performance

OPG has a highly effective health and safety program that provides safe work practices and conditions to achieve a high level of personnel safety at the Pickering NGS. During the licence period OPG demonstrated fully satisfactory performance in the conventional health and safety SCA at the Pickering NGS.

5.8.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's performance in this area through regulatory oversight activities, including onsite inspections and reviews of compliance reports and of revisions to relevant OPG program documents.

5.8.3.3 Proposed Improvements

No changes to the regulatory requirements or programs within this SCA are proposed.

5.8.4 Conclusion

Based on CNSC staff assessments of OPG's licence application, supporting documents and past performance, staff conclude that OPG's implementation of the conventional health and safety SCA has met and continues to meet applicable regulatory requirements.

5.8.5 Recommendation

The following standard licence condition is included in the proposed PROL:

- LC 8.1: The licensee shall implement and maintain a conventional health and safety program

Compliance verification criteria are detailed in the proposed LCH.

5.9 Environmental Protection

The Environmental Protection SCA covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.

The specific areas that comprise this SCA include:

- Effluent and emissions control (releases);
- Environmental management system (EMS);
- Assessment and monitoring;
- Protection of the public; and
- Environmental risk assessment.

In addition, CNSC staff conducted an environmental assessment (EA) under the NSCA to determine whether OPG has and will continue to make adequate provisions for the protection of the environment and the health of persons until the decommissioning and abandonment of the facility. The EA report, found in Appendix F of this CMD, provides CNSC staff's assessment of the licence application and the documents submitted in support of the application (including the Environmental Risk Assessment and Predictive Environmental Risk Assessment), annual environmental monitoring reports, the results of previous studies, compliance activities, CNSC's Independent Environmental Monitoring Program (IEMP) and the Preliminary Decommissioning Plan (PDP). A summary of staff's assessment is also provided below.

5.9.1 Trends

The following table indicates the overall performance ratings for the Environmental Protection SCA during the current licence period:

TRENDS FOR ENVIRONMENTAL PROTECTION			
Performance Ratings			
2013	2014	2015	2016
SA	SA	SA	SA
Comments			
Pickering's performance in this SCA was rated "Satisfactory" throughout the licence period.			

SA = Satisfactory

5.9.2 Discussion

OPG maintains an environmental protection program, which includes an effluent monitoring program and an environmental monitoring program, to comply with applicable federal and provincial regulatory requirements.

The environmental protection program includes policies, station instructions, methods and procedures to identify, control and monitor releases of radioactive and hazardous substances from Pickering NGS into the environment, and to protect the health and safety of people and the environment.

In 2017, OPG submitted revised Derived Release Limits (DRL) based on CSA guidelines N288.1-14 *Guidelines for Calculating Derived Release Limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities*. DRLs are calculated to ensure that the licensee controls and minimizes releases to levels which ensure that that public exposure is below the dose limit of 1 mSv per year as set out in the *Radiation Protection Regulations*. CNSC staff have reviewed the revised DRL and OPG is currently addressing CNSC comments. Once the CNSC formally accepts the revised DRL, the new limits will be reflected in the LCH.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Effluent and Emissions Control (releases)

The effluent 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*.

Based on the assessment of the OPG annual reports, quarterly reports, and regulatory performance indicators during the licence period, CNSC staff conclude that the airborne radiological releases from Pickering NGS remained well below their respective regulatory limits.

During one month in 2016, OPG exceeded the radiological liquid release action level for gross-beta. Environmental action levels are set at approximately 10% of the DRL to provide early warnings about any actual or potential losses of control of the Environmental Protection program. CNSC staff have reviewed the event report and additional information submitted in response to this action level exceedance and will continue to follow up with OPG through established compliance verification activities.

In July 2015, CNSC staff conducted an Effluent Monitoring Program Type II inspection. As a result of this inspection, staff identified certain areas for improvements that were adequately acted on by OPG.

Environmental Management System (EMS)

OPG has established and implemented an environmental management program to assess environmental risks associated with its nuclear activities and to ensure that adequate provisions are implemented such that adverse environmental effects are prevented or mitigated. OPG confirmed in the licence application that it has implemented REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures* version 2013.

OPG complies with environmental regulatory requirements and other expectations, including the International Organization for Standardization 14001, *Environmental Management Systems* (ISO-14001), which OPG's EMS is registered to. Having the ISO-14001certification is not a CNSC requirement; however it shows that a third party recognizes OPG's EMS as being in accordance with the standard.

Assessment and Monitoring

The Environmental Monitoring Program (EMP) at Pickering is designed in accordance 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 NGS. Based on this program, environmental samples from different pathways and the food chain are collected from various offsite locations and tested according to the EMP. Data from the program are also used to assess public doses resulting from the routine operation of nuclear facilities at the Pickering NGS. Review of OPG's results of the environmental monitoring programs (available on OPG website) for the period of 2013-2016 shows that the concentration of radionuclides and hazardous substances in the environment are very low and resulted very low dose to the public (results of public dose are presented in Radiation Protection Section).

CNSC conducted an inspection of the EMP for both Pickering and Darlington in October 2015. As a result of this inspection, staff identified certain areas for improvements that have since been adequately addressed by the licensee.

Fish barrier net (monitoring)

In 2008, fish mortality due to impingement and entrainment was raised as a significant environmental issue related to the operation of Pickering NGS. OPG was required to reduce annual impingement mortality by 80% by 2012. OPG meets the 80% reduction target with a fish diversion system (FDS) barrier net installed around the water intake structure at Pickering NGS. The FDS is in place from spring to fall.

OPG monitors the FDS performance and provides to CNSC an annual report on fish impingement and entrainment monitoring results. Table 11 provides a summary of the FDS performance during the last 5 years, in comparison with the impingement during the baseline impingement monitoring period (2003/2004).

Table 11: Biomass (kg) of fish impinged in 2003/2004 and since 2012

Year	2003-2004 (12 months)	2012	2013	2014	2015[1]	2016	2017[2]
Total Biomass (kg)	18,214	1,706	2,926	3,953	8,553	1,035	25,217

[1]A single event (approximately 6,000 kg) occurred in May 2015.
[2] Preliminary results (includes November 2017 event)

In 2016 for example, a total of 1,035 kg of fish were impinged. This represents a fish impingement reduction of 94% in comparison to 18,214 kg impinged during the baseline impingement monitoring period. A third party hydroacoustic evaluation of the FDS also concluded that the FDS effectiveness was more that 80% for spring, summer, and fall periods combined.

Since 2012, OPG has generally met or exceeded the annual 80% reduction target, with the exception of 2015 and 2017. In May 2015, approximately 6000 kg of fish were impinged as a result of a single event as the barrier net was being installed. As a result of this event, OPG implemented corrective actions, including changes to the FDS manual and installation procedures, to reduce the likelihood of reoccurrence. In 2017, OPG submitted an application for Authorization under Paragraph 35(2) of the *Fisheries Act*, and on January 11, 2018, DFO issued the Authorization. See section 6.9 of this CMD for additional details.

In November 2017, approximately 24,000 kg of biomass (predominately age-0 Alewife - which correlates to approximately 1500 kg of age-1 fish) was impinged on the intake screen after the barrier net had been removed for the winter. OPG notified both CNSC and Fisheries and Oceans Canada of this event. Fisheries and Oceans Canada and OPG are conducting an investigation. OPG is preparing the detailed event report.

Overall, CNSC staff are satisfied with the performance of the FDS.

Figure 6: Fish diversion system

Groundwater monitoring

Groundwater is sampled at over 100 sampling locations across the Pickering site for radionuclides and other contaminants. Tritium is found to be the primary contaminant of potential concerns. Tritium concentration trends at monitored locations show that in many cases concentrations have remained nearly constant or have decreased, indicating stable or improved environmental performance. There are some cases, however, where tritium concentrations have increased up to four-fold at specific locations within the boundaries of historical contamination in the Protected Area. CNSC staff determined that OPG followed up appropriately by investigating the causes and implementing corrective actions. Tritium concentrations have returned to levels consistent with historical concentrations, following the implementation of corrective measures.

Tritium in groundwater is mainly localized within the station's Protected Area. The foundation drains act as hydraulic sinks that capture most of the tritium plumes in the groundwater. The groundwater monitoring program results confirmed the site perimeter concentrations remain low, indicating no off-site impacts.

Independent environmental monitoring program and other monitoring

To complement ongoing compliance activities, the CNSC has implemented its own Independent Environmental Monitoring Program (IEMP). The IEMP results verify that the public and the environment in the vicinity of the Pickering Nuclear Generating Station are protected. The IEMP results for the Pickering Nuclear Generating Station are published on the CNSC's website (http://nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/index-iemp.cfm). Additional IEMP information is provided in the EA Report (Appendix F).

Additionally, other regional monitoring initiatives are carried out by other government organizations in the area around the Pickering NGS, which the CNSC takes into account when assessing the protection of public health and the environment. These include the Ministry of Ontario Environment and Climate Change Drinking Water Surveillance Program, the Ontario Ministry of Labour Ontario Reactor Surveillance Program, and the Health Canada Radiation Monitoring Network, along with a Fixed Point Surveillance system. Further discussion and information on these monitoring programs are provided in the EA Report (Appendix F). These programs provide further confirmation that the environment around the Pickering NGS is protected and that no health impacts are expected.

<u>Protection of the Public</u>

This specific area within the Environmental Protection SCA is related to ensuring that members of the public are not exposed to "unreasonable" risk with respect to hazardous substances discharged from the station. At the Pickering site, systems that discharge conventional (non-radiological) contaminants to the environment are approved under the Ontario Ministry of Environment in the Environmental

Certificates of Approvals (ECAs). These approvals are issued in accordance with provincial legislations.

Based on the assessment of the OPG annual reports, quarterly reports, reported spills and regulatory performance indicators, CNSC staff concludes that members of the public were not exposed to unreasonable risks due to hazardous or nuclear substances during the licence period.

Environmental Risk Assessment

In April 2017, OPG submitted an updated Environmental Risk Assessment (ERA) report for the Pickering site based on effluent and environmental monitoring data for the five-year period between 2011and 2015. The ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for radiological and non-radiological (hazardous) chemicals of potential concern and physical stressors. The purpose of the 2017 ERA was to update the previous baseline ERA that was submitted by OPG in 2014.

CNSC staff completed a detailed technical review of the 2017 site-wide ERA and found it to be consistent with the methodology of CSA standard N288.6-12, *Environmental risk assessments at class I nuclear facilities and uranium mines and mills*. Overall, the meaningful adverse ecological and human health effects due to releases to air and water from Pickering NGS are found to be unlikely. CNSC staff's assessment of the 2017 ERA was also provided to the Commission in CMD 17-HB.5 [57].

CNSC staff concluded that OPG's 2017 ERA report for Pickering provides a complete evaluation of all potential risks to human health and the environment associated with the facility operations. CNSC staff feedback sought to improve the transparency and clarity of certain statements. Staff also provided recommendations for OPG to consider in future versions of the ERA.

5.9.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.9.3.1 Past Performance

During the licence period, OPG continued to implement and maintain an effective environmental protection program at Pickering NGS in accordance with CNSC regulatory requirements and expectations. CNSC staff are satisfied that the environmental protection program currently in place for Pickering NGS continues to protect the health and safety of people and the environment.

5.9.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's compliance with regulatory requirements through regulatory oversight activities including onsite inspections and reviews of compliance reports and of revisions to relevant program documentation.

5.9.3.3 Proposed Improvements

OPG has committed to implement the following new and/or updated standards:

- REGDOC-2.9.1 *Environmental Protection Policies, Programs and Procedures* (2013), by September 1, 2018
- CSA N288.6-12 *Environmental Risk Assessment,* by September 1, 2018
- CSA N288.3.4-13 *Performance Testing of Nuclear Air Cleaning Systems at Nuclear Facilities,* by September 1, 2018
- CSA N288.7-15 *Groundwater Protection Programs,* by December 30, 2020

These standards have been included in the proposed LCH. CNSC staff will confirm OPG compliance with these standards through compliance verification activities.

5.9.4 Conclusion

Based on the CNSC staff's review of the licence renewal application, supporting documentation and past performance, CNSC staff conclude that there are no outstanding concerns related to the protection of health and safety of persons and the environment. CNSC staff are satisfied that the environmental protection program currently in place for Pickering NGS continues to protect the public and the environment.

5.9.5 Recommendation

The following standard licensee condition is included in the proposed licence:

- LC 9.1: The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

Compliance verification criteria are detailed in the proposed LCH.

5.10 Emergency Management and Fire Protection

The Emergency Management and Fire Protection SCA covers emergency plans and emergency preparedness programs that exist for emergencies and for non-routine conditions. This area also includes any results of participation in exercises.

The specific areas that comprise this SCA include:

- Conventional emergency preparedness and response
- Nuclear emergency preparedness and response
- Fire emergency preparedness and response

5.10.1 Trends

The following table indicates the overall performance ratings for the Emergency Management and Fire Protection SCA over the current licence period:

TRENDS FOR EMERGENCY MANAGEMENT AND FIRE PROTECTION			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	SA	SA
Comments			
Pickering received a “Satisfactory” rating in this SCA throughout the licence period.			

SA = Satisfactory

5.10.2 Discussion

OPG has effective emergency management and fire protection programs at Pickering NGS that meet applicable regulatory requirements and performance objectives. Under the current PROL, OPG is required to implement and maintain an emergency preparedness program and conduct exercises in accordance with CNSC regulatory document RD-353 *Testing and Implementation of Emergency Measures*. CNSC expectations for emergency preparedness programs are contained in REGDOC 2.10.1 *Nuclear Emergency Preparedness and Response*, and OPG has confirmed implementation of version 1 of this REGDOC at Pickering NGS as of September 30, 2017.

OPG also implements and maintains a fire protection program in accordance with CSA N293 *Fire Protection for Nuclear Power Plants*.

The provincial Office of the Fire Marshall and Emergency Management (OFMEM) updated the *Provincial Nuclear Emergency Response Plan* (PNERP) in December 2017, and are targeting to update the approved OFMEM Pickering implementing plan by March 2018. The process to update the PNERP included, for the first time, a public consultation period. The Province also used an independent expert panel to address the comments received from the public and to produce recommendations on the way forward. This project also included Health Canada modelling of releases from a postulated severe accident. OPG reviewed and provided comments during the public review period for the PNERP, and will enhance its emergency plans to align with any PNERP requirements. CNSC staff also provided comments on the PNERP focusing on its alignment with national and international standards. CNSC have confirmed that the updated PNERP conforms with both CSA N1600 and IAEA standards on Emergency Management.

During the licence period, OPG implemented a number of initiatives pertaining to this SCA, including:

- In response to the Fukushima event, implementation of portable Emergency Mitigation Equipment and infrastructure to ensure water and power can be supplied in an emergency situation;
- A major exercise (Exercise Unified Control) at Pickering conducted successfully during December 6 and 7, 2017. Both OPG and CNSC staff are reviewing the lessons learned for improvement of the response capabilities.
- Distribution of Potassium Iodide (KI) tablets to all residents, institutions and businesses within the Pickering primary zone, stockpiling of KI tablets for the secondary zone and distribution of information pamphlets to local residents to enhance public awareness of nuclear emergency preparedness and response around the station.
- Installation of an automated near boundary gamma monitoring system.
- Implementation of a real-time automatic data transfer system to the CNSC Emergency Operations Centre (EOC) for use during nuclear emergencies. This system will provide prompt plant information to staff in the CNSC EOC. This helps CNSC staff to independently assess the likelihood and magnitude of a radiological release.
- Development of a new computer code “Unified RASCAL Interface” (URI) to replace the Emergency Response Projection (ERP) computer code. This code is used to determine public doses of projected radiological releases from a nuclear power plant during an emergency. The URI code now includes multi-unit modelling capabilities and multi-unit containment re-pressurization modelling capabilities. OPG has implemented URI code and training has been delivered to the required external stakeholders. OPG and CNSC staff are reviewing the experience using this code.
- Updated public evacuation time estimates in 2015-2016 with the most recently available population growth estimates. OPG has also revised its governance to maintain public evacuation time estimates (with current and future census data on a per decade estimation).
- Implementation of a program to ensure there are adequate supplies at site in the event of an extreme external event that would require essential staff to be

sequestered at site. This includes food, water, hygiene and sleeping supplies for at least a 72 hour period. Radiation Personal Protective Equipment is also stocked in quantities sufficient for 72 hours.

- Installation of a new radio system (NextGen) to increase reliability, site coverage, and inter-operability with off-site emergency response including Pickering Fire Services. A separate additional radio system has also been acquired for extreme circumstances as a back up to the main systems.
- Installation of a new emergency personnel accounting system 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.
- Ongoing joint development of a wireless public alert system that broadcasts messages through wireless (cell phone) technology. OPG is partnering with Durham Region, the OFMEM, Bell Canada and the Weather Network to pilot a Wireless Public Alerting System (WPAS) project in Durham Region.
- Implementation of a program to manage Equipment Important to Emergency Response (EITER) 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 and no backup is available.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Conventional Emergency Preparedness and Response

OPG continues to maintain satisfactory conventional emergency response programs at the Pickering NGS. Emergency Response personnel are available on site 24 hours a day to respond to any type of emergency. Training and equipment continue to be maintained for medical response, hazardous materials and other conventional hazards that may be present. CNSC staff conclude that OPG's conventional emergency response programs meet regulatory requirements.

Nuclear Emergency Preparedness and Response

The Nuclear Emergency Preparedness program at Pickering NGS is described in OPG's *Consolidated Nuclear Emergency Plan*. The plan identifies the concepts, structure, roles and resources, to implement and maintain an effective OPG response capability in the event of a nuclear emergency. OPG notified the CNSC of a revision of the plan effective October 2017. CNSC staff reviewed the revised plan and did not identify any concerns.

OPG continued to demonstrate its preparedness to respond to a nuclear emergency at the Pickering site during the licence period in accordance with regulatory requirements. OPG has established and continues to maintain its emergency response organization and works together with offsite emergency management agencies and organizations.

On December 6 and 7, 2017, OPG conducted a full-scale exercise (Exercise Unified Control) at Pickering NGS. The exercise was designed to test the capacity of on-site groups and off-site agencies to respond to a nuclear emergency at the Pickering site. The exercise simulated a severe accident and tested OPG's ability to respond to extreme events, including the use of the portable emergency mitigation equipment and connections points added to the plant post-Fukushima accident. Multiple external agencies, including the CNSC participated in the exercise. CNSC staff also evaluated OPG's conduct and performance during the exercise and will present the conclusions once finalized.

CNSC staff continue to monitor and evaluate this area as part of the overall regulatory compliance oversight program and conclude that Pickering continues to support and maintain a comprehensive nuclear emergency preparedness program.

Fire Emergency Preparedness and Response

Fire protection at the Pickering NGS is achieved through the implementation of a comprehensive fire protection program to minimize the risk to the health and safety of persons and to the environment from fire, through appropriate fire protection system design, fire safe operation and fire prevention. OPG continues to demonstrate its preparedness to prevent and respond to a fire though a comprehensive and dedicated fire response capability.

OPG has highly qualified firefighting personnel. Fire training activities occur on site and, for live fire training, off site. OPG's fire training facility at Wesleyville provides training to OPG fire responders, as well as fire fighters from other nuclear power stations and municipal fire departments. Firefighting equipment at Pickering NGS meets requirements and is well maintained.

OPG performs drills and exercises on a regular basis. Such exercises include mutual aid exercises with municipal responders to ensure interoperability in case of emergencies requiring outside assistance.

OPG continuously evaluates its fire response program and capabilities through multiple oversight initiatives which include internal program reviews, industry peer reviews and audits by independent third parties.

CNSC staff performed a compliance inspection in March 2017 and found that the implementation of the fire protection program met regulatory requirement and the overall condition of the facility is satisfactory with respect to fire protection with the exception of minor opportunities for improvements that are addressed in accordance with OPG's Corrective Action Program.

CNSC staff conclude that the fire protection program at Pickering NGS meets regulatory requirements and Pickering is performing satisfactorily with respect to this SCA. CNSC staff continue to monitor this area as part of the compliance oversight program.

5.10.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.10.3.1 Past Performance

OPG continued to maintain effective emergency management and fire protection programs at Pickering NGS that met regulatory requirements and CNSC expectations.

5.10.3.2 Regulatory Focus

CNSC staff will continue to review and monitor OPG's progress and development of the changes and improvements to its emergency response capabilities including the implementation of updated REGDOCs and CSA standards, and continued maintenance and support of the emergency response programs.

In addition, staff will monitor changes in requirements which may arise from the revision of the Provincial Nuclear Emergency Response Plan, OFMEM Pickering implementation plan and any impacts they may have on the OPG emergency management program.

5.10.3.3 Proposed Improvements

OPG has committed to implement the following updated standards:

- REGDOC-2.10.1 (version 1) *Nuclear Emergency Preparedness and Reporting*, as of September 30, 2017.
- N293-12 *Fire Protection for CANDU Nuclear Power Plants*, implementation date to be confirmed.

CNSC staff will monitor OPG's progress in this area.

CNSC staff will continue to monitor the new developments and improvements within this SCA, including:

- Partnering with OPG, 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.
- OPG's development of a new public education campaign to provide guidance in the unlikely event of a nuclear emergency and how to prepare prior to an emergency.
- OFMEM implementation of the remaining program improvements related to Nuclear Emergency Management identified in Provincial audits and assessments.

The PSR IIP identified several actions related to this SCA, including the following:

- Completion of activities to allow for the capability to restore power to essential loads via EME generators to support operation of air cooling units and hydrogen ignitors
- Implementation of design and/or operational changes to interconnect Pickering Units 1, 4 and Pickering Units 5-8 fire protection system water supplies
- Completion of the functional testing demonstration as well as the implementation of emergency response projection computer tools.
- Completion of wrenches and locks installation on specific Pickering NGS 5-8 Yard Fire Protection System yard-post indicator valves

5.10.4 Conclusion

CNSC staff conclude that OPG has sufficient provisions at the Pickering NGS for emergency preparedness and response capability, OPG has made adequate preparations to respond to an emergency, and emergency management and fire protection programs at Pickering NGS meet regulatory requirements.

5.10.5 Recommendation

The following standard licence conditions are included the proposed PROL:

- LC 10.1 – the licensee shall implement and maintain an emergency preparedness program.
- LC 10.2 – the licensee shall implement and maintain a fire protection program.

Compliance verification criteria are detailed in the proposed LCH.

5.11 Waste Management

The Waste Management SCA covers internal waste-related programs that form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. This area also covers the planning for decommissioning.

The specific areas that comprise this SCA include:

- Waste characterization;
- Waste minimization;
- Waste management practices; and
- Decommissioning plans.

5.11.1 Trends

The following table indicates the overall performance ratings for the Waste Management SCA during the current licence period:

TRENDS FOR WASTE MANAGEMENT			
Performance Ratings			
2013	2014	2015	2016
SA	SA	FS	FS
Comments			
Pickering's performance in this SCA was "Satisfactory" to "Fully satisfactory".			

SA = Satisfactory, FS= Fully Satisfactory

5.11.2 Discussion

In addition to the Pickering NGS, the Pickering Waste Management Facility (PWMF) is also located on the Pickering nuclear site and is licensed separately under a Class 1B Waste Facility Operating Licence. The PWMF consists of several installations at three different locations to handle and store used nuclear fuel from Pickering NGS that has cooled in the irradiated fuel bays of the station for several years. The PWMF operating licence was renewed in February 2018.

The following subsections detail CNSC staff's assessment, conclusions and recommendations for Pickering NGS.

OPG has a mature waste management program at Pickering NGS that meets the requirements of CSA standard N292.3-08 *Management of Low and Intermediate Level Radioactive Waste*.

OPG also maintains a Preliminary Decommissioning Plan (PDP) for Pickering NGS in accordance with CSA N294-09 *Decommissioning of Facilities Containing Nuclear Substances*. This plan is updated every 5 years and submitted to the CNSC.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Waste Characterization, Waste Minimization, and Waste Management Practices

OPG has a waste management program that governs activities to minimize, control and properly dispose of radioactive, hazardous and conventional waste. OPG's waste management program documentation describes how waste is managed throughout its lifecyle to the point of disposal. This includes waste generation, storage, processing, recycling and removal/transfer activities. OPG uses waste management procedures to ensure that waste generated at the facility is separated properly. Waste receptacles are located throughout the facility for likely clean and active waste

During the licence period, CNSC inspections of Pickering's radioactive waste management and hazardous waste management programs confirmed that OPG's management of low- and intermediate-level radioactive waste and hazardous waste at Pickering met regulatory requirements.

CNSC staff most recently conducted an inspection of the hazardous waste management program in 2017. This inspection identified areas of strength as well as opportunities to improve compliance with OPG internal procedures [58]. CNSC staff will continue to follow up with OPG's until the findings are satisfactorily resolved and undertake further inspections and assessments as required to verify compliance.

Decommissioning Plan

In accordance with paragraph 3(k) of the *Class I Nuclear Facilities Regulations* and CNSC regulatory guide G-219 *Decommissioning Planning for Licensed Activities*, OPG is required to maintain a decommissioning plan throughout the life of the station.

OPG's Preliminary Decommissioning Plan (PDP) for the Pickering NGS sets out the strategy and the preliminary plan by which the facility will be decommissioned after the permanent shutdown. Decommissioning involves removing the radioactive and other hazardous materials from the site and restoring it to an agreed end state to obtain a CNSC licence to abandon. Decommissioning should be conducted in a manner that ensures that the health, safety, and security of workers, the public, and the environment are protected. After decommissioning, OPG will retain ownership of the property and the site will then be available for other non-nuclear OPG uses.

OPG's decommissioning strategy for Pickering is described in section 4.0 of this CMD.

The PDP must be periodically updated to reflect any changes in the facility or operations. CNSC requires OPG to revise the PDP for the Pickering NGS at a minimum of every five years or when required by the Commission.

The PDP for Pickering NGS was last revised and presented to the Commission in October 2017 [59]. CNSC staff verified that OPG's PDP complies with the licensing requirements, in particular those of CSA standard N294-09 *Decommissioning of facilities containing nuclear substances*.

Based on the updated PDP, OPG also revised their financial guarantees to reflect relevant changes in the PDP. More information on the financial guarantees is provided in section 6.4.

5.11.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.11.3.1 Past Performance

OPG has a mature waste management program for both radioactive and hazardous waste at Pickering NGS. OPG's PDP for Pickering NGS meets regulatory requirements. OPG's performance in this SCA met or exceeded regulatory expectations during the current licence period.

5.11.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's compliance with regulatory requirements through regulatory oversight activities including onsite inspections and reviews of compliance reports and revisions to relevant program documentation.

5.11.3.3 Proposed Improvements

OPG has committed to implement the following new or updated standards:

- N292.2-13, *Interim dry storage of irradiated fuel*, as of September 1, 2018

This standard has been included in the proposed LCH. CNSC staff will confirm OPG compliance with this standard through compliance verification activities.

5.11.4 Conclusion

Based on CNSC staff assessments of the licence application, supporting documents and past performance, CNSC staff conclude that OPG's waste management program is effectively implemented and complies with regulatory requirements. The PDP for Pickering meets regulatory requirements.

5.11.5 Recommendation

The following standard licence conditions are included in the proposed licence:

- LC11.1: The licensee shall implement and maintain a waste management program.
- LC 11.2: The licensee shall maintain a decommissioning plan.

Compliance verification criteria for are detailed in the proposed LCH.

5.12 Security

The Security SCA covers the programs required to implement and support the security requirements stipulated in the regulations, the licence, orders, or expectations for the facility or activity.

This CMD covers the following specific areas:

- Facilities and equipment
- Response arrangements
- Security practices
- Drills and exercises
- Cyber security

5.12.1 Trends

The following table indicates the overall performance ratings for the Security SCA over the current licence period:

TRENDS FOR SECURITY			
Performance Ratings			
2013	**2014**	**2015**	**2016**
FS	FS	SA	SA
Comments			
Pickering received "Fully satisfactory" to "Satisfactory" ratings throughout the licence period.			

SA = Satisfactory, FS= Fully Satisfactory

5.12.2 Discussion

OPG maintains a security program at Pickering NGS that meets the requirements of the *Nuclear Security Regulations* (NSR) and CNSC regulatory documents. Overall, CNSC staff are satisfied with OPG's performance in this SCA. In 2015, the rating was reduced from "fully satisfactory" to "satisfactory" as a result of OPG's failure to effectively correct security equipment issues in a timely manner and for taking unilateral decisions to cease corrective actions necessary for compliance. OPG has since corrected the issues and is in compliance with the NSR.

In December 2017, OPG submitted an updated Site Security Report in accordance with regulatory guide G-274 *Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities*, which provides adequate information regarding the Pickering security program. OPG also continues to submit its annual Threat and Risk Assessment as required by the NSR.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Facilities and Equipment

OPG has processes in place to adequately prevent security events and maintains the security equipment at Pickering NGS. OPG has made improvements to the Pickering NGS preventive maintenance program to ensure that adequate personnel are available in order to effectively maintain security equipment under this program.

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. This system became operational for the security exercise under the CNSC Performance Testing Program in March 2018 and was evaluated as a performance objective.

Response Arrangements

OPG maintains a Nuclear Response Force that meets the requirements of both the NSR and REGDOC 2.12.1 *High-Security Sites: Nuclear Response Force*. CNSC staff are monitoring the implementation of corrective actions to act on lessons learned identified in the security exercise evaluated by CNSC staff in 2016.

OPG has also developed an Incident Command course, which provides valuable training and information for both the off-site response force and the Pickering NGS on-site nuclear response force. Course material is updated based on outcomes and opportunities for improvement noted in previous security exercises.

Security Practices

OPG has procedures in place at Pickering NGS to guide plant and security personnel in security practices. During the current licence period, OPG faced a number of reportable events related to employees not following procedures. OPG has since implemented a corrective action plan to reduce the frequency of these types of occurrences.

As a result of the Treasury Board Secretariat (TBS) update to its Standard on Security Screening, CNSC staff identified additional requirements for licensees to implement as part of their Site Access Security Clearance (SASC) programs. OPG has submitted a detailed implementation plan which CNSC staff have assessed as acceptable.

Drills and Exercises

OPG maintains a drill and exercise program and continues to conduct drills at Pickering NGS in accordance with regulatory requirements. In addition to conducting mandatory drills at Pickering NGS every 30 days, OPG continues to hold major security exercises every two years in accordance with section 36(2) of the NSR under the CNSC Performance Testing Program. Areas for improvement that are identified are acted upon and shared amongst security staff to promote awareness and build on best practices.

Cyber Security

OPG maintains a cyber security program at Pickering NGS.

With the issuance of CSA N290.7-14, *Cyber Security for Nuclear Power Plants and Small Reactor Facilities*, in October 2015, CNSC staff requested OPG to perform a gap analysis between the current cyber security program at Pickering NGS and the requirements of the CSA N290.7-14, and submit an implementation plan to address any identified gaps.

In 2016, OPG submitted its implementation plan, which CNSC staff have accepted. OPG's cyber security program will be fully implemented to comply with this standard by the end of 2019. CNSC staff will continue to monitor the OPG progress in this area through the conduct of regular compliance verification activities.

CNSC staff concluded that OPG's cyber security program meets current regulatory requirements in this specific area.

5.12.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.12.3.1 Past Performance

Over the licence period, OPG continued to implement and maintain an effective nuclear security program at the Pickering NGS. Corrective action plans in response to findings arising from CNSC compliance verification activities are being implemented to the satisfaction of CNSC staff.

5.12.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's performance in this area through regulatory oversight activities, including onsite inspections and reviews of compliance reporting and of revisions to relevant OPG program documents.

5.12.3.3 Proposed Improvements

OPG plans to be fully compliant with CSA N290.7-14 *Cyber Security for Nuclear Power Plants and Small Reactor Facilities*, by the end of 2019. CNSC staff will continue to monitor OPG's progress in this area. This standard has been included in the proposed LCH along with the applicable effective implementation date.

5.12.4 Conclusion

Based on CNSC staff's assessments of OPG's licence application, supporting documents and past performance, CNSC staff conclude OPG meets regulatory requirements.

5.12.5 Recommendation

The following standard licence condition is included the proposed PROL:

- LC 12.1: The licensee shall implement and maintain a security program

Compliance verification criteria are included in the proposed LCH.

5.13 Safeguards and Non-Proliferation

The safeguards and non-proliferation SCA covers the programs and activities required for the successful implementation of the obligations arising from the *Treaty on the Non-Proliferation of Nuclear Weapons* (NPT) and bilateral Nuclear Cooperation Agreements. This SCA comprises a safeguards program and a non-proliferation program.

The scope of the non-proliferation program under this licence is limited to the tracking and reporting of foreign obligations and origins of nuclear material. This tracking and reporting assists the CNSC in the implementation of Canada's bilateral Nuclear Cooperation Agreements with other countries. The import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and Export Control Regulations,* require separate authorization from the CNSC, consistent with section 3(2) of the *General Nuclear Safety and Control Regulations*.

This CMD covers the following specific areas of the Safeguards and Non-proliferation SCA:

- Nuclear material accountancy and control;
- Access and assistance to the IAEA;
- Operational and design information;
- Safeguards equipment, containment and surveillance; and
- Import and export.

5.13.1 Trends

The following table indicates the overall performance ratings for the Safeguards and Non-Proliferation SCA during the current licence period:

TRENDS FOR SAFEGUARDS AND NON-PROLIFERATION			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	SA	SA
Comments			
Pickering received "Satisfactory" ratings throughout the licence period.			

SA = Satisfactory

5.13.2 Discussion

Pickering NGS has an effective safeguards program that conforms to measures required by the CNSC to meet Canada's international safeguards obligations as well as other measures arising from the *Treaty on the Non-Proliferation of Nuclear Weapons*. Pursuant to that treaty, Canada has entered into a Comprehensive Safeguards Agreement and an Additional Protocol with the IAEA (hereafter, the safeguards agreements). The objective of the safeguards agreements is to provide annual assurance to the international community that all declared nuclear material is in peaceful, non-explosive uses and that there is no indication of undeclared material.

The CNSC provides the mechanism, through the *Nuclear Safety and Control Act*, regulations and licence, for the implementation of safeguards. Requirements for the application of safeguards are contained in the licence and LCH and in regulatory document RD-336 *Accounting and Reporting of Nuclear Material*. Compliance includes the timely provision of reports on the movement and location of nuclear material, provision of access and assistance to IAEA inspectors for safeguards activities, support for IAEA equipment, and the submission of annual operational information, additional protocol updates as well as accurate design information.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Nuclear Material Accountancy and Control

CNSC staff are satisfied that OPG complied with CNSC's regulatory requirements specified in RD-336 *Accounting and Reporting of Nuclear Material* during the licence period.

Access and Assistance to the IAEA

CNSC staff determined that the licensee granted adequate access and assistance to the IAEA for safeguard activities, including inspections and the maintenance of the IAEA's equipment.

During the licence period, the IAEA performed inspections and verifications, including four Physical Inventory Verification (PIV) inspections and four short-notice random inspections. In all cases, Pickering NGS provided the IAEA with the necessary access and assistance to perform the inspection activities, and complied with all regulatory requirements.

During the PIV in November 2016, the IAEA inspectors found that some of the spent fuel in the Pickering irradiated fuel bays could not be adequately verified because the bundle inspection platforms prevented access. Since then, OPG has been working closely and collaboratively with the CNSC and the IAEA to develop and implement corrective measures to address this issue.

CNSC staff also performed an evaluation of Pickering NGS' preparedness for the PIV in 2013, since it was not selected by the IAEA for this type of inspection that year. CNSC staff were satisfied that Pickering NGS would have been adequately prepared for an IAEA physical inventory verification had one been requested.

Operational and Design Information

Over the licence period, OPG submitted its annual operational programs with quarterly updates, annual update to the additional protocol, and other required information to the IAEA and the CNSC in a timely manner.

Safeguards Equipment, Containment and Surveillance

OPG continues to support IAEA equipment operation and maintenance activities at Pickering NGS, including maintenance work on the VXI Integrated Fuel Monitoring System and the Digital Multi-Camera Optical Surveillance System, to ensure the effective implementation of safeguards measures at Pickering NGS. OPG also supported IAEA and CNSC field surveys in 2017 to identify options for an equipment-based approach for safeguards on spent fuel transfers.

OPG reported to the CNSC an event at the station which resulted in a loss of external power to some IAEA equipment overnight from September 19 to September 20, 2017. The event was immediately reported to the IAEA and the IAEA later confirmed that there was no impact on IAEA safeguards equipment as battery back-up power came online. Continuity of knowledge with respect to material subject to safeguards was therefore maintained.

Import and Export

The scope of the non-proliferation program under this licence is limited to the tracking and reporting of foreign obligations and origins of nuclear material. CNSC staff determined that the licensee complied with the CNSC's regulatory requirements in this respect.

5.13.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.13.3.1 Past Performance

During the current licence period, Pickering NGS provided the CNSC and IAEA with all reports and necessary information in compliance with safeguards regulatory requirements, including those related to nuclear material accounting and reporting.

Overall, Pickering NGS' programs for safeguards and non-proliferation continued to meet CNSC requirements and expectations.

5.13.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's performance through participation in IAEA inspections, CNSC evaluations and ongoing assessments of compliance with reporting requirements.

5.13.3.3 Proposed Improvements

No changes to the regulatory requirements or programs within this SCA are proposed.

5.13.4 Conclusion

CNSC staff have assessed Pickering NGS' documentation and analyses under the *Safeguards and Non-Proliferation* SCA and have found it to be acceptable. CNSC staff therefore conclude that the overall performance for the SCA is satisfactory and that the licensee is qualified to carry out the authorized activities within this SCA.

5.13.5 Recommendation

The following standard licence condition is included in the proposed licence.

- LC 13.1: The licensee shall implement and maintain a safeguards program.

Compliance verification criteria are detailed in the proposed LCH.

5.14 Packaging and Transport

The Packaging and Transport SCA covers the safe packaging and transport of nuclear substances to and from the licensed facility.

The specific areas that comprise this SCA include:

- Package design and maintenance;
- Packaging and transport; and
- Registration for use.

5.14.1 Trends

The following table indicates the overall performance ratings for the Packaging and Transport SCA over the current licence period:

TRENDS FOR PACKAGING AND TRANSPORT			
Performance Ratings			
2013	**2014**	**2015**	**2016**
SA	SA	SA	SA
Comments			
Pickering received a “Satisfactory” rating throughout the licence period.			

SA = Satisfactory

5.14.2 Discussion

OPG has a packaging and transport program at Pickering NGS that complies with the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations*. CNSC staff are satisfied that Pickering’s program is effectively implemented and the transport of nuclear substances to and from facilities located on the Pickering site is done in a safe manner.

Details pertaining to the specific areas within this SCA are presented in the following subsections.

Package Design and Maintenance

The *Packaging and Transport of Nuclear Substances Regulations, 2015* apply to the packaging and transport of nuclear substances, including the design, production, use, inspection, maintenance and repair of packages, and the preparation, consigning, handling, loading, carriage and unloading of packages. OPG package designs and maintenance program meet these requirements. Where necessary, OPG package designs are certified by the CNSC.

Packaging and Transport

OPG has programs in place to ensure compliance with the requirements of both the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the

Transportation of Dangerous Goods Regulations for all shipments of nuclear substances to and from the Pickering NGS site. Shipments of nuclear substances within the nuclear facility where access to the property is controlled are exempted from the application of the *Packaging and Transport of Nuclear Substances Regulations, 2015* and the *Transportation of Dangerous Goods Regulations*.

In addition, in accordance with the *Transportation of Dangerous Goods Regulations*, OPG personnel who handle, offer for transport or transport dangerous goods at the Pickering NGS site must be trained and issued a training certificate by OPG.

There were no significant events reported under the *Packaging and Transport of Nuclear Substances Regulations, 2015* for consignments transported from the Pickering facility over the last 5 years. OPG have reported reportable events to the CNSC in a timely manner, as required by the *Packaging and Transport of Nuclear Substances Regulations, 2015*.

During the licence period, CNSC staff conducted inspections of OPG's packaging and transport program at other OPG sites (OPG has one program covering activities for all their sites) and found it to be acceptable.

Registration for Use

OPG's packaging and transport program covers the registration for use of certified packages as required by the regulations. OPG has demonstrated compliance with CNSC requirements in this area.

5.14.3 Summary

A summary of the licensee's past performance, challenges and proposed improvements are presented in the following subsections.

5.14.3.1 Past Performance

Over the licence period, OPG continued to implement and maintain an effective packaging and transport program at Pickering NGS that met regulatory requirements.

5.14.3.2 Regulatory Focus

CNSC staff will continue to monitor and evaluate OPG's performance in this SCA through regulatory oversight activities including inspections and reviews of compliance reports and other licensee submissions.

5.14.3.3 Proposed Improvements

No changes to the regulatory requirements or licensee programs within this SCA are proposed.

5.14.4 Conclusion

Based on CNSC staff assessments of the licence renewal application, supporting documents and past performance, CNSC staff conclude that OPG's packaging and transport program at Pickering NGS is effectively implemented and complies with the *Packaging and Transport of Nuclear Substances Regulations,2015* and the *Transportation of Dangerous Goods Regulations*.

5.14.5 Recommendation

The following standard licence condition is included in the proposed licence:

- LC 14.1: The licensee shall implement and maintain a packaging and transport program.

Compliance verification criteria are detailed in the proposed LCH.

6. OTHER MATTERS OF REGULATORY INTEREST

6.1 Indigenous Engagement

The CNSC is committed to building long-term relationships with Indigenous groups who have interest in the nuclear sector and the facilities and activities the CNSC regulates. CNSC staff proactively reach out and engage with Indigenous groups to share information, identify their interests and look for opportunities to work together prior to, during and post licensing decisions.

The common law duty to consult with Aboriginal peoples applies when the Crown contemplates actions that may adversely affect potential or established Aboriginal and/or treaty rights. The CNSC, as an agent of the Crown and as Canada's nuclear regulator, recognizes and understands the importance of building relationships and consulting with Indigenous peoples in Canada. The CNSC ensures that all of its licensing decisions under the NSCA uphold the honour of the Crown and consider Aboriginal peoples' potential or established Aboriginal and/or treaty rights pursuant to section 35 of the *Constitution Act, 1982*.

The site of the Pickering NGS lies within the traditional territories of the Williams Treaties First Nations (WTFN) which include:

- Mississaugas of Alderville First Nation (MAFN)
- Curve Lake First Nation (CLFN)
- Hiawatha First Nation (HFN)
- Mississaugas of Scugog Island First Nation (MSIFN)
- Chippewas of Beausoleil First Nation (CBFN)
- Chippewas of Georgina Island First Nation (CGIFN)
- Chippewas of Rama First Nation (CRFN)

Additional Indigenous groups with interest in the Pickering NGS who have asked to be kept informed of any activities related to that site include the following Indigenous groups and their affiliates:

- Mississaugas of the New Credit First Nation (MNCFN)
- Mohawks of the Bay of Quinte First Nation (MBQFN)
- Six Nations of the Grand River (SNGR)
- Métis Nation of Ontario (MNO) on behalf of the MNO Region 8 Consultation Committee
- The Chiefs of Ontario (COO)
- The Union of Ontario Indians (UOI)
- The Association of Iroquois and Allied Indians (AIAI)

During meetings with CNSC staff, representatives of the WTFN, the MNCFN and MNO Region 8 have raised issues regarding, among others, the impacts of the Pickering NGS on the environment. The full range of concerns and issues raised by other Indigenous groups are summarized in the table found in Appendix E.4, section E.4.2.

CNSC staff engaged with Indigenous groups with interest in the Pickering NGS prior to OPG's submission of its licence renewal application and throughout the regulatory review process. All Indigenous groups with an interest were invited to participate in this process, apply for participant funding and intervene at the public hearing in order to advise the Commission directly of their concerns and interests. A summary of CNSC engagement activities may be found in section 6.1.2. CNSC staff considered the information received from OPG in the licence renewal application, as well as information received by Indigenous groups, to determine whether there is a duty to consult on this application. CNSC staff observed that:

- The Commission's potential renewal of OPG's operating licence for the Pickering NGS for a ten-year period constitutes Crown conduct
- Pickering NGS is located within the traditional territories of the Williams Treaties First Nations who have raised concerns regarding localized fish kill and potential broader environmental impacts, but not regarding specific impacts to potential or established Aboriginal and/or treaty rights
- OPG's licence renewal application does not propose any changes to the facility's footprint, is located in a secure fenced-in site that has been in operation for many decades and there are no new activities and/or changes that reasonably could be anticipated to result in any novel off-site impacts

As a result of reviewing and considering this information, CNSC staff are of the view that the activities described within OPG's licence renewal application for the Pickering NGS do not raise the duty to consult. CNSC staff, recognizing the CNSC's responsibilities as a lifecycle regulator, will continue to meet with the Indigenous groups with interest to encourage and maintain productive and respectful relationships and to discuss and respond to issues as they arise.

6.1.1 Licensee Engagement Efforts with Indigenous Groups

REGDOC-3.2.2 *Aboriginal Engagement* provides guidance for licensees whose proposed projects may raise the Crown's duty to consult. OPG voluntarily followed the guidance in REGDOC-3.2.2 by engaging with the WTFN, MNCFN, MBQFN and MNO Region 8 Consultation Committee.

As summarized in OPG's Indigenous Community Engagement table, which was provided to CNSC staff for review, OPG distributed fact sheets on the Pickering NGS to all of the Indigenous groups as well as conducted initial discussions with the WTFN prior to submitting their licence application to the CNSC in August 2017. OPG subsequently met the WTFN, the MBQFN and MNO Region 8 Consultation Committee on the Pickering NGS re-licensing and to discuss environmental topics with a specific focus on impingement and entrainment.

As a result of discussions with the MNCFN, OPG was informed their interests could be represented by the WTFN. OPG continues to keep interested Indigenous groups informed of on-going activities of interest at Pickering NGS including available tours, open houses and cultural displays planned for future implementation.

CNSC staff held regular check-in meetings with OPG regarding OPG's Indigenous engagement activities and OPG provided regular updates on their Indigenous Community Engagement table. The table tracks OPG's engagement with the WTFN, MNCFN, MBQFN and MNO Region 8.

6.1.2 Summary of CNSC Engagement Activities with Indigenous Groups

In advance of OPG's Pickering NGS licence renewal application submission, CNSC staff identified Indigenous groups with potential interest in the licence renewal by reviewing which treaty lands or asserted traditional territories are close to the facility (i.e. as identified through Indigenous group websites and the Aboriginal and Treaty Rights Information System). CNSC staff also reviewed which Indigenous groups had demonstrated an interest in being kept informed of Pickering NGS-related matters at previous CNSC hearings and through previous interactions with CNSC staff.

The Indigenous groups identified were: WTFN; MNCFN; MBQFN; SNGR; MNO; the COO; the UOI; and the AIAI.

Following receipt of the licence renewal application from OPG on August 28, 2017, CNSC staff conducted various activities with these Indigenous groups to provide information on the application and to listen to and try to address any concerns raised. These activities included letters of notification, follow-up emails and phone calls and meetings. The CNSC's activities with these Indigenous groups in relation to the Pickering NGS licence renewal application are summarized in Appendix E.4, section E.4.2.

In advance of a CNSC Open House to be held at the Pickering Community Centre on March 8, 2018, CNSC staff reached out to all of the identified Indigenous groups to invite them to attend the event and raise any project-related interests or concerns. CNSC staff continue to reach out on a regular, on-going basis to all of the Indigenous groups with interest in the Pickering NGS.

6.2 Other Consultation

As per its normal public information process, CNSC staff informed the public via the CNSC website, and other methods, that a public hearing will be held for the application to renew the Pickering NGS.

6.2.1 CNSC Participant Funding Program

The CNSC made a total of $100,000 available through its Participant Funding Program (PFP) to assist members of the public, Indigenous groups, and other stakeholders in providing value-added information to the Commission through informed and topic-specific interventions. This funding was used to review

OPG's licence renewal application and other relevant documentation specifically related to the application, and to prepare for and participate in the Commission public hearing.

The public, other stakeholders and Indigenous groups were informed of the availability of participant funding through a series of public communications:

- Posting of the PFP Funding Announcement on the PFP section of the CNSC website;
- News release to subscribers of the CNSC website;
- Advertisements on-line and print media; and
- Notification by letter to potentially interested Indigenous groups.

This PFP Opportunity was open from September 29, 2017 to December 1, 2017. A Funding Review Committee, independent from CNSC staff, reviewed the funding applications received, and made recommendations on the allocation of funding to eligible applicants.

Based on recommendations from the Funding Review Committee, the CNSC awarded a total of $97,632.97 in participant funding to nine recipients, who are required to submit a written intervention and make an oral intervention at the Commission public hearing. One Indigenous group applied for and was awarded funding: the Mohawks of the Bay of Quinte First Nation. Others included the following individuals and non-governmental organizations:

- Jerry Cuttler
- Paul James Sedran
- Canadian Environmental Law Association
- Ontario Clean Air Alliance
- Women in Nuclear
- Durham Nuclear Awareness
- Northwatch
- Lake Ontario Waterkeeper

In accordance with section 17 of the *Canadian Nuclear Safety Commission Rules of Procedure*, a Notice of Public Hearing [60] has been issued and posted on the CNSC website inviting written comments and requests for appearances before the Commission.

Hearing Part One: April 4, 2018

Place: CNSC public hearing room, 14th floor, 280 Slater Street, Ottawa, Ontario

Time: As set by the agenda published prior to the hearing date

Hearing Part Two: June 26-28, 2018

Place: Hope Fellowship Church, 1685 Bloor Street, Courtice, ON.

Time: As set by the agenda published prior to the hearing date

The public hearing will be webcast live and then archived for 90 days on the CNSC website at http://www.nuclearsafety.gc.ca/eng/

Members of the public who have an interest or expertise in this matter, or information that may be useful to the Commission, are invited to comment on OPG's application on hearing Part Two. Requests to intervene must be filed with the Secretary of the Commission by May 7, 2018 online at http://www.nuclearsafety.gc.ca/eng/the-commission/intervention/index.cfm.

Pursuant to the *Canadian Nuclear Safety Commission Rules of Procedure*, the request to intervene must include the following information:

- a written submission of the comments to be presented to the Commission;
- a statement setting out whether the requester wishes to intervene by a written submission only or by both a written submission and oral presentation; and
- the name, address, and telephone number of the requester.

Agendas and information on the hearing process, including how to participate in the public hearings, are available at the CNSC website: http://www.nuclearsafety.gc.ca/eng/ under section "Hearings".

The Notice of Public Hearing was:

- distributed by traditional new release, social media, CNSC web posting and email to subscribers; and
- advertised through paid print ads in four newspapers and online media through the Indigenous online news in September 2017 and March 2018.

Information about the regulatory process for the renewal of OPG's operating licence for the Pickering NGS was communicated to the public, stakeholders and Indigenous groups through various methods by the CNSC such as feature articles, graphic updates to web, open houses and social media.

6.2.2 Conclusion

As described above, CNSC staff have encouraged the public to participate in the Commission public hearing. The CNSC provided assistance to interested members of the public, Indigenous Groups, and other stakeholders, through the PFP, to prepare for and participate in the Commission public hearing.

6.3 Cost Recovery

Paragraph 24(2)(c) of the NSCA requires that the licence application is accompanied by the prescribed fee. The *Cost Recovery Fees Regulations* (CRFR) set out the specific requirements based on the activities to be licensed. An applicant for a Class I facility licence is subject to “Part 2” of the CRFR, which is based on “Regulatory Activity Plan Fees”.

OPG’s application for the licence renewal of Pickering NGS is not a new application and, as such, the applicant is not required to submit the initial fee of $25,000 as described in paragraph 7(1)(a). In this case, OPG is subject to paragraph 5(2) of the NSCA, which relates to quarterly invoices sent to licensees.

OPG is in good standing with respect to *CRFR* requirements for Pickering NGS. Based on OPG’s previous performance, there is no concern over payment of future cost recovery fees.

6.4 Financial Guarantees

Subsection 24(5) of the NSCA provides the authority for the Commission to require a financial guarantee (FG) in a licence. In accordance with the current licence, OPG is required to maintain a FG in a form that is acceptable to the Commission. Paragraph 3(1)(*l*) of the *General Nuclear Safety and Control Regulations* stipulates that, “an application for a licence shall contain a description of any proposed financial guarantee related to the activity for which a licence application is submitted.” CNSC regulatory guide G-206, *Financial Guarantees for the Decommissioning of Licensed Activities* covers the provision of FGs for decommissioning activities.

6.4.1 Discussion

OPG maintains a consolidated FG for decommissioning its Ontario assets, including the Pickering NGS. OPG’s consolidated FG, dated May 2017, projected the minimum FG requirement for 2018 at $16,468 million.

Based on OPG’s December 31, 2017 year-end evaluation, the total guarantee available in Nuclear Funds was $21,171 million, which is higher than the CNSC FG requirement for 2018. Therefore, CNSC staff conclude that OPG’s FG meets CNSC’s requirement for 2018.

The FG that was accepted by the Commission in 2017 for Pickering NGS, as documented in the *Record of Decision* [61], includes segregated funds established pursuant to the Ontario Nuclear Funds Agreement between OPG and the Province of Ontario; the trust fund for the management of used nuclear fuel established pursuant to the *Nuclear Fuel Waste Act*. The total required amount for each year in the 2018-2022 period is projected to be satisfied without Provincial Guarantee because the projected value of the Nuclear Funds exceeds the decommissioning liability.

Currently, the FG is in effect and is sufficient to fund the future decommissioning activities as anticipated by decommissioning plans. In order to meet the licence requirements of “maintaining a financial guarantee acceptable to the Commission” and “maintaining a preliminary decommissioning plan” CNSC staff expect, as laid out in the LCH, that the decommissioning plans, including the associated cost estimates and the proposed FG, be revised by OPG on a five-year cycle. OPG's next submission of the PDP and FG is due in 2022. It is anticipated that the revised FG will be presented to the Commission by the end of 2022.

6.4.2 Conclusion

OPG maintains a FG for Pickering NGS in accordance with regulatory requirements. In 2017, the Commission approved OPG's revised consolidated FG for the 2018-2022 period.

6.4.3 Recommendation

The following standard licence condition is included in the proposed licence.

- LC G.5: The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

Compliance verification criteria for this LC are included in the proposed LCH.

6.5 Licensee Public Information Program

Since 2012, the CNSC requires NPP operators and other major licensees to maintain a Public Information and Disclosure program supported by a robust disclosure protocol that addresses stakeholders' needs.

OPG maintains a public information and disclosure program which promotes an open and transparent dialogue with their target audiences and stakeholders. Through various community engagement initiatives, OPG staff provides regular information on operations, major project activities and key milestones to their stakeholders, Indigenous groups and members of the public.

6.5.1 Discussion

OPG staff and executive members promote and participate in various components of the public information and disclosure protocol program year round. In the fall of 2017, OPG hosted a series of open houses in advance of licence renewal, in an effort to engage and promote two-way dialogue with interested parties. The sessions were reasonably well attended and generated quality discussion about the future of Pickering NGS. In addition, the sessions provided a means to gauge clarity of messaging and clarify any misconceptions about Pickering NGS.

Pickering NGS manages and maintains assets with the intention of continued safe, reliable commercial operation until 2024. A series of supplemental materials is distributed through a community newsletter *Neighbours*, and made available at the Pickering NGS visitor center. The materials highlight the key areas of public interest for Pickering NGS operations, including emergency preparedness, Pickering NGS's role in Canada's electricity sources, annual environmental monitoring results and how OPG continues to meet the requirements of the NSCA. These outreach activities help ensure public knowledge of and confidence in the licence renewal process.

OPG's information delivery is consistent and timely and uses a variety of means, determined by audience preference. Through the production and distribution of community newsletters, website updates, quarterly event reports, news releases, community partnership and sponsorship, public and Indigenous engagement, social media and government relations, OPG works to keep all of their stakeholders and the public informed of current and future station activities, their commitments to safety, security and the environment, updates of emergency preparedness measures and special projects.

The availability and clarity of information pertaining to nuclear activities is essential to establishing an atmosphere of openness, transparency and trust between the licensee and the public. CNSC staff are satisfied that OPG has a well-established Public Information and Disclosure program that meets the regulatory requirements of RD/GD-99.3, Public Information and Disclosure. The program ensures information about health, safety and security of persons and the environment, and other issues associated with the lifecycle of OPG facilities, is effectively communicated to their target audiences and available to the general public.

OPG provides annual reports on the implementation of its Public Information and Disclosure program.

6.5.2 Conclusion

The *2016 OPG Communications Report* provides a clear overview of the regular communication activities outlined above. Through conversation with Pickering NGS communications staff, participation in public activities organized by OPG and communication monitoring, CNSC staff conclude the Pickering NGS Public Information and Disclosure program meets regulatory requirements.

6.5.3 Recommendation

The following standard licence condition is included in the proposed licence:

- LC G.6: The licensee shall implement and maintain a public information and disclosure program

Compliance verification criteria for this LC are included in the proposed LCH.

6.6 Nuclear Liability Insurance

On January 1, 2017 the *Nuclear Liability and Compensation Act* (NLCA) came into force, replacing the *Nuclear Liability Act* (NLA). Whereas the administration of the NLA was shared between the CNSC and Natural Resources Canada (NRCan), the role of administering the NLCA resides solely with NRCan. Therefore, the CNSC will not require that OPG provide proof of compliance with the NLCA on an ongoing basis. OPG will be expected to meet its obligation for nuclear liability coverage under the NLCA, consistent with the CNSC general licence conditions requiring licensees to be in compliance with all applicable laws.

CNSC staff confirmed with NRCan that OPG is compliant with the NLCA financial security obligations.

6.7 Fukushima Action Items

OPG requested closure of the last remaining open generic Fukushima Action Item (FAIs) for Pickering NGS in October of 2014. CNSC staff accepted this request and concluded that OPG had strengthened reactor defence-in-depth and enhanced its emergency response at the Pickering stations in response to lessons learned from the Fukushima nuclear accident [62].

A Type II inspection of Fukushima actions was carried out by CNSC staff in 2016. The inspection focused on assessing compliance of a sample of engineering design change packages and procedures resulting from FAIs. CNSC staff concluded that OPG was in compliance with the regulatory requirements but with some inconsistencies and non-compliances with the licensee's own governance. OPG addressed the findings in a corrective action plan and closure of all action items was accepted by CNSC staff.

One Fukushima-related site specific follow up action items remains open. Action Item 2016-48-7470, discussed below, was opened to track the implementation of the emergency mitigating equipment (EME) and telecommunications projects at Pickering.

As part of the PSR project, OPG undertook a re-assessment of the original FAIs to determine if there were any impacts associated with the operation of Pickering past 2020. Carrying out of the Integrated Implementation Plan activities will further enhance plant's capability to withstand challenges posed by postulated accidents.

Emergency Mitigating Equipment and Telecommunications (Action Item 2016-48-7470)

Action Item 2016-48-7470 was raised to track Pickering site-specific activities related to the installation of Emergency Mitigating Equipment modifications and improvements to on-site and off-site emergency communications capability. OPG's most recent status update in August 2017 confirmed that Phase 1 EME modifications and enhancements and Phase 2 EME modifications were on track for completion by December 2017 [63]. OPG has informed the CNSC that these were completed by the end of 2017 as scheduled.

Fukushima Action Item (FAI) Reassessment for PSR

In a complementary evaluation performed during the safety factor review phase of the PSR, OPG reassessed Pickering FAIs to determine if there were any impacts associated with plant commercial operation past 2020 and whether the closure basis of FAIs remains valid in the context of extended operation of some of the structures, systems and components of Pickering NGS up until 2028 [64]. CNSC staff reviewed the results of OPG's reassessment, and identified one additional gap that was ultimately incorporated into the PSR IIP. The additional gap is related to FAI 1.3.2 regarding the protection of containment integrity during severe accidents. See section 5.3.2 of this CMD for details. CNSC staff will monitor the resolution of all IIP actions through the compliance verification criteria developed for LC 15.1.

6.8 OSART Mission

In 2016, an IAEA Operational Safety Review Team (OSART) mission was conducted to evaluate the Pickering NGS operational safety performance against IAEA safety standards. The Pickering mission was the 189th in the IAEA OSART program, which began in 1982. These missions provide member states with the opportunity to share best practices and to support continuous improvements to their operations. The international multi-disciplinary review team performed evaluations in the following areas:

- leadership and management for safety
- training and qualifications
- operations
- maintenance
- technical support
- OPEX feedback
- radiation protection
- chemistry
- emergency preparedness and response
- accident management
- human-technology and organization interactions
- long term operations and
- transition to decommissioning

The 2016 OSART team concluded that management at Pickering NGS is committed to improving the operational safety and reliability of the plant. The team identified 8 good practices, 11 suggestions and 10 recommendations.

OPG developed improvement strategies and established action plans for all the recommendations. To date the overall corrective action plan is approximately 85% complete. OPG is targeting to complete the remaining improvement actions by Q2 of 2018, with the exception of the recommendation related to managing alcohol and drug use testing of key staff in safety important roles.

Independent of this recommendation, in November 2017, the Commission published REGDOC-2.2.4 *Fitness for Duty Volume II: Managing Alcohol and Drug Use*. OPG has been engaged in discussions with industry peers and the CNSC to work towards an industry wide resolution of the fitness for duty program recommendation.

CNSC staff reviewed the OSART report and confirmed that in the areas where the OSART team identified opportunities for improvements, Pickering NGS remained compliant to Canadian regulatory requirements. CNSC staff are currently monitoring the effectiveness of the implemented improvements to determine if further compliance activities or corrective actions are necessary.

A follow-up mission by the IAEA is currently planned for Q3 of 2018.

The final OSART report is available through the CNSC website at http://nuclearsafety.gc.ca/eng/resources/educational-resources/feature-articles/OSART-mission.cfm

6.9 Fisheries Act Authorization

In December 2013, DFO and the CNSC signed a Memorandum of Understanding (MOU) outlining areas for cooperation and administration of the *Fisheries Act*. Under the MOU, DFO will rely on the CNSC to take on responsibilities for the assessment and monitoring of environmental impacts on fish, including species listed in the *Species at Risk Act* (SARA), and to make recommendations to DFO related to authorizations under Paragraph 35(2) of the *Fisheries Act*. DFO remains accountable for decisions under the habitat provisions of the *Fisheries Act* and for protecting aquatic species listed under the SARA.

In May 2015, OPG had an episodic fish impingement event at the Pickering NGS that impinged an estimated biomass between 5,410 to 6,428 kg. The main fish species impinged was alewife. DFO conducted an investigation and issued a letter to OPG that included a requirement for OPG to submit an application for an authorization under Paragraph 35(2)(b) of the *Fisheries Act*.

The *Fisheries Act* requires offsets for any residual harm caused to fish and fish habitats, after mitigation measures have been put in place. The offset project that OPG is proposing for the Pickering NGS requires a separate DFO authorization. Therefore, OPG has been working with DFO directly on the submission both applications. CNSC staff have remained involved by working closely with DFO and OPG, participating in all meetings, and reviewing all OPG submissions to ensure that OPG comes into compliance with the *Fisheries Act*.

As stated above, OPGs submission consists of two applications for authorization. The first application is for the proposed offset project in the Duffins Creek wetland, and the other for the OPG Pickering NGS. The project at Duffins Creek wetland is a proposed offset project that is expected to improve 4.6 hectares of fish habitat. The rehabilitation construction, however, will cause the destruction of some existing fish habitat and is the rational for requesting the Authorization. OPG in partnership with Toronto Region Conservation authority is completing this project. The second application for Authorization is for fish losses resulting from impingement and entrainment at Pickering NGS. Offsets to counteract these losses are from proposed offset measures at the Big Island Wetland from the restoration of the Simcoe Point Wetland in Duffins Creek, and from OPG Atlantic Salmon stocking contributions in Duffins Creek as a component of the Lake Ontario Atlantic Salmon Restoration Program.

In July 2017, OPG submitted an application to DFO for authorization under Paragraph 35(2) of the *Fisheries Act*. DFO conducted their review of the application and on August 30, 2017, deemed the application incomplete. Outstanding information items included additional details on measures and standards to avoid or mitigate serious harm to fish, residual serious harm to fish after implementation of avoidance and mitigation measures and standards, and additional information on the proposed offsetting plan.

In October 2017, a Fisheries Offset Productivity Monitoring Workshop was held between OPG, DFO and CNSC staff. The purpose of the workshop was to define appropriate and defensible methods to measure and evaluate fisheries productivity at OPG's proposed offset project at the Big Island Wetland, to monitor trends as the offset evolves, and to compare offset productivity with annualized losses (Age 1 equivalent) at the Pickering NGS.

In December 2017, OPG submitted a revised application for Authorization under Paragraph 35(2) of the *Fisheries Act*, and on January 11, 2018, DFO issued the Authorization to OPG to carry on the following activities that are likely to result in serious harm to fish:

- Water taking from Lake Ontario at the Pickering NGS for the operation of CANDU reactors, resulting in the impingement and entrainment of fish.
- Construction of a levee, and a fish gate and water control structure at the Simcoe Point Wetland.

The authorization also requires that OPG install a Fish Diversion System (FDS) barrier net by May 1st and that it remain in place and functioning until November 1st of each year, in order to avoid and mitigate serious harm to fish. However, as DFO determined that there is likely to be serious harm to fish even after the installation of the FDS, the authorization also requires that OPG offset the residual impacts with the following offsetting measures:

- Use of approximately 7.6 ha drawn from the existing Big Island Wetland complex habitat bank
- Rehabilitation of Simcoe Point to create a 4.6 ha coastal wetland
- Stocking of approximately 1,500 kg of Age 1 equivalent of Atlantic Salmon into Duffins Creek.

The above must be carried on in accordance with conditions in the Authorization. As per the MOU between the CNSC and DFO, CNSC is responsible to inform DFO of any non-compliance with a condition of the authorization. The authorization is valid from the Date of Issuance to December 2028.

While both the *Fisheries Act* and the NSCA ensure the protection of the environment, one Act cannot curtail the authority of another. Environmental protection is governed by a number of acts and regulations across multiple jurisdictions. Licensees must comply with all relevant federal, provincial and municipal acts and regulations.

6.10 Follow up Requests from the Commission

In the *Record of Proceedings, Including Reasons for Decision* from the 2013 Pickering licence renewal [11], the Commission directed OPG to provide a number of documents before seeking Commission approval for removal of the hold point (in 2014). These documents included:

• The revised PSA for Pickering A that meets the requirements of CNSC Regulatory Standard S-294	Complete
• An updated PSA for both Pickering A and Pickering B that takes into account the enhancements required under the Fukushima Action Plan	Complete
• A whole-site PSA or methodology for a whole site PSA, specific to the Pickering NGS site	Complete
• An action plan to address any identified issues should OPG exceed its targeted safety goals [in the Pickering A PSA]	Complete
• A report on OPG’s analysis and way for future enhancements to protect containment under the FAI	Complete

In addition, OPG was directed to:

• Produce and distribute to all households in the Pickering area an emergency management public information document summarizing the integrated emergency response plan of all involved organizations, including all key roles and responsibilities and include information on potassium iodide (KI) tablet distribution	Complete
• Produce and distribute to all households in the Pickering area an emergency management public information document summarizing the integrated emergency response plan of all involved organizations, including all key roles and responsibilities and include information on potassium iodide (KI) tablet distribution	Complete
• Clarify its long-term plan for waste management, by June 30, 2017, at the time of OPG’s notification to the Commission of the end date of commercial operations of all Pickering NGS units.	Complete

CNSC staff assessments, conclusions and recommendation to remove the hold point were provided to the Commission in CMD 14-H2 [13] at the May 7, 2014 Commission Hearing. In the *Record of Proceedings, Including Reasons for Decision* for the removal of the Pickering hold point [12], the Commission further directed OPG to:

- provide a report on the detailed risk improvement plan for Pickering NGS (resulting from bullet 4 above)
- increase monitoring, inspection and reporting on the operation of the Pickering reactor units

These additional requests from the Commission were captured in the Pickering LCH along with details on the scope of information to be provided and timing of the submissions. CNSC staff have provided annual updates on these items to the Commission through the NPP Regulatory Oversight Report. CNSC staff are satisfied that OPG has complied with these additional requests from the Commissions.

Additional details on these items are provided below.

6.10.1 Revised PSA for Pickering A and Updated PSA for Pickering A and B

The Commission directed OPG to provide a revised Pickering A PSA that meets the requirements of CNSC standard S-294, as well as an updated PSA for both Pickering A and Pickering B that takes into account the enhancements required under the Fukushima Action Plan. OPG submitted the revised and updated PSAs prior to the May 2014 Hearing for the removal of the Pickering hold point. Additional information is provided in CMD 14-H2 [13].

6.10.2 Pickering Whole Site PSA

To address the Commission direction from the 2013 *Record of Proceedings*, OPG submitted a concept level whole-site PSA methodology in February 2014. As discussed in CMD 14-H2, this was reviewed and accepted by CNSC staff.

OPG submitted the Pickering whole-site PSA in December 2017 [65], which includes supporting documents such as:

- Assessments of the irradiated fuel bay and fuel dry storage on whole-site risk, and
- Assessments of contributions from different operating states such as full operation and the shutdown state.

CNSC staff are currently reviewing this submission and will provide the Commission with the assessment results and conclusions in the NPP Regulatory Oversight Report.

CNSC staff CMD 17-M64 [14] and OPG CMD 17-M64.1 [66] were presented at the Commission Meeting of December 14, 2017, to provide Commission members and the public with an update on the development of whole site PSA.

As discussed at the Commission Meeting, OPG's results for the Pickering whole-site PSA show that the site Core Damage Frequency is less than the single unit-based safety goal of 1 in 10,000 years, and the Site Large Release Frequency is less than the single unit-based safety goal of 1 in 100,000 years. CNSC staff agree with OPG's overall results, specifically the methodology used to avoid the double counting of accident sequences.

CNSC staff provided the Commission with an update on the development of CNSC Safety Goals and staff's active role in the international effort, especially with the NEA and IAEA, to develop whole-site PSA methodology. The NEA work on the status of site level PSA developments is targeted for completion in December 2018, while the IAEA project on multi-unit PSA is targeted for completion by October 2019.

6.10.3 PSA Risk Improvement Plan

OPG developed and implemented a PSA Risk Improvement Plan to implement safety improvements for PSA values that were below the safety goal limit but above the administrative safety goal target, specifically for Pickering A Severe Core Damage Frequency (SCDF) and Large Release Frequency (LRF) for internal fires, and Pickering A LRF for Internal Events At-Power.

CNSC staff reviewed and accepted the plan which addressed physical changes to the station as well as changes to the PSA modeling. Improvements to plant design included:

- Emergency Mitigating Equipment (EME) modifications
- Installation of Passive Autocatalytic Recombiners
- Tie-down of EME for high wind
- Installation of flood barriers

These improvements have resulted in a significant risk reduction to internal fires, SCDF and LRF results.

Since 2015, OPG has provided annual updates to CNSC on the progress and status of the Risk Improvement Plan. CNSC staff have verified and confirmed that OPG has completed the risk improvement tasks based on the plan.

CNSC staff are satisfied with the current status of the implementation of risk improvement tasks. OPG has committed to complete all the items in the risk improvement plan by the end of 2017, and provide the CNSC with an update in February 2018. CNSC staff will verify the completion of the Risk Improvement Plan and report to the Commission on this matter through the NPP Regulatory Oversight Report.

6.10.4 Enhancements to Protect Containment

In January 2014, in response to one of the Fukushima Action Items, OPG submitted their plans to ensure containment integrity under severe accident conditions. CNSC staff reviewed the submission and concurred with OPG's strategy and the proposed implementation. The subject was presented to the Commission at the May 2014 Pickering hold point Hearing. Details are available in CMD 14-H2 [12]. Since then, design enhancements have been implemented to facilitate provision of power and cooling to reactor and containment systems with the intent to preserve containment integrity.

In light of OPG's plan for the continued operation of Pickering NGS beyond 2020, CNSC staff requested that OPG assess the impact the need and feasibility of further enhancements. As discussed in sections 5.3.3 and 5.4.3 of this CMD, the PSR identified modifications to protect containment through the provision of emergency power and water to the reactor air cooling units, as well as emergency power to the hydrogen igniters and the Filtered Air Discharge System (FADS). In addition, modifications will be completed to make fire protection system water available to the steam generators, heat transport system and calandria. These and other specific activities are documented in the PSR IIP.

6.10.5 Emergency Management and Public Information document

The Commission directed OPG to ensure the production of an emergency management public information document to be distributed to all households in the Pickering area summarizing the integrated emergency response plan of all involved organizations, including all key roles and responsibilities. OPG fulfilled this request by June 2014, as directed by the Commission.

6.10.6 Long Term Waste Management Plan

OPG provided clarification of its long-term waste management plan in its letter of June 28, 2017 [10].

OPG intends to dispose of low- and intermediate-level waste generated during operations and from decommissioning activities in the deep geologic repository (DGR) proposed for the Bruce nuclear site in Tiverton, Ontario. The DGR will be owned and operated by OPG. The proposed project is currently undergoing an Environmental Assessment under the *Canadian Environmental Assessment Act.*

Long term plans for used fuel

The Government of Canada has selected Adaptive Phased Management (APM) as Canada's plan for the long-term management of used nuclear fuel. APM involves the containment and isolation of used nuclear fuel in a deep geological repository in a suitable rock formation.

The Nuclear Waste Management Organization (NWMO) is responsible for implementing the APM approach. In May 2010, the NWMO launched its site selection process for a willing and informed community to host a geological repository for the long-term management of Canada's used nuclear fuel.

Following the shutdown of Pickering NGS units, OPG intends to continue storing used fuel in the dry storage containers at the Pickering Waste Management Facility, until a long-term management facility is available.

6.10.7 Increased Monitoring, Inspection and Reporting on the Operation of the Pickering Reactor Units,

This direction from the Commission was addressed to both OPG and CNSC staff [12].

As discussed in section 5.6.2, OPG implements Life Cycle Management Programs (LCMPs) for the major components (i.e. feeders, pressure tubes and steam generators). The LCMPs include structured, forward-looking inspection and maintenance schedule requirements to monitor and trend aging effects and any preventative actions necessary to minimize and control aging degradation.

CSA standard N285.4 defines the basic periodic inspection program requirements for pressure-retaining SSC. The standard provides scope, frequency and methods of inspections, acceptance criteria for inspection findings, and the disposition process requiring regulatory acceptance before reactor restart from an outage.

CNSC staff have confirmed that the major component LCMPs exceed the basic requirements and provide a more comprehensive in-service inspection plan than the mandatory requirements specified in CSA N285.4. In addition to regular inspection report submissions to the CNSC, OPG provides an annual summary report on the fitness for service of Pickering NGS major components. CNSC staff report annually to the Commission on this matter through the NPP Regulatory Oversight Report.

The results of CNSC staff's increased monitoring and inspection are discussed in section 5.6.2 of this CMD.

6.11 Delegation of Authority

The Commission has the authority to issue licences as per subsection 24(2) of the NSCA. A PROL is a Class IA licence under Part IV of the CNSC classes of licences and can only be issued by the Commission. However, the Commission can delegate certain consent approvals to another person to oversee changes to licensed activities, facilities and operations that are governed by licence conditions and the licensing basis.

Clause (iii) in Part V Explanatory Notes in the PROL indicates that LCH includes information regarding delegation of authority.

During the licence period, there are day-to-day licensing and compliance decisions that need to be made within the licensing basis that are necessary to further enhance licensee performance and to implement new requirements. It is necessary that CNSC staff be allowed to carry out this responsibility in order to provide adequate regulatory oversight of changes that are administrative in nature or are less significant and do not require a PROL amendment or Commission approval.

6.11.1 Licence

There is one proposed licence condition in the Pickering NGS PROL that contain the phrase "a person authorized by the Commission":

- LC 3.2 (restart after a serious process failure)

With respect to LC 3.2, CNSC staff recommend the Commission delegate the authority for consent to restart a reactor after a serious process failure to the following CNSC staff:

- Director, Pickering Regulatory Program Division
- Director General, Directorate of Power Reactor Regulation
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch

This delegation of authority has been previously granted by the Commission [11]. Additional information on the proposed licence conditions subject to a delegation of authority are provided in the LCH in Part Two of this CMD.

6.11.2 Licence Conditions Handbook

The LCH associated with the PROL provides details associated with each LC, such as applicable standards or regulatory documents, regulatory interpretation, compliance verification criteria, version-controlled documents, licensee written notification documents and guidance. It also includes information on delegation of authority. The LCH sets out how CNSC staff will assess compliance with the conditions of the licence. The structure of the LCH allows more freedom for the facility to evolve and update its documentation within the licensing basis.

CNSC staff recommend the Commission consider the LCH in making its decision on the renewal of the Pickering NGS PROL, and accept that the Director General of the Directorate of Power Reactor Regulation will be the sole process owner for modifying this staff-level document during the licence period.

7. OVERALL CONCLUSIONS AND RECOMMENDATIONS

CNSC staff have concluded the following with respect to Section 24(4)(a) and (b) of the NSCA, in that OPG:

1. is qualified to carry on the activities authorized by the licence; and
2. in carrying out the licensed activities, has made, and will continue to make, adequate provision for the protection of the environment, the health and safety of persons, and the maintenance of national security and measure required to implement international obligations to which Canada has agreed.

Therefore, CNSC staff recommend that the Commission:

1. Accepts CNSC staff's conclusions in section 1.3 and exercises its authority under the NSCA to renew the Pickering NGS PROL, and associated LCH, authorizing OPG to carry out the activities listed in Part IV of the licence from September 1, 2018 to August 31, 2028.
2. Accept the station-specific conditions included in the proposed licence requiring OPG to:
   a. implement the Integrated Implementation Plan;
   b. maintain Units 2 and 3 in the safe storage phase;
   c. maintain pressure tube fracture toughness sufficient for safe operation;
   d. implement and maintain plans for the end of commercial operations of all Pickering units;
   e. implement and maintain a Cobalt-60 program for activities described under Part IV of the licence; and
   f. limit the import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment.
3. Authorize OPG to operate the Pickering NGS Units 5-8 fuel channels up to a maximum of 295,000 EFPH for the lead unit.
4. Authorize the delegation of authority for the following licence condition which mentions "a person authorized by the Commission":
   a. LC 3.2 (restart after a serious process failure)

REFERENCES

1. OPG Letter, R. Lockwood to M. A. Leblanc, “Application for Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence”, August 28, 2017, CD# P-CORR-00531-05055, e-Doc 5328792
2. OPG Letter, R. Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – Preliminary List of CNSC Regulatory Documents and CSA Standards”, August 11, 2017, CD# P-CORR-00531-05087, e-Doc 5320044,
3. OPG Letter, R. Lockwood to M.A Leblanc, “Supplementary Information to the Application for Renewal of the Pickering Nuclear Generating Station Power Reactor Operating Licence”, December 11, 2017, CD# P-CORR-00531-05223, e-Doc 5414520.
4. OPG Letter, R. Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – CNSC Regulatory Documents and CSA Standards”, December 14, 2017, CD# P-CORR-00531-05228, e-Doc 5417613.
5. OPG Letter, H. Ferguson to A. Viktorov, N. Riendeau and K. Glenn, “Gap Analysis and Implementation Plan for Compliance with CSA Standard N288.7-15”, December 14, 2017. CD# N-CORR-00531-18933, e-Doc 5421310.
6. OPG Letter, H. Ferguson to A. Viktorov, N. Riendeau and K. Glenn, “Gap Analysis and Implementation Plan for Compliance with CSA Standard N288.3.4-13”, December 14, 2017. CD# N-CORR-00531-18966, e-Doc 5421300.
7. OPG Letter, R. Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – Update on the CSA N293-12 Implementation Plan”, December 15, 2017, CD# P-CORR-00531-05188, e-Doc 5419135.
8. OPG Letter, R. Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – Compliance with Standard CSA N285.4”, December 15, 2017, CD# P-CORR-00531-05193, e-Doc 5419126
9. OPG Letter, R. Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – Update to CNSC Regarding Use of CSA N285.8-15 for Fitness for Service Assessment of Pressure Tubes”, December 15, 2017, CD# P-CORR-00531-05213, e-Doc 5419124.
10. OPG Letter, R. Lockwood to G. Frappier, “End Date of Commercial Operations for Pickering NGS”, June 28, 2017. CD# P-CORR-00531-04930, e-Doc 5290277.

11. Record of Proceedings, Including Reasons for Decision in the matter of Ontario Power Generation Inc. Application to Renew the Power Reactor Operating Licence for the Pickering Nuclear Generating Station, February 20 and May 29 to 31, 2013. E-doc 4177096
12. Record of Proceedings, Including Reasons for Decision in the Matter of Ontario Power Generation Inc. Application to Request Removal of a Hold Point for the Pickering Nuclear Generating Station, May 7, 2014. E-doc 4480741
13. CMD 14-H2 Pickering NGS – Release of Licence Hold Point, e-Doc 4400887.
14. CMD 17-M64 - Presentation from CNSC Staff on Whole Site Probabilistic Safety Assessment (PSA), e-Doc 5409790.
15. CNSC Letter, M. Santini to B. McGee, “Pickering NGS: CNSC Staff Assessment of 2014 COP, SOP and CALs”, June 18, 2015, e-Doc 4782433.
16. OPG – CNSC Protocol for the Conduct of a Periodic Safety Review in support of Pickering NGS Licence Renewal, January 17, 2017, e-Doc 5143721.
17. 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.
18. OPG Letter, R. Lockwood to A. Viktorov, “Pickering NGS: Periodic Safety Review 2 – Process to Address CNCS Identified Additional Gaps”, September 18, 2017, CD# P-CORR-00531-05132, e-Doc 5342940.
19. CNCS Letter, A. Viktorov to R. Lockwood, “Pickering NGS: CNSC Staff Review of OPG Process to Address CNSC Identified Additional Gaps”, November 15, 2017, e-Doc 5392832.
20. OPG letter, R. Lockwood to A. Viktorov, “Pickering NGS – Periodic Safety Review 2 – Submission of Global Assessment Report Revision 1”, February 12, 2018, CD# P-CORR-00531-05292, e-Doc 5460376
21. CNSC letter, A. Viktorov to R. Lockwood, “Pickering NGS: Periodic Safety Review 2 - CNSC Staff Review of OPG Global Assessment Report (GAR), Revision 1”, February 19, 2018, e-Doc 5461487
22. OPG letter, R. Lockwood to A. Viktorov, “Pickering NGS Periodic Safety Review 2 – Submission of Integrated Implementation Plan”, November 30, 2017. CD# P-CORR-00531-05085, e-Doc 5406515
23. CNSC letter, A. Viktorov to R. Lockwood, “ Pickering NGS: Periodic Safety Review 2 – CNSC Staff Review of OPG Integrated Implementation Plan (IIP), Rev. 000”, February 13, 2018, e-Doc 5455745
24. OPG letter, R. Lockwood to A. Viktorov, “Pickering NGS Periodic Safety Review 2 – Submission of Integrated Implementation Plan Revision 1”, March 1, 2018. CD# P-CORR-00531-05311, e-Doc 5470841

25. CNSC letter. A. Viktorov to R. Lockwood, “Pickering NGS: CNSC Staff Acceptance of Pickering NGS Periodic Safety Review 2 (PSR2) Integrated Implementation Plan (IIP), Revision 1”, March 2, 2018, e-Doc 5470609
26. Pickering Site Strategic Plan - P-PLAN-09314-00003-R000, July 14, 2017, e-Doc 5310699.
27. CNSC Letter, A. Viktorov to R. Lockwood, “Pickering NGS: Regulatory Expectations for Pickering End of Commercial Operation”, August 2, 2017, e-Doc 5307950.
28. CNSC letter, T. E. Schaubel to P. Pasquet, “Pickering NGS-B – CNSC Staff Expectations for the Transition to End-of-Life, New Action Item 2010-8-05”, May 5, 2012. e-Doc 3546506,
29. CNSC letter, M. Santini to G. Jager, “Pickering NGS – Clarification Related to the Applicable Framework Regarding the End-of-Life Approach and Continued Operations”, August 1, 2012. e-Doc 3973315,
30. OPG - CNSC Protocol for managing the end of commercial operation of Pickering NGS, June 23, 2013, e-Doc 4164039.
31. CNSC Type II Compliance Inspection Report OPG-2017-003 “Organization, Roles and Responsibilities”, April 6, 2017, e-Doc 5176964.
32. CNSC Type II Compliance Inspection Report PRPD-2015-013 “Management Review Inspection”, May 25, 2017, e-Doc 4797528.
33. CNSC Type II Inspection Report PRPD-2017-013 “Self and Independent Assessment Programs”, August 31, 2017, e-Doc 5237496.
34. CNSC Type II Inspection Report PRPD-2017-019 “Problem Identification and Resolution – Event Investigation”, August 23, 2017, e-Doc 5325520.
35. CNSC Type II Inspection Report PRPD-2016-005 “Configuration Management”, May 18, 2016, e-Doc 4955349
36. CNSC Type II Inspection Report PRPD-2017-010 “Supplier Management”, September 25, 2017, e-Doc 5276840.
37. CNSC Type II Inspection Report PRPD-2017-011 “Minimum Shift Complement”, July 28, 2017, e-Doc 5261105.
38. OPG Letter, G. Jager to G. Frappier and H. Tadros, “OPG Implementation Plan for REGDOC 2.2.4 Fitness for Duty: Managing Worker Fatigue. Action Item 2017-0PG-9637”, September 25, 2017, CD# P-CORR-00531-18759, e-Doc 5355839
39. CNSC letter, N. Riendeau and A. Viktorov to B. Duncan and R. Lockwood, “Darlington and Pickering NGS: Verification of Reporting of Hours of Work Non-Compliance – Action Item 2017-OPG-12076”, November 27, 2017. E-Doc 5398917
40. CNSC Letter, G. Frappier to R. Lockwood, “Darlington NGS & Pickering NGS: Implementation of REGDOC-2.2.4, Fitness for Duty, Volume II:

Managing Alcohol and Drug Use - New Action Item 2017-OPG-12225", December 21, 2017, e-Doc 5419875.

41. CNSC Letter, A. Viktorov to R. Lockwood, "Pickering NGS: Review of Computational Aid No. 4 (CA-4) – Closure of RIB 5996 and New Action Item 2017-48-11959", November 2, 2017, e-Doc 5373467.
42. CNSC Letter, B. D. Howden to W. S. Woods, "Darlington and Pickering NGS: Enhanced Neutron Overpower Protection (E-NOP) Extreme Value Statistics (EVS) Methodology, Closure of Action Item 2009OPG-06 - New Action Item 2016-OPG-7349", January 21, 2016, e-Doc 4907195.
43. CNSC Letter, M. Santini and A. Viktorov to S. Woods, "Resolution of Large Break LOCA (LBLOCA) Safety Analysis Margin Issue – Completion of Preparatory Phase of REGDOC-2.4.1 Compliant Safety Analysis using a More Realistic Implementation of the Limit of Operating Envelope (LOE) Methodology - New Action item 2017-OPG-6447", May 10, 2017, e-Doc 5236345
44. CNSC letter, B.D. Howden to W.S. Woods, "CNSC Calandria-Tube Strain Contact Boiling (CSCB) Experiments", December 17, 2015. CD# N-CORR-00531-17968, e-Doc 4906060.
45. CNSC letter, M. Santini and A. Viktorov to W.S. Woods, "Darlington and Pickering NGS: CNSC Calandria-tube Strain Contact Boiling Experiments, New Action Item 2017-OPG-9657", April 4, 2017. E-Doc 5218860
46. CMD 16-M34 - Submission from CNSC Staff on Risk-Informed of CANDU Safety Issues, e-Doc 5016949.
47. CMD 17-M12 Submission from CNSC Staff on the Continuation of Commission Meeting Item: Risk-informed Assessment of CANDU Safety Issues, e-Doc 5077033.
48. CNSC letter, N. Riendeau and A. Viktorov to W.S. Woods, "Pickering and Darlington NGS: Application for Closure of Action Item 2014-OPG-5632 - Remaining Work for CSI AA3: Computer Code and Plant Model Validation", October 13, 2017, e-Doc 5353232
49. CNSC Type II Compliance Inspection Report PRPD-2014-214 "Implementation of Pressure Boundary Program" January 14, 2015, e-Doc 4612494
50. CNSC Desktop Review Report PRPD-2017-022 "Maintenance and Reliability", January 24, 2018, e-Doc 5370492
51. CNSC Type II Compliance Inspection Report PRPD-2015-015 "Integrated Aging Management Program" October 6, 2015, E-doc 4810051
52. CMD 18-M4, "Technical Update on Fuel Channel Fitness-for-Service in Canadian Nuclear Power Plants", January 23, 2018, eDocs 5422679
53. CNSC Type II Compliance Inspection Report PRPD-2015-025 "Implementation of CSA N285.4-05: Fuel Channel Pressure Tubes

Supplementary Inspections- Focus Area: Inspection of Pressure Tubes, Collection, Reporting and Retention of Inspection Data”, March 4, 2016, e-Doc 4875234.

54. CNSC Type II Compliance Inspection Report PRPD-2017-007 “Fuel Channel Pressure Tubes: Analyses and Methodologies”, September 12, 2017, e-Doc 5265309.
55. CNSC Type II Compliance Inspection Report PRPD-2017-008 “Worker Dose Control” April 4, 2017, e-Doc 5062029.
56. CNSC Type II Compliance Inspection Report PRPD-2016-023 “Fixed Area Gamma Monitoring and Type I Semi-Portable Alarming Gamma Monitoring Systems”, March 3, 2017, e-Doc 5119478.
57. Supplemental CNSC staff CMD 17-H5.B, Ontario Power Generation Inc.: Pickering Waste Management Facility, October 30, 2017. E-doc 5297716
58. CNSC Type II Compliance Inspection Report PRPD-2017-009 “Non-Radiological Hazardous Waste Management”, August 30, 2017, e-Doc 5228197.
59. CMD 17-H11 - Submission from CNSC Staff on OPG Consolidated Financial Guarantee 2018-2022, e-Doc 5306917.
60. Notice of Public Hearing and Participant Funding, Ref. 2018-H-03, September 29, 2017, E-doc 5342922
61. CNSC Record of Decision in the Matter of Ontario Power Generation Inc. “Financial Guarantee for the Future Decommissioning of Ontario Power Generation Inc.’s Facilities in Ontario” Hearing date October 11, 2017, e-Doc 5400969
62. CNSC Letter, M. Santini and F. Rinfret to M. Elliot, “Darlington and Pickering NGS: CNSC Review of OPG Status Update #6 on Fukushima Action Items”, January 21, 2015, e-Doc 4595113.
63. OPG Letter, R. Lockwood to A. Viktorov, “Pickering NGS – CNSC Action Item 2016-48-7470 Status Update on Emergency Mitigating Equipment and Telecommunications Projects”, August 2, 2017, CD# P-CORR-00531-05096, e-Doc 5313005.
64. OPG Letter, B. McGee to A. Viktorov, “Pickering NGS: Periodic Safety Review 2 – Submission of Reassessment of Fukushima Action Items”, March 1, 2017, CD# P-CORR-00531-04934, e-Doc 5202421.
65. OPG letter, R. Lockwood to A. Viktorov, “Pickering Whole-Site Risk Assessment”. December 13, 2017. e-Doc 5416582
66. CMD 17-M64.1 - Presentation from OPG on Update on Whole Site Probabilistic Safety Assessment (PSA), e-Doc 5410205.

GLOSSARY

Acronym	**Term**
AIA	Authorized Inspection Agency
AIM	Abnormal Incidents Manual
ALARA	As Low As Reasonably Achievable
BDBA	Beyond Design Basis Accident
BTI	Business Transformation Initiative
CAA	Composite Analytical Approach
CANDU	Canada Deuterium Uranium
CEAA	Canadian Environmental Assessment Act
CMD	Commission Member Document
CME	Common Mode Events
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
Co-60	Cobalt-60
CSA	Canadian Standards Association
CSI	CANDU Safety Issue
CRFR	Cost Recovery Fees Regulations
CT	Calandria Tube
DCC	Digital control computer
DDP	Detailed Decommissioning Plan
DFO	Fisheries and Oceans Canada
DRL	Derived Release Limit
EA	Environmental Assessment
EFPH	Equivalent Full Power Hours
EHPSW	Emergency High Pressure Service Water
ELPSW	Emergency Low Pressure Service Water
EME	Emergency Mitigating Equipment
EMS	Environmental Management System

E-NOP	Enhanced NOP
EOP	Emergency Operating Procedures
EPG	Emergency Power Generator
ERA	Environmental Risk Assessment
FADS	Filtered Air Discharge System
FAI	Fukushima Action Item
FG	Financial Guarantee
FHA	Fire Hazard Assessment
FSSA	Fire Safe Shutdown Analysis
GAI	Generic Action Item
GAR	Global Assessment Report
HTS	Heat Transport System
HROL	Hydrided region overload
IAEA	International Atomic Energy Agency
I&C	Instrumentation and Control
IEMP	Independent Environmental Monitoring Program
IIP	Integrated Implementation Plan
INPO	Institute of Nuclear Power Operations
KI	Potassium Iodide
LBB	Leak Before Break
LC	Licence condition
LCH	Licence Conditions Handbook
LCMP	Life Cycle Management Plan
LOCA	Loss of Coolant Accident
LOE	Limit of operating envelope
LRF	Large Release Frequency
MEL	Master Equipment List
MOL	Ministry of Labour
MOU	Memorandum of Understanding
MSC	Minimum Shift Complement
mSv	Millisievert

MWe	Megawatts
NEW	Nuclear Energy Worker
NGS	Nuclear Generating Station
NOP	Neutron Overpower Protection
NPP	Nuclear Power Plant
NRCan	Natural Resources Canada
NSCA	Nuclear Safety and Control Act
NSCMP	Nuclear Safety Culture monitoring Panels
NSR	Nuclear Security Regulations
OEM	Original Equipment Manufacturer
OHSA	Occupational Health and Safety Act
OP&Ps	Operating Policies and Principles
OPEX	Operating Experience
OPG	Ontario Power Generation Inc.
PARs	Passive Autocatalytic Recombiners
PDP	Preliminary decommissioning plan
PFP	Participant Funding Program
PFU	Predicted Future Unavailability
PIDP	Public Information and Disclosure Program
PIP	Periodic Inspection Program
PROL	Power Reactor Operating Licence
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PT	Pressure Tube
PWMF	Pickering Waste Management Facility
QA	Quality Assurance
R&D	Research and Development
RD	Regulatory Document
SAM	Severe Accident Management
SAMG	Severe Accident Management Guidelines
SAP	Stabilization activity plan

SASS	Severe accident software simulator
SAT	Systematic Approach to Training
SBLOCA	Small Break Loss of Coolant Accidents
SCA	Safety and Control Area
SCDF	Severe Core Damage Frequency
SIS	Systems Important to Safety
SOE	Safe Operating Envelope
SOP	Sustainable operations plan
SSCs	Structures, Systems and Components

A. RISK RANKING

The CNSC uses a risk-informed regulatory approach in the management and control of regulated facilities and activities. CNSC staff have therefore established an approach based on CSA guideline, *CAN/CSA-Q850, Risk Management: Guideline for Decision Makers*, to risk rank specific issues, events and areas of regulatory interest.

This approach conforms to other international standards as well, such as IAEA Safety Guides GS-G-1.3, *Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body,* and GS-G-1.2, *Review and Assessment of Nuclear Facilities by the Regulatory Body*. This approach, referred to as the *CNSC Risk Informed Decision Making Process,* has been applied to each SCA at a generic level to determine relative risk rankings as they relate to the given facility and activity types.

The following matrix provides a high-level overview of risk ranking, and the management and monitoring approach associated with the various degrees of risk.

APPROACH TO ASSESSING AND MANAGING POTENTIAL RISK			
CONSEQUENCE	**MANAGEMENT/MONITORING APPROACH**		
Significant Impact	Considerable management of risk is required	Must manage and monitor risk with occasional control	Extensive management is essential. Constant monitoring and control
Moderate Impact	Occasional monitoring	Management effort is recommended	Management effort and control is required
Low Impact	Random monitoring	Regular monitoring	Manage and monitor
Probability of Occurrence	Unlikely to Occur	Might Occur	Expected to Occur

RISK RANKING SCALE					
L	Low Risk	**M**	Moderate Risk	**H**	High Risk

Due to the complex nature of operational activities for power reactors, this simplified approach gives insufficient differentiation between the areas reviewed. Therefore, the *CNSC Risk Informed Decision Making* process has been applied to generate relative risk rankings for the purpose of determining a risk estimate for each SCA. The table below gives the relative risk rankings (normalized weight factor) for the SCAs determined by this process.

Table A.1: Normalized weighing factor for SCAs

Functional Area	Safety and Control Area	Normalized Weight Factor
Management	Management System	0.102
	Human Performance Management	0.096
	Operating Performance	0.096
Facility and Equipment	Safety Analysis	0.096
	Physical Design	0.102
	Fitness for Service	0.096
Core Control Processes	Radiation Protection	0.113
	Conventional Health and Safety	0.106
	Environmental Protection	0.096
	Emergency Management and Fire Protection	0.096
	Waste Management	0.099
	Security	0.099
	Safeguards and Non-Proliferation	0.099
	Packaging and Transport	0.099

Over the span of a year, individual inspection findings at a facility are risk ranked as high, medium or low. When these are combined, a rating for each specific area can be found for that year. These specific area ratings can then be grouped to determine a risk ranking for an entire SCA. Then the annual integrated plant rating, reported in the annual NPP Regulatory Oversight Report, is found by integrating the scores for the individual SCAs and factoring in licensee's past performance, the weighing factors, and expert judgment.

Generally, a high-risk SCA would be subject to increased regulatory scrutiny and control (e.g., high frequency of inspection) while a low-risk SCA would generally require minor verification and control. These risk rankings are not static and will change over time for a given facility and activities (e.g. phase, age, condition of plant, evolution of program knowledge and understanding, etc.).

B. RATING LEVELS

The following rating terminology is used by the CNSC.

Table B.1: Rating terminology

RATING LEVEL	DESCRIPTION
FS	Fully Satisfactory
SA	Satisfactory
BE	Below Expectations
UA	Unacceptable

Note: For SCAs with a security classification of "PROTECTED B" or higher, the classification is indicated in place of the rating level.

Fully Satisfactory (FS)

Safety and control measures implemented by the licensee are highly effective. In addition, compliance with regulatory requirements is fully satisfactory, and compliance within the safety and control area (SCA) or specific area exceeds requirements and CNSC expectations. Overall, compliance is stable or improving, and any problems or issues that arise are promptly addressed.

Satisfactory (SA)

Safety and control measures implemented by the licensee are sufficiently effective. In addition, compliance with regulatory requirements is satisfactory. Compliance within the SCA meets requirements and CNSC expectations. Any deviation is minor and any issues are considered to pose a low risk to the achievement of regulatory objectives and CNSC expectations. Appropriate improvements are planned.

Below Expectations (BE)

Safety and control measures implemented by the licensee are marginally ineffective. In addition, compliance with regulatory requirements falls below expectations. Compliance within the SCA deviates from requirements or CNSC expectations to the extent that there is a moderate risk of ultimate failure to comply. Improvements are required to address identified weaknesses. The licensee is taking appropriate corrective action.

Unacceptable (UA)

Safety and control measures implemented by the licensee are significantly ineffective. In addition, compliance with regulatory requirements is unacceptable and is seriously compromised. Compliance within the SCA is significantly below requirements or CNSC expectations, or there is evidence of overall non-compliance. Without corrective action, there is a high probability that the deficiencies will lead to unreasonable risk. Issues are not being addressed effectively, no appropriate corrective measures have been taken and no alternative plan of action has been provided. Immediate action is required.

C. BASIS FOR THE RECOMMENDATIONS

C.1 Regulatory Basis

The recommendations presented in this CMD are based on compliance objectives and expectations associated with the relevant SCAs and other matters. The regulatory basis for the matters that are relevant to this CMD are as follows:

Management System

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 3(*d*) that an application for a licence for a Class I nuclear facility shall contain the proposed quality assurance program for the activity to be licensed.
- The *General Nuclear Safety and Control Regulations* requires that an application for a licence shall contain, under paragraphs:
    - 3(1)(*k*), the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the NSCA and the regulations made under the NSCA, including the internal allocation of functions, responsibilities and authority.
    - 15(*a*), the persons who have the authority to act for them (the applicant/licensee) in their dealings with the Commission.
    - 15(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.

Human Performance Management

- It is a requirement of the *General Nuclear Safety and Control Regulations* under section 12, that the licensee shall:
    - 12(1)(a), ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence.
    - 12(1)(b), train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence.
    - 12(1)(e), require that every person at the site of the licensed activity to use equipment, devices, clothing and procedures in accordance with the Act, the regulations made under the Act and the licence.
- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(m) that a licence application contains information on the proposed responsibilities of and the qualification requirements and training program for workers, including the procedures for the requalification of workers.
- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(n) that a licence application contains information on 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.

- It is a requirement of the *Class I Nuclear Facilities Regulations* under subsection 9(2) that the Commission or a designated officer authorized under paragraph 37(2)(b) of the Act may certify a person referred to in paragraph 44(1)(k) of the Act for a position referred to in a licence after receiving from the licensee an application stating that the person:
    - (a) meets the applicable qualification requirements referred to in the licence
    - (b) has successfully completed the applicable training program and examination referred to in the licence
    - (c) is capable, in the opinion of the licensee, of performing the duties of the position

Operating Performance

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(d) that an application for a licence to operate a Class I nuclear facility shall contain the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility.

Safety Analysis

- 3(1)(i) of the *General Nuclear Safety and Control Regulations* requires that an application for a licence shall contain a description and the results of any test, analysis or calculation performed to substantiate the information included in the application.
- It is a requirement of the *Class I Nuclear Facilities Regulations* that an application for a licence to operate a Class I nuclear facility shall contain the following information under paragraphs:
    - 6(c), a final safety analysis report demonstrating the adequacy of the design of the nuclear facility
    - 6(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.

Physical Design

- Paragraph 3(1)(d) of the *General Nuclear Safety and Control Regulations* requires that an application for a licence shall contain a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence.
- Other requirements set out in paragraphs 3(a), 3(b), 6(a) and 6(b) of the *Class I Nuclear Facilities Regulations* require more specific information to be submitted in the licence application related to the site and design of the facility and the final safety analysis report.

- Paragraphs 6(c) and 6(d) of the *Class I Nuclear Facilities Regulations* require that an application for a licence contain a final safety analysis report demonstrating the adequacy of the design of the facility and proposed measures, policies, methods and procedures for operating and maintaining the facility.

Fitness for Service

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(d) that an application for a licence to operate a Class I nuclear facility contain the proposed measures, policies, methods and procedures for operating and maintaining the nuclear facility.

Radiation Protection

- The *General Nuclear Safety and Control Regulations* require, under subsection 3(1), that a licence application contain the following information under paragraphs:
    - 3(1)(e), the proposed measures to ensure compliance with the Radiation Protection Regulations
    - 3(1)(f), any proposed action level for the purpose of section 6 of the *Radiation Protection Regulations*
- The *Radiation Protection Regulations* require, under sections 4 to 6, that the licensee implements a radiation protection program, ascertain and record doses, and take the required actions in the case that an action level has been reached.
- The *Class I Nuclear Facilities Regulations* require that an application for a licence to operate a Class I nuclear facility contain:
    - under paragraph 6(e), the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances
    - under paragraph 6(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 measure that will be taken to prevent or mitigate those effects

Conventional Health and Safety

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 3(f) that an application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the proposed worker health and safety policies and procedures.
- OPG is required to comply with the *Occupational Health and Safety Act of Ontario*, and the *Labour Relations Act*. Related legislation includes the *Ontario Workplace Safety and Insurance Act* and the *Ontario Human Rights Code*.

Environmental Protection

- The *General Nuclear Safety and Control Regulations*, under paragraphs 12(1)(c) and (f), require that each licensee take all reasonable precautions to protect the environment and the health and safety of persons, and to control the release of radioactive nuclear substances and hazardous substances within the site of the licensed activity and into the environment.

- The *Radiation Protection Regulations* prescribe dose limits for the general public, which under subsection 1(3) is 1 mSv per calendar year.
- In addition, sections 3 and 6 of the *Class I Nuclear Facilities Regulations* must be met by the applicant. The application for a licence shall contain under paragraphs:
    - 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
    - 3(g), the proposed environmental protection policies and procedures
    - 3(h), the proposed effluent and environmental monitoring programs
    - 6(e), the proposed procedures for handling, storing, loading and transporting nuclear substances and hazardous substances
    - 6(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
    - 6(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
    - 6(j), the proposed measures to control releases of nuclear substances and hazardous substances into the environment

Emergency Management and Fire Protection

- 12(1)(c) of the *General Nuclear Safety and Control Regulations* states that every licensee shall "take all reasonable precautions to protect the environment and the health and safety of persons and to maintain security"
- 12(1)(f) of the *General Nuclear Safety and Control Regulations* states that every licensee shall "take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment of the licensed activity"
- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 6(k) that a licence application contains information on the licensee's 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 national security, including measures to:
    - assist offsite authorities in planning and preparing to limit the effects of an accidental release

  - notify offsite authorities of an accidental release or the imminence of an accidental release
  - report information to offsite authorities during and after an accidental release
  - assist offsite authorities in dealing with the effects of an accidental release
  - test the implementation of the measures to prevent or mitigate the effects of an accidental release

Waste Management

- It is a requirement of the *General Nuclear Safety and Control Regulations* under paragraph 3(1)(j) that an application for a licence include the name, quantity, form 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.

Security

- It is a requirement of all Class I licensees to comply with the *Nuclear Security Regulations*.

Safeguards

- It is a requirement of the *General Nuclear Safety and Control Regulations* under paragraph 12(1)(i) that each licensee take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement, where the applicable agreements are:
  - The *Agreement between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*
  - The *Protocol Additional to the Agreement between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*

Packaging and Transport

OPG is required to comply with the *Packaging and Transport of Nuclear Substances Regulations, 2015.*

Preliminary Decommissioning Plan and Financial Guarantees

- The *General Nuclear Safety and Control Regulations* requires under paragraph 3(1)(l) that a licence application contains a description of any proposed financial guarantee relating to the activity to be licensed.
- Paragraph 3(k) of the *Class I Nuclear Facilities Regulations* requires that an application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain the proposed plan for the decommissioning of the nuclear facility or of the site.

Licensee's Public Information Program

- It is a requirement of the *Class I Nuclear Facilities Regulations* under paragraph 3(j) that an application for a licence in respect of a Class I nuclear facility, other than a licence to abandon, shall contain information on the licensee's public information program.

C.2 Technical Basis

The technical basis for recommendations presented in this CMD includes international guidance documents, national standards and regulatory documents, and is specified in the applicable sections of the LCH.

D. SAFETY AND CONTROL AREA FRAMEWORK

D.1 Safety and Control Areas Defined

The SCAs identified in section 2.4, and discussed in summary in sections 5.1 through 5.14 are comprised of specific areas of regulatory interest which vary between facility types.

The following table provides a high-level definition of each SCA. The specific areas within each SCA are identified in section C.2.

Table D.1: Safety and control area definitions

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
Management	Management System	Covers the framework which establishes the processes and programs required to ensure an organization achieves its safety objectives and continuously monitors its performance against these objectives and fostering a healthy safety culture.
	Human Performance Management	Covers activities that enable effective human performance through the development and implementation of processes that ensure that licensee staff is sufficient in number in all relevant job areas and that licensee staff have the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.
	Operating Performance	This includes an overall review of the conduct of the licensed activities and the activities that enable effective performance.
Facility and Equipment	Safety Analysis	Maintenance of the safety analysis that supports that overall safety case for the facility. Safety analysis is a systematic evaluation of the potential hazards associated with the conduct of a proposed activity or facility and considers the effectiveness of preventative measures and strategies in reducing the effects of such hazards.
	Physical Design	Relates to activities that impact on the ability of systems, components and structures to meet and maintain their design basis given new information arising over time and taking changes in the external environment into

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
		account.
	Fitness for Service	Covers activities that impact on the physical condition of systems, components and structures to ensure that they remain effective over time. This includes programs that ensure all equipment is available to perform its intended design function when called upon to do so.
Core Control Processes	Radiation Protection	Covers the implementation of a radiation protection program in accordance with the RP Regulations. This program must ensure that contamination and radiation doses received are monitored and controlled.
	Conventional Health and Safety	Covers the implementation of a program to manage workplace safety hazards and to protect personnel and equipment.
	Environmental Protection	Covers programs that identify, control and monitor all releases of radioactive and hazardous substances and effects on the environment from facilities or as the result of licensed activities.
	Emergency Management and Fire Protection	Covers emergency plans and emergency preparedness programs which exist for emergencies and for non-routine conditions. This also includes any results of exercise participation.
	Waste Management	Covers internal waste-related programs which form part of the facility's operations up to the point where the waste is removed from the facility to a separate waste management facility. Also covers the planning for decommissioning.
	Security	Covers the programs required to implement and support the security requirements stipulated in the regulations, in their licence, in orders, or in expectations for their facility or activity.
	Safeguards and Non-Proliferation	Covers the programs and activities required for the successful implementation of the obligations arising from the Canada/IAEA safeguards agreements as well as all other measures arising from the *Treaty on the Non-*

SAFETY AND CONTROL AREA FRAMEWORK		
Functional Area	**Safety and Control Area**	**Definition**
		Proliferation of Nuclear Weapons.
	Packaging and Transport	Programs that cover the safe packaging and transport of nuclear substances and radiation devices to and from the licensed facility.

D.2 Specific Areas for this Facility Type

The following table identifies the specific areas that comprise each SCA for nuclear power plants:

Table D.2: Specific areas for nuclear power plants

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
Management	Management System	▪ Management System ▪ Organization ▪ Performance Assessment, Improvement and Management Review ▪ Operating Experience (OPEX) ▪ Change Management ▪ Safety Culture ▪ Configuration Management ▪ Records Management ▪ Management of Contractors ▪ Business Continuity
	Human Performance Management	▪ Human Performance Programs ▪ Personnel Training ▪ Personnel Certification ▪ Initial Certification Examinations and Requalification Tests ▪ Work Organization and Job Design ▪ Fitness for Duty
	Operating Performance	▪ Conduct of Licensed Activity ▪ Procedures ▪ Reporting and Trending

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
		▪ Outage Management Performance ▪ Safe Operating Envelope ▪ Severe Accident Management and Recovery ▪ Accident Management and Recovery
Facility and Equipment	Safety Analysis	▪ Deterministic Safety Analysis ▪ Hazard Analysis ▪ Probabilistic Safety Analysis ▪ Criticality Safety ▪ Severe Accident Analysis ▪ Management of Safety Issues (including R&D Programs)
	Physical Design	▪ Design Governance ▪ Site Characterization ▪ Facility Design ▪ Structure Design ▪ System Design ▪ Components Design
	Fitness for Service	▪ Equipment Fitness for Service/Equipment Performance ▪ Maintenance ▪ Structural Integrity ▪ Aging Management ▪ Chemistry Control ▪ Periodic Inspection and Testing
Core Control Processes	Radiation Protection	▪ Application of ALARA ▪ Worker Dose Control ▪ Radiation Protection Program Performance ▪ Radiological Hazard Control ▪ Estimated Dose to Public
	Conventional Health and Safety	▪ Performance ▪ Practices

SPECIFIC AREAS FOR THIS FACILITY TYPE		
Functional Area	**Safety and Control Area**	**Specific Areas**
		▪ Awareness
	Environmental Protection	▪ Effluent and Emissions Control (releases) ▪ Environmental Management System (EMS) ▪ Assessment and Monitoring ▪ Protection to the Public ▪ Environmental Risk Assessment
	Emergency Management and Fire Protection	▪ Conventional Emergency Preparedness and Response ▪ Nuclear Emergency Preparedness and Response ▪ Fire Emergency Preparedness and Response
	Waste Management	▪ Waste Characterization ▪ Waste Minimization ▪ Waste Management Practices ▪ Decommissioning Plans
	Security	▪ Facilities and Equipment ▪ Response Arrangements ▪ Security Practices ▪ Drills and Exercises
	Safeguards and Non-Proliferation	▪ Nuclear Material Accountancy and Control ▪ Access and Assistance to the IAEA ▪ Operational and Design Information ▪ Safeguards Equipment, Containment and Surveillance ▪ Import and Export
	Packaging and Transport	▪ Package Design and Maintenance ▪ Packaging and Transport ▪ Registration for Use

E. SUPPORTING INFORMATION

E.1 Event Initial Reports

Two event initial reports (EIRs) were submitted for Pickering during the current licence period. Details are provided in the Table below.

Table E.1: Event initial reports for Pickering (September 2013 to February 2017)

Subject	Brief Description
Leak of heavy water within containment at Unit 7 of Pickering	A station emergency was initiated at Pickering due to a loss of moderator inventory at Unit 7 on November 21, 2014. At the time of the event, the unit was in a planned outage and the reactor in an over-poisoned moderator reactor shutdown guarantee when the moderator collection tank high-level alarm was received. Moderator heavy water passed through openings of an auxiliary system under maintenance and spilled onto the reactor building floor inside containment. A station emergency was declared to provide additional management oversight, to direct personnel to evacuate the incident area and to assemble for accounting. The moderator level stabilized four hours later and all the spilled heavy water (approximately 6,200 litres) was contained within the reactor building. Containment was isolated as per approved procedures to ensure retention of airborne tritium inside the reactor building during the station emergency to minimize release to the environment. The spilled heavy water was cleaned-up. CNSC site inspectors conducted an inspection and confirmed findings of OPG’s investigation of the event. This event was reported to the Commission through CMD 14-M80 on December 17, 2014. CMD 14-M80 completed CNSC staff notification to the Commission on this event.
Minor injury incident of security staff	Confidential information (per CMD 15-M34).

E.2 Fuel Channel Fitness for Service

The following subsections describe the current issues pertaining to the continued demonstration of structural integrity and fitness for service of Pickering fuel channels until the end of commercial operation.

Pressure tube axial elongation and projected end of bearing travel time

Pressure tubes are exposed to an extreme environment that includes elevated temperatures, high pressure and fast neutron flux. These conditions cause dimensional changes in the pressure tubes, including axial elongation. The elongation of the pressure tubes reduces the available bearing travel length and time. OPG calculates the projected end of the bearing travel time based on the most limiting channel in the respective units. The bearing travel related to fuel channel elongation is a factor that could limit fitness for service of the fuel channels and it requires continued pressure tube elongation measurements to identify the limiting fuel channel assemblies. The channels with limited bearing travel time, in comparison to the target end of life, are selected for reconfiguration or shifting. OPG has a well-developed management strategy incorporated into the aging management programs to address this issue.

Deuterium ingress

Hydrogen equivalent concentration ([Heq]) is an important factor that adversely affects pressure tube material properties. The [Heq] consists of the initial hydrogen from the manufacturing process and deuterium ingress during operation due to corrosion. There are two established sources for deuterium ingress into the pressure tubes; one is from uniform corrosion, which extends along the entire length of the pressure tube. The other source comes from the corrosion at the inlet and outlet sections of the pressure tube (known as the “rolled joint” region). The inlet and outlet regions tend to have higher deuterium ingress in comparison to remaining “body of tube” region.

Deuterium ingress is not a life-limiting mechanism on its own; however, with continued operation it affects the pressure tube material property through increasing [Heq].

Heq is a critical factor that influences material toughness when the pressure tube material is exposed to transition temperatures (such as during reactor head-up and cool-down). Fracture protection and leak-before-break assessments are directly influenced by [Heq]. Similarly, [Heq] also play an important factor in pressure tube flaw assessments as well as pressure tube to calandria tube contact assessment. All these assessments depend on accurate Heq in-service measurements, as well as conservative predictions for a given channel or the entire core.

Based on current Heq in-service measurements, and supporting predictive models, the pressure tubes in Pickering units are not expected to reach very high [Heq] values and it is not considered life-limiting for Pickering. CNSC continues to monitor OPG in-service measurements as well as and periodic material surveillance results.

Pressure tube flaw degradation mechanisms

The following sections introduce the three known pressure tube flaw degradation mechanisms that may lead to the development of a through-wall crack.

Delayed hydride cracking

Hydrogen tends to migrate to areas of high stress and lower temperature. With sufficient hydrogen in the vicinity of a sharp flaw, the hydrogen would migrate to the flaw tip (creating a hydride in the area). Should the applied hoop stress (from coolant pressure or residual stress at the flaw location) exceed a critical value, the formed brittle hydride can crack. If this happens, additional hydrogen will migrate to the area of greater stress, and the crack will grow.

These cracks cannot be visually detected during in-service pressure tube inspections for two primary reasons: a) limitation of the inspection tool resolution; and b) the tubes would not subject to the same stress at the crack opening.

When inspecting tubes for flaws, any suspect flaw is carefully investigated. Licensees may replicate the flaw by applying a molding compound, and following its removal, the replica flaw geometry is measured (e.g. flaw-tip radius) and assessed.

Crack initiation by hydrided region overload

Hydrided region overload occurs when hydrides, created under a certain applied stress (i.e. operating pressure), are subjected to a higher hoop stress (normally from an increase in coolant pressure). This can occur either during normal operation (i.e. current shut-down procedures) or during a design basis transient.

An increase in hydrogen equivalent concentration tends to increase the brittleness of pressure tube material, thereby reducing resistance to pressure transients, particularly during reactor shutdown or reactor trips.

Fatigue

Fatigue is defined as cracking in a susceptible material produced by the combined action of repeated or fluctuating stress. Coolant chemistry can also play a role. This degradation mechanism is presently the least prevailing amongst the three flaw depredation mechanisms.

Pressure tube – calandria tube contact (PT-CT contact)

In addition to elongation, irradiation-induced dimensional changes also makes pressure tubes sag between their spacers. This may increase to a point where the hot pressure tube could come into contact with the cooler calandria tube, referred to as PT-CT contact. PT-CT contact may result in the formation of a brittle hydride blister which could subsequently crack and potentially lead to pressure tube rupture at the contact location.

This degradation mechanism is particularly important for units operating with loose-fitting spacers (also known as loose-fitting garter springs), such as Pickering Units 5-8. Loose fitting spacers can shift under normal operating conditions, thereby increasing the unsupported span length of the fuel channel which can lead to PT-CT contact.

Irradiation-induced material property changes in tight-fitting spacers

Tight-fitting spacers are predicted to maintain their position, and do not face challenges such as those for loose-fitting spacers. More specifically, as the X-750 spacers age, their ability to maintain structural integrity diminishes. Research confirmed the creation of helium bubbles along the grain boundaries of the spacer material. OPG, along with its industry partners, are presently funding research where irradiated X-750 spacers are being crush-tested to predict their limitations.

Calandria tube – liquid injection shutdown system (CT-LISS) nozzle contact

Due to irradiation-induced dimensional changes in the calandria tubes the gap between the calandria tube and LISS nozzle tends to narrow in certain areas. Contact between the two components is undesirable and can affect the ability of the affected LISS nozzle to operate as expected, as well as affecting the structural integrity of the calandria tube.

This degradation mechanism applies to Pickering Units 5-8, as the design for Units 1, 4 do not contain LISS nozzles.

Reduction in fracture toughness

Fracture toughness is a material property, which describes the ability of a material containing a crack to resist fracture. Among other parameters, the fracture toughness is sensitive to the presence of hydrides and, in turn, the [Heq] level in the pressure tube. Other factors that are believed to affect fracture toughness are impurities such as chlorine, as well as material fabrication. In 2013, OPG collaborated with other industry partners to develop new fracture toughness models to predict pressure tube material behaviour due to changes in parameters such as [Heq], chlorine concentration, and temperature. The models are composed of an upper shelf regime, transition temperature regime, and lower shelf regime.

1. The upper shelf regime is characterized by tubes being in a ductile state, and subject to normal operating temperatures. Current R&D results suggest that the fracture toughness in this regime is unaffected by [Heq].
2. The transition temperature regime is characterised by tubes transitioning between a brittle and ductile state. Current R&D confirms that the transition temperature regime is dependent on [Heq] concentration, whereby higher Heq levels lead to lower fracture toughness. This regime is applicable to reactor start up and shut down conditions. Current research suggests that the transition point between the transition temperature regime and upper shelf regime may be shifting towards higher temperatures, such that the cooler inlet sections of pressure tubes may be at risk of not operating in the upper shelf regime during normal operating conditions.
3. The lower shelf regime is characterized as being in a brittle state, and subject to low temperature. Fracture toughness in this regime is dependant on [Heq].

Other degradation mechanisms

Other degradation mechanisms like pressure tube wall thinning, diametral expansion and sag are not considered as life limiting with respect to structural integrity, up to the end of commercial operation of Pickering pressure tubes, as OPG has a well-established process to inspect the pressure tubes and mitigating measures to address any issues if necessary.

Pressure tube leak-before-break (LBB) assessments

Terminal solid solubility for dissolution (TSSD) is the threshold level at which pressure tube material is susceptible to delayed hydride cracking under any sustained hot condition. When [Heq] is predicted to exceed the TSSD, the governing fitness-for-service standard requires licensees to demonstrate leak-before-break (LBB). To initiate delayed hydride cracking, a sharp flaw should be present in the pressure tube and the [Heq] should exceed the TSSD limit. If either of these two conditions are not met, it's difficult to initiate delayed hydride cracking in a pressure tube. As only a small number of pressure tubes are volumetrically inspected in any given outage to detect any susceptible flaws that are crack-like and could initiate delayed hydride cracking under favorable conditions, a core-wide evaluation is necessary to account for the possibility that a crack could exist in an uninspected tube somewhere in the reactor core. The evaluation involves postulating pressure tube through-wall cracks, and simulating crack growth and comparing it against the critical crack length through a Monte Carlo method, from normal operating conditions through to a depressurized state.

LBB assessments are used to demonstrate that in the unlikely event of a leak from a pressure tube, the consequential leak will be detected in time to shut down the reactor and cool and depressurize the primary heat transport system before the pressure tube ruptures. Licensees estimate this through a conditional probability. Factors that would affect the demonstration of LBB includes pressure tube dimensional changes, changes in fracture toughness, leak-detection system availability and operator response time.

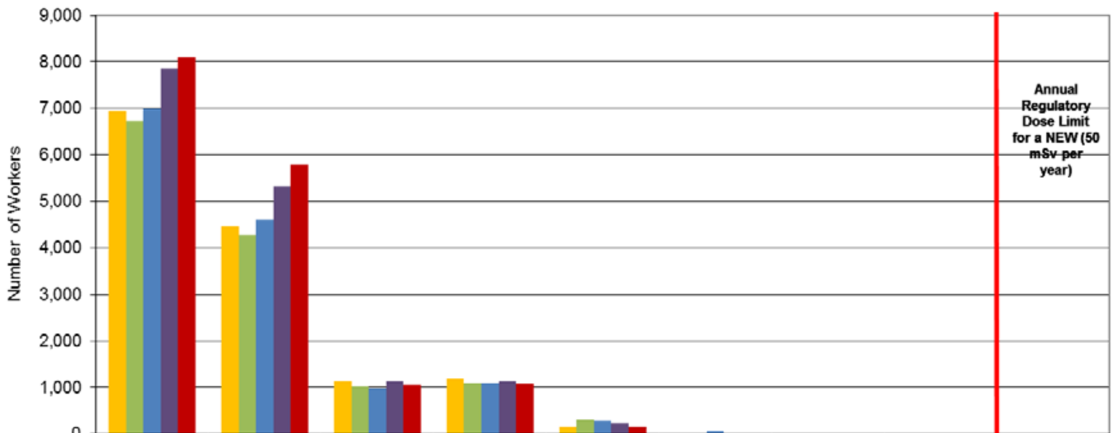
E.3 Radiation Protection

Individual Effective Doses at Pickering NGS

Figure 7 presents the distribution of annual effective doses to all monitored persons at Pickering NGS according to dose information from the National Dose Registry (NDR).

Figure 7 also shows that in the current licence period, there were no radiation exposures received at Pickering NGS that exceeded the annual regulatory dose limit of 50 mSv for a Nuclear Energy Worker (NEW). In addition, approximately 81 percent of workers monitored received doses at or below the annual regulatory dose limit of 1 mSv for a member of the public.

Figure 7: Annual effective dose distribution to workers at Pickering NGS

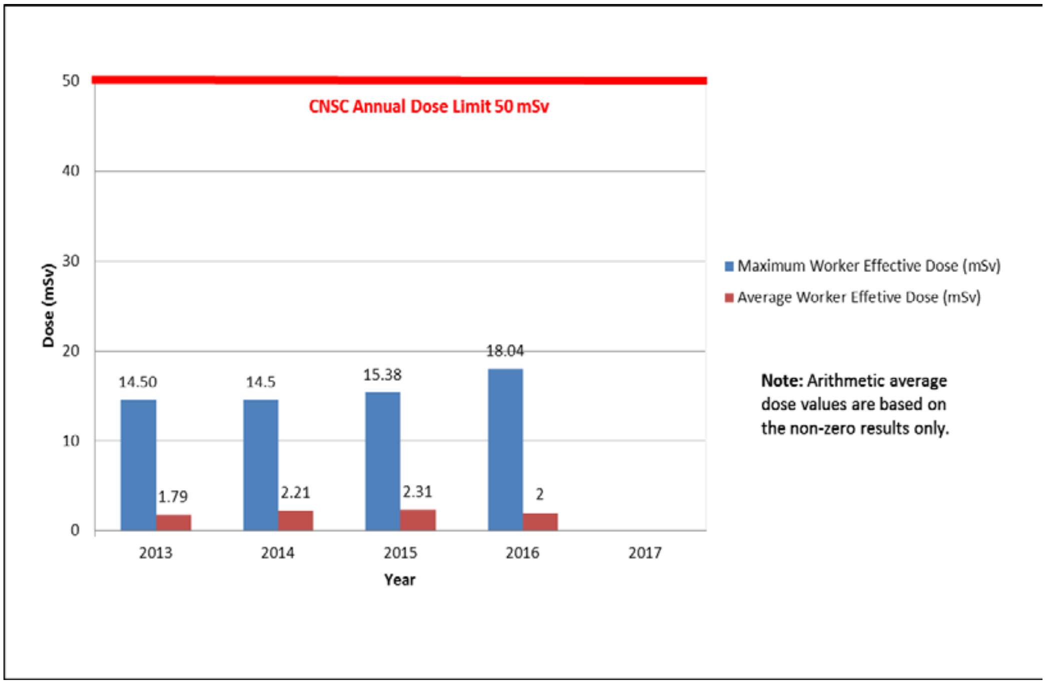


	Number of Workers Monitored	< 0.01 mSv (Reportable Level)	0.01 - 1 mSv	1 - 5 mSv	5 - 10 mSv	10 - 15 mSv	15 - 20 mSv	20 - 50 mSv	> 50 mSv
2013	6,946	4,465	1,122	1,189	154	16	0	0	0
2014	6,728	4,287	1,018	1,088	312	23	0	0	0
2015	7,002	4,601	976	1,098	280	46	1	0	0
2016	7,854	5,323	1,130	1,134	242	21	4	0	0
2017*	8,089	5,793	1,059	1,072	157	8	0	0	0

Dose Range (mSv)

*Year to date dose data includes information submitted by OPG up to September 2017

Figure 8: Maximum and average individual effective dose to workers



2017 Data will be available after April 30, 2018.

Figure 8 illustrates the maximum and average individual effective dose to monitored persons at Pickering NGS. This figure shows that the annual average[4] effective dose at Pickering NGS ranged from 1.79 mSv to 2.31 mSv. The maximum individual effective dose received by a worker at the Pickering NGS site ranged from 14.5 mSv to 18.04 mSv during 2013-2016.

In general, the fluctuations in maximum and average doses observed from year to year are reflective of the type and scope of work being performed at the facility. No negative trends were identified during the licence period. CNSC staff continue to monitor doses to workers through the compliance verification program.

Annual Collective Doses at Pickering NGS

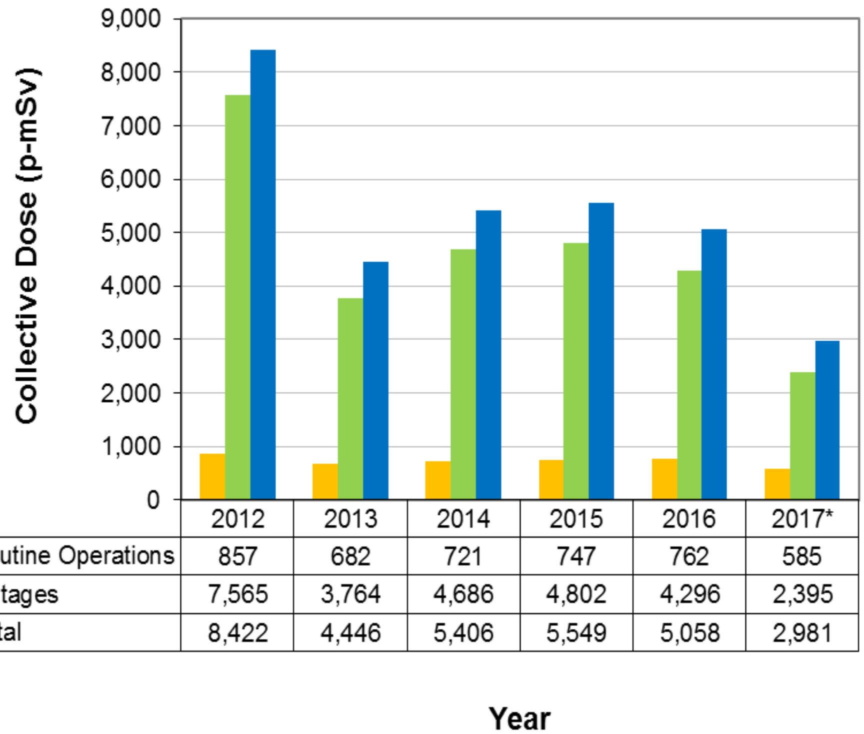
During the licence period, Pickering NGS has implemented work management and planning strategies to control collective dose and minimize individual exposures ALARA. Collective doses at Pickering NGS were maintained within or below dose targets.

Figures 9 and 10 illustrate the distribution of annual collective effective dose per operational state (routine versus outage) and the distribution of dose by internal and external doses at Pickering NGS.

[4] The “average effective dose” or “average effective dose – non-zero results only” is obtained by dividing the total collective dose by the total number of individuals receiving a dose above the minimum reportable level of 0.01 mSv.

During the current licence period for Pickering NGS, Units 1, 4 and Units 5-8 were operational and Units 2 and 3 remained in safe storage. Outage activities accounted for approximately 85 percent of the total collective dose while routine operations accounted for an average of about 15 percent of the total collective dose and remained nearly constant from year to year. Most of the radiation dose received by workers came from external exposure. Approximately 17 percent of the collective dose was from internal exposure with tritium being the main contributor to exposed workers' internal doses.

Figure 9: Collective effective dose by operational state for Pickering NGS, 2013-2017

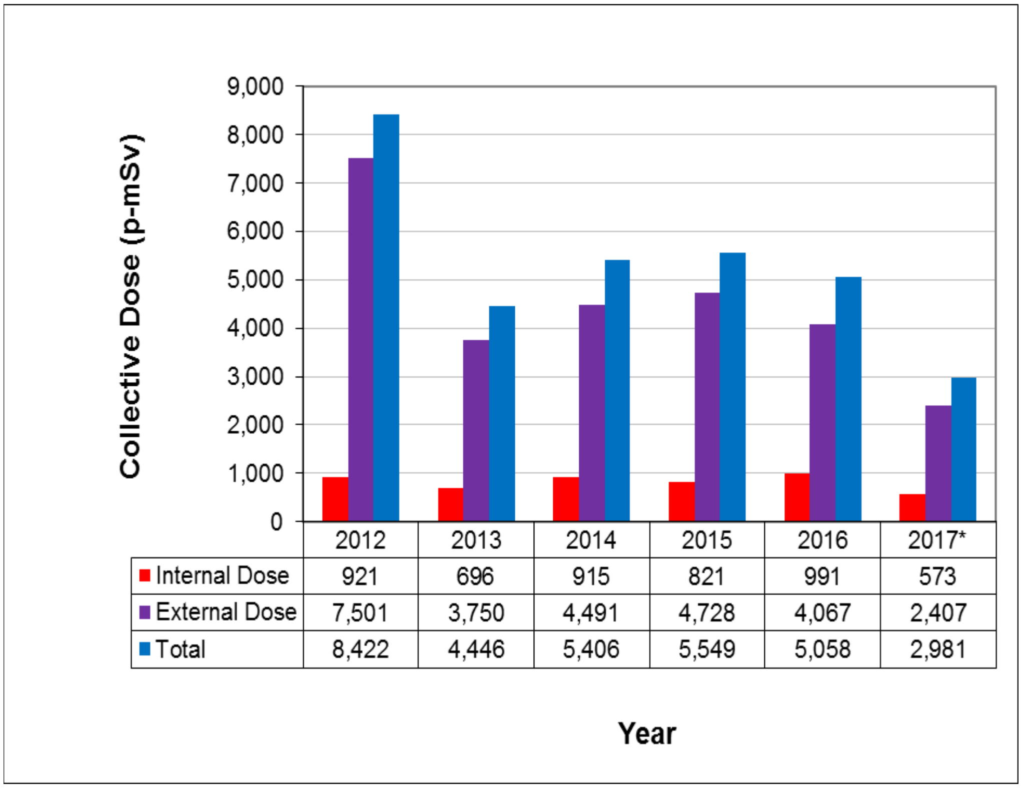


	2012	2013	2014	2015	2016	2017*
Routine Operations	857	682	721	747	762	585
Outages	7,565	3,764	4,686	4,802	4,296	2,395
Total	8,422	4,446	5,406	5,549	5,058	2,981

* Year to date dose data includes information submitted by OPG up to September 2017.

Note: For routine operations, variations between years are attributed partly to how long the plant operated during each year as well as to typical dose rates associated with the station's operation. The outage dose (planned and forced) includes the dose to all personnel, including contractors. Parameters affecting the dose include the number of outages for the year, the scope and duration of the work, the number of workers involved and dose rates associated with the outage work.

Figure 10: Collective dose from internal and external exposures for Pickering NGS, 2014–2017



* Year to date dose data includes information submitted by OPG up to September 2017.

Note: The external dose is the portion of the dose received from radiation sources outside the body. The internal dose is the portion received from radioactive material taken into the body.

E.4 Indigenous Engagement

E.4.1 Established and Asserted Aboriginal Rights

<u>**Williams Treaties First Nations (WTFN)**</u>

The Pickering NGS is located within the Region of Durham, Ontario which itself is covered by the Williams Treaties (1923) to which there are 7 signatory First Nations:

- Mississaugas of Alderville First Nation
- Curve Lake First Nation
- Hiawatha First Nation
- Mississaugas of Scugog Island First Nation
- Chippewas of Beausoleil First Nation
- Chippewas of Georgina Island First Nation
- Chippewas of Rama First Nation

Figure 11: Map of the Williams Treaties (1923)

Source: Canada Report on the Royal Commission on Aboriginal Peoples Vol. 1: Looking Forward, Looking Back, Ministry of Supply Services, 1996.

Mississaugas of Alderville First Nation (MAFN)

Located about 83 kilometres (km) east of the Pickering NGS, MAFN has been home to the Mississauga Anishinabeg of the Ojibway Nation since the mid-1830's. Before that time the people lived in their traditional lands around Bay of Quinte (Grape Island).

MAFN is affiliated with the Ogemawahj Tribal Council, the Union of Ontario Indians (UOI) (Anishinabek Nation) and Chiefs of Ontario (COO).

Curve Lake First Nation (CLFN)

Located about 90 km southwest of the Pickering NGS the Curve Lake people are the Mississaugas of the great Anishnaabeg Nation. The First Nation territory consists of a mainland peninsula and large island (Fox Island) on Buckhorn and Chemong Lake. Curve Lake First Nation also co-owns smaller islands located throughout the Trent Severn Waterway system. Curve Lake is affiliated with the UOI and COO.

Hiawatha First Nation (HFN)

Located 76 km east of the Pickering NGS on the north shore of Rice Lake east of the Otonabee River, HFN is home to the Miissississaugii people from the Mississauga Nation (i.e. Ojibways). HFN is affiliated with the COO and the Association of Iroquois and Allied Indians (AIAI).

Mississaugas of Scugog Island First Nation (MSIFN)

Located approximately 42 km from the Pickering NGS, the SIFN moved into southern Ontario from their former homeland north of Lake Huron around the year 1700 and are a branch of the greater Ojibwa Nation. MSIFN is affiliated with the UOI, COO and the Ogemawahj Tribal Council (OTC).

Chippewas of Beausoleil First Nation (CBFN)

Located about 140 km northwest from the Pickering NGS, the CBFN consists of three Islands known as Christian, Hope and Beckwith, as well as land on the mainland at Cedar Point. The CBFN is affiliated with the OTC, UOI and COO.

Chippewas of Georgina Island First Nation (CGIFN)

Located 95 km from the Pickering NGS, the GIFN is affiliated with OTC, COO and the UOI.

Chippewas of Rama First Nation (CRFN)

Located approximately 95 km north of Pickering NGS, the RFN are Ojibwe peoples and part of the Three Fires Confederacy along with the Odawa and Pottawatomi Nation. They are affiliated with the OTC, COO and UOI.

Mississaugas of New Credit First Nation (MNCFN)

Located near Brantford, Ontario approximately 112 kms southwest of Pickering NGS within the Southern Ontario Treaty lands. Their traditional territory extends from Long Point on Lake Erie to the Rouge River east of Toronto. The MNCFN have a number of asserted claims including the *"The Rouge River Valley Tract Unsurrendered Traditional Lands - Statement of Claim"* to Canada and the Ontario Ministry of Aboriginal Affairs which asserts that MNCFN traditional territory was never surrendered by the MNCFN or their ancestors.

Mohawks of the Bay of Quinte First Nation (MBQFN)

Located 150 km from the Pickering NGS, the MBQFN are part of the Mohawk Nation within the Iroquois /Haudenosaunee Confederacy and are a member First Nation of the

AIAI. Following the American Revolution, the MBQFN was granted a tract of land, which came to be known as the Mohawk Tract, of approximately 92,700 acres on the Bay of Quinte. A deed to this land, known as the Simcoe Deed or Treaty 3 ½ was executed on April 1, 1793 by Lieutenant Governor John Graves Simcoe. Today, the MBQFN have approximately 18,000 acres remaining of the original treaty land base.

Six Nations of the Grand River (SNGR)

The SNGR consist of the Oneida, Cayuga, Mohawk, Seneca, Onondaga and Tuscocara. During the American Revolution they were awarded a tract of land along the Grand River in exchange for their loyalty to the British.

Métis Nation of Ontario (MNO)

The MNO was established in 1993 to represent the collective aspirations, rights and interests of Métis people and communities throughout Ontario. The MNO has a democratic, province-wide governance structure which ensures Métis people are represented at the local, regional and provincial levels. The MNO recognizes nine distinct Regions. The Pickering site is located within Region 8.

Figure 12: MNO Regions

Source: MNO website: http://www.metisnation.org/programs/economic-development/mno-regions

Chiefs of Ontario (COO)

The COO is an advocacy forum and secretariat for collective decision-making, action, and advocacy for the 133 First Nations communities located in Ontario. Guided by the Chiefs in Assembly, the COO upholds self-determination efforts of the Anishinaabek, Mushkegowuk, Onkwehon:we, and Lenape Peoples in protecting and exercising their inherent and treaty rights.

The Union of Ontario Indians (UOI)

The UOI was incorporate by the Anishinabek Nation as its secretariat in 1949. The UOI is a political advocate for 40 member First Nations across Ontario and is the oldest political organization in Ontario. It can trace its roots back to the Confederacy of Three Fires, which existed long before European contact.

The Association of Iroquois and Allied Indians (AIAI)

The AIAI was founded in 1969 and is mandated as a Provincial Territorial Organization (PTO) to defend and enhance the Indigenous and treaty rights of its member First Nations. The AIAI represents First Nations citizens from seven member communities. It is unique among provincial associations because of the diversity of its members which include Oneida, Mohawk, Delaware, Potawatomi, and Ojibway communities from all across Ontario. HFN and MBQFN are represented by the AIAI.

E.4.2 Summary of Key CNSC Meetings/Activities with Indigenous Groups Related to the Pickering Site

Group(s)	Letter(s)	Email(s)	Phone Call(s)	Meeting(s)	Questions Raised / Issues Discussed
WTFN	√	√	√	September 20, 2017 November 21, 2017	▪ Concerns over high rate of fish kill and why wetlands within WTFN were not chosen for associated conservation efforts ▪ Why Indigenous groups were not consulted when the facility was first built ▪ How the CNSC remains impartial when it is financed through a cost-recovery program ▪ How the CNSC identifies Indigenous groups and addressees Aboriginal and treaty rights ▪ How may First Nations influence a Commission decision when the duty to consult is not raised ▪ If there is Indigenous representation on the Commission ▪ What plans are in place for the long-term storage of nuclear waste including from the Pickering NGS and what happens to that waste if there is no willing host community ▪ How CNSC will ensure OPG meets its obligations in terms of the shut-down of the PNGS and continue monitoring the site ▪ How is the transportation of nuclear waste regulated and controlled, and what routes are there within the WTFN traditional territories ▪ How Indigenous groups may contribute to the

Group(s)	Letter(s)	Email(s)	Phone Call(s)	Meeting(s)	Questions Raised / Issues Discussed
					Independent Environmental Monitoring Program (IEMP) identification of species or sites to sample (interest raised regarding wild game, pollinators) ▪ What is meant by following the most ‘stringent’ standards ▪ What is meant by the term ‘licence to abandon’ ▪ How are cumulative impacts addressed (i.e. in relation to worker safety) ▪ How are environmental impacts mitigated if identified in relation to a facility (e.g., concerns raised in relation to the salinization of Lake Ontario, impact to hunting and fishing) ▪ What activities at Pickering NGS would trigger an environmental assessment and how could the new environmental assessment legislation impact the ten year licence renewal
MNCFN	√	√	√	November 1, 2017	▪ What is the Province of Ontario’s new energy plan ▪ What is the source of uranium and how it is used in nuclear reactors ▪ How do we obtain a tour of the facility (which OPG subsequently committed to) ▪ How to apply for participant funding and intervene in a hearing ▪ What field work the CNSC does ▪ How the MNCFN might contribute to the IEMP site sampling locations
MBQFN	√	√	√	X	Awarded participant funding
SNGR	√	√	√	X	No response to CNSC communications
MNO Region 8	√	√	√	January 14, 2018	▪ What steps will CNSC take related to the eventual shut-down of the PNGS reactors ▪ Concerns regarding the impacts of the facility on all fish, but most specifically on salmon ▪ Raised the importance of understanding how perceptions regarding the hazards of nuclear power facilities impact Metis harvesting and fishing ▪ Is sediment tested under the IEMP ▪ How does CNSC advocate licensee Aboriginal engagement
COO	√	√	√	X	No response to CNSC communications
UOI	√	√	√	X	No response to CNSC communications
AIAI	√	√	√	X	Replied that no further follow-up required as AIAI members are represented by WTFN

F. ENVIRONMENTAL ASSESSMENT REPORT

Environmental Assessment Report: Ontario Power Generation Inc. Pickering Nuclear Generating Station – PROL 48.00/2018 Licence Renewal

e-Doc 5394841

Canada's Nuclear Regulator

Environmental Assessment Report:

Ontario Power Generation Inc.

Pickering Nuclear Generating Station - PROL 48.00/2018 Licence Renewal

March 2018

e-Doc: 5342754 (Word)
e-Doc: 5394841 (PDF)

Canadian Nuclear Safety Commission

Commission canadienne de sûreté nucléaire

Canada

REVISION HISTORY

The following table identifies the revision history of this document.

Revision number	Change	Summary of changes	Date
000	Initial release	N/A	
001			

EXECUTIVE SUMMARY

The Canadian Nuclear Safety Commission (CNSC) conducts environmental assessments (EA) under the *Nuclear Safety and Control Act* (NSCA) for all projects, in accordance with its mandate, to ensure the protection of the environment and the health of persons. The safety component of CNSC's mandate is covered in the safety case assessment carried out for all projects.

This EA Report, written by CNSC staff for the Commission and the public, describes the findings of the EA under the NSCA completed for the licence application by Ontario Power Generation Inc. (OPG) to renew the Pickering Nuclear Generating Station (NGS) Power Reactor Operating Licence (PROL 48.03/2018) for a period of 10 years, from September 1, 2018 to August 31, 2028. During the licensing period, OPG is proposing to continue normal operation of all reactor units until the end of 2024, at which point stabilization activities associated with shutdown will begin in preparation for the safe storage of all units.

This EA Report includes CNSC staff's assessment of the licence application and the documents submitted in support of the application, annual environmental monitoring reports, the results of previous studies, compliance verification activities (e.g., inspections, audits, reviews, etc.) conducted at the Pickering site, as well as the findings of CNSC's Independent Environmental Monitoring Program (IEMP) and the Preliminary Decommissioning Plan (PDP).

The EA Report focuses on items that are of current public and regulatory interest such as releases to air, groundwater and surface water, for ongoing operations and activities related to the stabilization and safe storage with surveillance phases.

CNSC staff's findings from this EA under the NSCA include, but are not limited to, the following:

- OPG's environmental protection programs meet CNSC regulatory requirements.
- OPG's Environmental Risk Assessment (ERA) assessed the potential environmental (ecological and human health) risks from radiological, non-radiological and physical stressors associated with current facility operations is in accordance with Canadian Standards Association (CSA Group) Standard N288.6-12, *Environmental risk assessment at class I nuclear facilities and uranium mines and mills* (2012).
- OPG's Predictive Effects Assessment (PEA) assessed the potential environmental (ecological and human health) effects from radiological, non-radiological and physical stressors associated with future stabilization and safe storage with surveillance activities is in accordance with the overall methodology of CSA Group Standard N288.6-12, *Environmental risk assessment at class I nuclear facilities and uranium mines and mills* (2012).
- The results from other regional monitoring programs carried out by other levels of government confirm that the environment and health of persons around the Pickering site are protected.
- The results of CNSC's IEMP confirm that the public and the environment in the vicinity of the Pickering site are protected from the releases of the facility.

Based on the EA under the NSCA conducted for this licence application, CNSC staff conclude that OPG has and will continue to make adequate provision for the protection of the environment and the health of persons until decommissioning and abandonment of the Pickering nuclear site (PN Site).

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1.0 INTRODUCTION

1.1 Purpose

The purpose of this Environmental Assessment (EA) Report is to document the results of the EA conducted under the *Nuclear Safety and Control Act* (NSCA) for the licence application by Ontario Power Generation Inc. (OPG) to renew the Pickering Nuclear Generating Station (NGS) Operating Licence (PROL 48.03/2018) for a period of 10 years, from September 1, 2018 to August 31, 2028 [1]. The current PROL expires on August 31, 2018 [2]. OPG's licence renewal application includes continued 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. An EA under the NSCA was conducted to determine whether OPG has and will continue to make adequate provisions for the protection of the environment and the health of persons until the decommissioning and abandonment of the facility.

This EA Report is based on information submitted by OPG and activities completed by the Canadian Nuclear Safety Commission (CNSC) staff, including the following:

- regulatory oversight (section 2.0)
- CNSC staff review of the 2016 Pickering NGS Preliminary Decommissioning Plan (PDP) (section 2.1.6)
- CNSC staff review of OPG's Follow-up Program (section 2.3.3)
- CNSC staff review of the site-wide 2017 Environmental Risk Assessment (ERA) (section 3.2)
- CNSC staff review of the site-wide 2017 Predictive Effects Assessment (PEA) (section 3.3)
- Independent Environmental Monitoring Program (IEMP) results (section 4.0)
- update on the regional monitoring activities (section 5.0)

A review has been conducted for all components related to the project, but only a selection of topics are presented in detail in this report. Topics were selected as those being of interest to the Commission, members of the public, Indigenous groups, and of regulatory interest. These topics include atmospheric, aquatic, geological, hydrogeological, terrestrial environments and human health. Topics of regulatory interest include Greenhouse Gas (GHG) emissions and regional monitoring conducted by other levels of government.

CNSC staff assess the environment at every phase of a project and its activities, and will continue to do so until the decommissioning and abandonment of the site. CNSC staff assess potential impacts of the environment and health of persons throughout all phases of a facility's lifecycle. An EA report is prepared prior to licensing to provide transparency to the public and advice to the Commission.

1.2 Background

The Pickering Nuclear Site (PN Site) is located on the north shore of Lake Ontario in the city of Pickering, within the regional municipality of Durham, approximately 32 kilometres east of downtown Toronto, Ontario (see figure 1.1). The PN Site is owned and operated by the licensee, OPG. OPG is licensed by the CNSC to operate two nuclear facilities in Pickering, ON: Pickering

NGS and the Pickering Waste Management Facility (PWMF). This EA Report includes CNSC staff's assessment of the licence application and the documents submitted by OPG for licence renewal of the Pickering NGS as well as monitoring data collected as part of CNSC's IEMP (see section 4.0 of this EA Report). It does not include the operations at the PWMF as it operates separately under the Waste Facility Operating Licence issued by the CNSC.

The Pickering NGS consists of eight CANDU[1] pressurized heavy water nuclear reactor units and auxiliary systems that support their operations and the production of electricity. Six reactor units are in operation (Units 1, 4, and 5-8), and two reactor units (Units 2 and 3) are in safe storage state as of 2010. Units 1 to 4 are located on the western site of the nuclear station, formerly licensed as "Pickering A" and Units 5 to 8 are located on the eastern side of the nuclear station, formerly licensed as "Pickering B". The PWMF, consisting of two sites, located within the boundary of the PN Site provides interim storage for used nuclear fuel generated by the Pickering NGS operations and some waste associated with the retubing of Units 1-4 in the 1980s. The entire PN Site is fenced and access to the site is restricted and controlled by OPG.

The PN Site comprises a large number of buildings of various sizes with a wide range of functions (see figure 1.2). The largest features with the greatest potential impact on the environment are described below:

- **Reactor buildings:** the facility has eight reactor buildings, each of which contain one reactor, 12 steam generators, a ventilation system to control air flow and temperature, a moderator which circulates heavy water, and other related equipment. Units 1 and 4 have 390 fuel channels and a dump tank for the heavy water moderator; units 5 to 8 have 380 fuel channels and no tank. All airborne emissions from the reactor buildings are controlled and monitored for radioactive contaminants by the stack monitoring system.
- **Turbine Buildings:** these two buildings each contain steam turbines, electricity generators, steam condensers and feedwater systems.
- **Reactor Auxiliary Bay:** these buildings house the irradiated fuel bays (IFBs) which are used to store and cool used fuel bundles from Units 5-8. Used fuel that has been stored in the IFBs for at least 10 years are transferred to dry storage containers (DSCs) and transported to the PWMF for interim storage. Used fuel bundles from Units 1-4 are held in this bay for 4 years and then transferred to the Auxiliary Irradiated Fuel Bay (AIFB). Filters and ion exchange columns are used to remove radionuclides from the IFBs.
- **Auxiliary Irradiated Fuel Bay:** the AIFB is used to store and cool used fuel bundles from Units 1-4 and for cobalt-60 from Units 5-8. Once cooled, the used fuel bundles are transferred to DSCs and transported to the PWMF for interim storage.
- **Forebay, Intake Channel and Discharge Channels:** the intake channels for Units 1-4 and 5-8 draw condenser cooling water (CCW) from the forebay into each unit. There are two CCW pumps per reactor to pump water to the condensers. After the CCW is used in the condensers, the CCW is discharged to Lake Ontario through the drainage channel.

[1] CANada Deuterium Uranium

- **Fish Diversion System (FDS):** the FDS is a barrier net surrounding the intake structure, which is seasonally installed for 8 to 9 months of the year (see figure 1.3). The FDS is in place to mitigate impingement of fish at the PN facility.

OPG owns approximately 240 ha of land and 100 ha of water property, located either adjacent to, or on the PN Site. The majority of these lands are designated part of the station's exclusion zone, which is the land within or surrounding a nuclear facility on which there can be no permanent dwelling. The PN Site is surrounded by residential and recreational areas to the north-west, the hydro corridor to the north, industrial areas to the east and north-east and Lake Ontario to the south. The PN Site is located close to other important water bodies, namely Hydro Marsh (owned by OPG), Duffins Creek and Frenchman's Bay.

Figure 1.1: Location of PN Site

Figure 1.2: Overview of PN Site and surrounding features

Figure 1.3: Ontario Power Generation's fish diversion system, a mitigation structure to reduce the biomass impinged and entrained

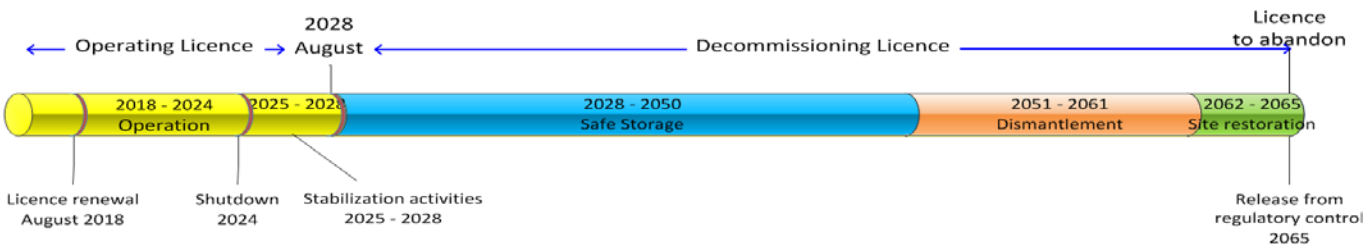
Figure 1.4: Aerial overview of the PN Site

1.2.1 Project Overview

Commercial operations at the PN Site began in 1971 and currently, with the six operating reactor units, the Pickering NGS has a net electrical power output of 3,100 megawatts. OPG has indicated that Pickering NGS will reach a stage where it is no longer feasible to maintain all six operating units for power generation without significant investment in refurbishment. As such, OPG's current business plan is to cease commercial operations of all Pickering units by December 31, 2024. As indicated in the Province of Ontario's *Long Term Energy Plan*, as outlined in the licensee's application [1], continued operation of Pickering NGS until 2024 is planned to provide the province a reliable source of GHG free baseload to offset production losses arising from the proposed refurbishment of reactor units at the Darlington and Bruce NGSs. Once power generation has ceased, OPG plans to begin a multi-decade process to decommission the Pickering NGS, including used fuel storage, decommissioning of structures, systems and components and waste management. It is OPG's intent to retain ownership of the site throughout the course of the decommissioning activities and subsequent restoration of the site.

On August 28, 2017, OPG submitted an application for the renewal of their power reactor operating licence (PROL48.03/2018) for a 10-year licence period [1]. The 10-year licensing period would cover two project phases – the Continued Operations Phase consisting of the continued commercial operation of the facility to 2024, followed by a two to three year Stabilization Phase proposed for completion by end of licensing in 2028. The stabilization phase involves the shut-down of the reactors, removal of fuel and heavy water and the additional ancillary activities necessary to place the facility in a state of safe storage (table 1.1). The safe storage with surveillance phase allows radiation levels to decrease making the subsequent steps of dismantling and demolition safer and easier. A key activity in the first ten years of the safe storage with surveillance phase involves the continued progressive transfer of adequately cooled used fuel from the IFB to the PWMF. OPG will be required to apply to the CNSC for a Licence to Decommission to cover the safe storage, dismantling and site restoration phases and a Licence to Abandon to release the site from regulatory control. The timeline of these phases is displayed in Figure 1.5.

Figure 1.5: Timeline photo



To support the 10-year licence period, a Periodic Safety Review (PSR) has been completed by OPG and is being reviewed by CNSC staff as part of the licence application review process. The PSR was completed in accordance with CNSC REGDOC-2.3.3 *Periodic Safety Reviews* [3], to confirm and enhance the safety case for continued operation of Pickering beyond 2018.

To demonstrate that OPG has provisions in place to protect the environment and human health and for the activities proposed for this licence application, OPG submitted an updated ERA [4] and PEA [5] in accordance with *Regulatory Document* (REGDOC) *2.9.1: Environmental Principles, Assessments and Protection Measures* (2013) [6] and CSA Group Standard N288.6-12 *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [7]. The ERA is required to demonstrate that the licensee has provisions in place to protect the environment and human health and to inform the licensing process for the continued operation and transition to safe storage activities. OPG's ERA and PEA evaluates the risk of contaminants and physical stressors to human and ecological receptors. Human receptors were identified as those within 20 km of the PN Site. Ecological receptors were those identified on-site, within the immediate PN Site and within the near-field receiving waters. A summary of the documents is provided below with more detail included in section 3.0.

- **Environmental Risk Assessment:** the site-wide ERA has been updated with additional monitoring data, site-specific special studies and current science to establish the present status of the environment and assess implications to non-human biota and human health. This allows for a determination as to whether or not the facility has been performing within the environmental envelope established as the previous licensing basis for the facility (see section 3.2). The updated ERA also serves as the initial reference point for the PEA.
- **Predictive Effects Assessment:** the site-wide PEA considers potential implications to environment and human health resulting from activities associated with transitioning the station from commercial operations to safe storage with surveillance. The PEA considers the stabilization phase and the first 10 years of the safe storage with surveillance phase. The latter was included to address changes in emissions and release profiles expected as a result of transfers of used fuel from the IFBs (see section 3.3) to dry storage in the PWMF. The current PEA does not consider the staged dismantling and restoration phases.

The planned activities for each stage are detailed in table 1.1.

Table 1.1: Summary of the activities and timelines for remaining project phases

Phase	Timeframe	Activity
Continued operation phase (normal operations) (2018-2024)	6 years	• Continued commercial operations and facility maintenance • Shut down of all units by December 31, 2024
Stabilization phase (2024-2028)	2-3 years per unit	• 2-3 years per unit to transition each unit and the station from current operating state to safe storage state • Reactor units will be rendered impossible to refuel • Removal of all nuclear fuel and transfer to the IFB and Auxiliary IFB • Removal and storage of approximately 3,000 megagrams (Mg) of tritiated heavy water • Stabilization of all systems no longer required for recycling and/or disposal • Reduction of CCW flow as each reactor unit is taken off-line and CCW pumps are shut down • Continued operation of the IFBs and AIFB
Safe storage with surveillance phase (2028-2050)	25-30 years	• Continued operation/surveillance of the IFBs • Transfer of used fuel from the IFBs to the DSCs at PWMF • Natural decay of radioactivity

Phase	Timeframe	Activity
Staged dismantling and demolition phase (2051-2061)	10 years	• Dismantling of the first reactor, followed in sequence by the others • Removal of radioactive and other hazardous materials from the site and transfer to approved long-term management disposal facilities
Restoration phase (2061-2066)	5 years	• Conduct a comprehensive radiological survey of the site to verify it meets the necessary clearance levels before demolition • Release lands in order to allow for repurposing for alternative uses • At the end of this phase, Pickering nuclear facility would be released from regulatory control

Waste Management

Waste will be generated at the Pickering NGS during continued operations as well as with the stabilization and safe storage with surveillance phases. Waste includes used fuel bundles, radioactive solid, liquid and gaseous waste and non-radioactive solid, liquid and gaseous waste. Current waste management practice at the PN Site will continue during the stabilization and safe storage with surveillance phases as follows:

- used fuel bundles will continue to be stored in the IFBs for a minimum of ten years before being transferred to dry storage at the PWMF
- low- and intermediate-level radioactive solid waste and non-aqueous liquids will continue to be shipped to the Western Waste Management Facility at the Bruce site
- radioactive liquid waste will continue to be received and treated at the Radioactive Liquid Waste Management System (RLWMS) prior to its discharge to Lake Ontario
- radioactive gaseous emissions will continue to be filtered through high-efficiency particulate air (HEPA) and charcoal filters prior to release
- non-hazardous solid waste will be disposed of in an off-site landfill

2.0 REGULATORY OVERSIGHT

The CNSC regulates nuclear facilities and activities in Canada to protect the environment and the health and safety of persons in a manner that is consistent with Canadian environmental policies, acts and regulations and with Canada's international obligations. The CNSC assesses the environmental effects of nuclear facilities and activities at every phase of their lifecycle. This regulatory oversight of environmental protection measures at the PN Site are elaborated further within section 2.0

To meet CNSC's regulatory requirements, OPG is responsible for implementing and maintaining environmental protection measures that identify, control and (where necessary) monitor all releases of radiological and non-radiological (i.e., hazardous) substances and effects on human health and the environment, from the PN Site. These environmental protection measures must comply with, or have implementation plans in place to comply with, the regulatory requirements set out in table 2.1.

Table 2.1: Implementation of regulatory requirements

Regulatory document or standard	Status
CNSC Regulatory Document REGDOC 2.9.1, *Environmental Protection: Policies, programs and Procedures* (2013) [6]	Implemented
CSA Group Standard N288.1-08, *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* [8]	The current approved Derived Release Limits (DRLs) were developed in accordance with CSA N288.1-08, with which OPG remains fully compliant
CSA Group Standard N288.1-14 Update No 1., *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* [9]	On July 13, 2017, OPG submitted a set of proposed DRLs and Environmental Action Levels to the CNSC that conform to CSA N288.1-14 guidelines. Following CNSC concurrence, OPG will submit an implementation date for the new DRLs and request the Licence Condition Handbook be updated accordingly
CSA Group Standard N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills* [10]	Implemented
CSA Group Standard N288.5-11, *Effluent Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills* [11]	Implemented
CSA Group Standard N288.6-12, *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [7]	OPG submitted an updated ERA report for the PN Site in 2017 in support of the Pickering licence renewal project. CNSC staff completed a detailed technical review of the ERA and found it to be consistent with the overall methodology of the CSA Standard N288.6-12. CNSC staff provided comments to OPG with specific recommendations to validate several ERA conclusions

Regulatory document or standard	Status
	and to improve the ERA quality.
CSA Group Standard N288.7-15, *Groundwater protection programs at class I nuclear facilities and uranium mines and mills* [12]	OPG has stated that the PN Site will be compliant with CSA N288.7-15 by December 30th, 2020
CSA Standard N294-09, *Decommissioning of Facilities Containing Nuclear Substances* [13]	Implemented

In addition, as part of CNSC's regulatory oversight, compliance activities of verification, enforcement and reporting are in place to ensure that CNSC licensees are in compliance with CNSC's regulatory framework. OPG is required to submit an annual environmental monitoring report that details the results of the environmental protection measures related to the operations of the Pickering NGS. These annual reports are reviewed by CNSC staff and are publicly accessible on OPG's external website [14].

The CNSC also publishes an annual *Regulatory Oversight Report on Canadian Nuclear Power Plants* [15]. This report compiles data collected through various means of inspection, review and oversight conducted by CNSC staff and highlights industry trends. These reports are presented annually at the Regulatory Oversight Report Commission meeting.

2.1 Environmental Protection Measures

Environmental protection measures identify, control and monitor releases of radioactive and hazardous substances from facilities or activities, and their effects on the environment, to protect the environment and the health of persons. Environmental protection measures are an important component of the overall requirement for licensees to make adequate provision for protection of the environment.

Environmental protection measures may also be referred to as environmental protection programs. Applicants and licensees are not required to update their management system or other documents to reflect the term "environmental protection measures", but they must meet the requirements listed in this section.

2.1.1 Environmental Risk Assessment

An ERA of nuclear facilities is a systematic process used to identify, quantify and characterize the risk posed by contaminants and physical stressors in the environment on biological receptors, including the magnitude and extent of the potential effects associated with a facility. ERAs must be submitted in accordance with CSA Group Standard N288.6-12 *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [7]. An ERA is a practice or methodology that can provide science-based information to support decision-making, risk-informed recommendations for improvement of the effluent and EMP and risk management, and to prioritize the implementation of mitigation measures.

An ERA:

- identifies and prioritizes the contaminants and physical stressors of concern, their sources or points of release, and the potential human and non-human receptors
- identifies facility- or activity-specific characteristics, site-specific environmental characteristics, and interactions between them
- provides an assessment of the receptor exposure to the contaminants and physical stressors
- provides an assessment of the environmental risk to receptors posed by the facility
- identifies and quantifies the uncertainties in the assessment of the environmental risk
- is used to demonstrate protection of the environment and human health under the NSCA, and should be conducted every five-years, or when major changes have occurred to the facility, or new scientific information is available

In 2014, an integrated ERA for the PN Site was prepared using monitoring data from 2007 to 2011 [16]. The 2014 ERA identified areas where supplementary monitoring studies were recommended to clarify risk and reduce uncertainty in dose calculations and exposure for human and ecological receptors in future ERAs. In 2015, an updated baseline environmental sampling program was undertaken by OPG to address these recommendations. The baseline environmental sampling program included additional monitoring data for lake surface water, sediment and surface water from Frenchman's Bay, stormwater, soil and noise.

In April 2017, OPG submitted an updated ERA report for the PN Site based on effluent and environmental monitoring data for the five year period between 2011and 2015[4], to support the current application for licence renewal. The ERA included an ecological risk assessment (EcoRA) and a human health risk assessment (HHRA) for radiological and non-radiological (hazardous) contaminants of potential concern (COPCs) and physical stressors related to the PN Site and its activities. The purpose of the 2017 ERA was to update the previous ERA that was completed by OPG in 2014 and support the current application for licence renewal. The ERA encompasses normal operations at the PN Site during the Continued Operations Phase of the project. OPG has posted the submitted ERA on its website.

CNSC staff completed a detailed technical review of the 2017 site-wide ERA and found it to be consistent with the overall methodology of the CSA Group Standard N288.6-12, *Environmental risk assessments at class I nuclear facilities and uranium mines and mills (2012)* [7]. Although OPG's 2017 ERA report for the PN Site provides a complete evaluation of all potential risks to human health and the environment associated with the facility operations. CNSC staff provided comments to OPG with specific recommendations to validate several ERA conclusions and to improve the ERA quality. CNSC staff also made recommendations regarding the means to reduce uncertainties for future versions of the ERA. An ERA is required to be reviewed and revised every five years or earlier should there be significant changes in either the facility or activity or in the science on which the ERA is based.

The 2017 ERA conclusions are summarized in table 2.2. Overall, meaningful adverse ecological and human health effects due to releases to air and water are unlikely, which is consistent with the overall conclusions of previous *Canadian Environmental Assessment Act (*CEAA) EAs completed for the PN Site (see table 2.4 for a list of previously completed EAs).

Table 2.2: Summary of OPG's 2017 environmental risk assessment conclusions

Type	Members of the public	Aquatic biota	Terrestrial Biota
Radiological	No adverse impacts expected from radiological COPCs released from the PN Site.	No adverse impacts expected from radiological COPCs released from the PN Site	No adverse impacts are expected from radiological COPCs released from the PN Site
Non-radiological	No adverse impacts expected from non-radiological COPCs released from the PN Site.	No adverse impacts expected from non-radiological COPCs released from the PN Site, with the exception of measured maximum copper surface water concentrations near the PN Site outfall that exceeded fish and benthic invertebrate benchmarks. However, mean copper concentrations in water samples were below the benchmarks. The community, as a whole, is not likely to be impacted	No adverse impacts expected from non-radiological COPCs released from the PN Site, with the exception of some terrestrial biota that are predicted to receive exposure concentrations above benchmarks (Earthworms, terrestrial plants and Meadow Voles). However the measured concentrations were highly localized or in areas deemed as unsuitable habitat and although there may be effects to some individuals the community, as a whole, is not likely to be impacted
Physical*	No adverse impacts expected to human health expected from noise at the PN Site.	Impingement and entrainment of fish from the operation of the Pickering NGS occurs from the use of lake water for condenser cooling water. A FDS is used to mitigate impingement and has been demonstrated to reduce impingement fish losses by the 80% reduction target (see section 3.2.4 under Physical Stressors)	No adverse impacts are expected from noise or wildlife collisions associated with the operation of the PN Site

*Physical stressors for aquatic receptors include entrainment/impingement of aquatic biota and thermal releases to the aquatic environment. Physical stressors for terrestrial receptors include noise, road kill and habitat alteration.

2.1.2 Predictive Environmental Effects Assessment

In May 2017, OPG submitted a PEA, *Predictive Effects Assessment for Pickering Nuclear Safe Storage* [5], to determine whether the potential changes to the baseline conditions resulting from transitioning the station from the Continued Operation Phase to the Stabilization and Storage with Surveillance Phases would pose risks to human and ecological receptors. The PEA did not consider the Staged Dismantling and Restoration phases. As part of CNSC's ongoing lifecycle approach to regulatory review, subsequent licensing decisions will include EA determinations.

CNSC staff completed a detailed technical review of the PEA and found it to be consistent with the overall methodology of the CSA Group Standard N288.6-12, *Environmental risk assessment at class I nuclear facilities and uranium mines and mills (2012)* [7]. The results of the review indicate that meaningful human health or ecological effects attributable to the proposed Stabilization and safe storage with surveillance activities are unlikely. CNSC staff will verify predictions made in the PEA based on operational experience, results of monitoring, supplementary studies or recent developments in scientific knowledge. Any variances will be addressed in future iterations of the ERA report as the project transitions to the Stabilization and Storage with Surveillance Phases.

The 2017 PEA conclusions are summarized in table 2.3. Adverse effects associated with the transition from power generation to safe storage are considered unlikely.

Table 2.3: Summary of OPG's 2017 predictive effects assessment conclusions

Type	Members of the public	Aquatic biota	Terrestrial Biota
Radiological	No additional adverse impacts expected from radiological COPCs released from the PN Site during Stabilization or Safe Storage with Surveillance phases	Continued operations assessed within the ERA are bounding and no additional adverse impacts are expected from non-radiological COPCs released from the PN Site, during Stabilization or Safe Storage with Surveillance phases	Continued operations assessed within the ERA are bounding and no additional adverse impacts are expected from non-radiological COPCs released from the PN Site, during Stabilization or Safe Storage with Surveillance phases
Non-Radiological	Continued operations assessed within the ERA are bounding and no additional adverse impacts are expected from non-radiological COPCs released from the PN Site during Stabilization or Safe Storage with Surveillance phases	Continued operations assessed within the ERA are bounding and no additional adverse impacts are expected from non-radiological COPCs released from the PN Site during Stabilization or Safe Storage with Surveillance phases	Continued operations assessed within the ERA are bounding and no additional adverse impacts are expected from non-radiological COPCs released from the PN Site during Stabilization or Safe Storage with Surveillance phases
Physical	Continued operations assessed within the ERA are bounding and no additional adverse impacts are expected to human health from noise at the PN Site during Stabilization or Safe Storage with Surveillance phases	No additional adverse impacts expected due to entrainment and impingement. Continued operations assessed within the ERA are bounding and Stabilization and Storage with Surveillance activities will result in reduced flows into the station once the CCW pumps are not required, and the assumed removal of the FDS. Impingement and entrainment cease to be a concern at the low flow rates anticipated	Continued operations assessed within the ERA are bounding and no additional adverse impacts are expected from noise or wildlife collisions associated with the operation of the PN site

2.1.3 Environmental Management System

An Environmental Management System (EMS) refers to the management of an organization's environmental policies, programs and procedures in a comprehensive, systematic, planned and documented manner. It includes the organizational structure, planning and resources for developing, implementing and maintaining policy for environmental protection.

An EMS is the integrated set of documented activities (policies, programs and procedures) that provide a framework for action with respect to environmental protection. An EMS encompasses:

- control measures on releases and wastes to prevent or mitigate environmental effects
- demonstration of the effectiveness of those control measures
- training of personnel
- public disclosure and information

Pickering NGS has established and implemented an EMS, integrated into the corporate wide management system, in accordance with REGDOC-2.9.1, Environmental Protection: Policies, Programs and Procedures [6].

2.1.4 Effluent and Emissions Control and Monitoring

Controls on environmental releases are established to provide protection to the environment and to respect the principles of sustainable development and pollution prevention. The effluent and emissions preventive and control measures are established on the basis of best industry practice, incorporating the application of as low as reasonably achievable (ALARA) principles, process optimization, continuous improvement and the results of an ERA.

OPG has controls in place to minimize airborne and waterborne effluents and emissions for radiological and non-radiological COPCs, and to ensure that releases are within regulatory limits and ALARA.

- OPG uses DRLs and action levels, approved by the CNSC, to control radiological effluent and emission releases from the site. A DRL for a given radionuclide is the release rate that would cause an individual of the most highly exposed group to receive a dose equal to the regulatory annual dose limit of 1 mSv. OPG's monitoring results for radiological releases are summarized in sections 3.2.2 and 3.3.2 of this report.
- Non-radiological liquid effluent is monitored in accordance with the provincial Environmental Compliance Approval (ECA) requirements. Non-radiological liquid effluent from the RLWMS must comply with the provincial Municipal Industrial Strategy for Abatement (MISA) regulations under O. Reg. 215/95 [17]. For COPCs where no criteria is available, toxicity benchmarks are used as screening criteria. COPCs not addressed by the ECA are assessed through the ERA to determine whether they merit additional regulatory oversight. OPG's monitoring results for non-radiological effluent releases are summarized in sections 3.2.2 and 3.2.3 of this report.
- Non-radiological airborne emissions are required to be in compliance with provincial regulation O. Reg. 419/05, which is met by complying with the ECA for Air and Noise. An Emissions Summary and Dispersion Modelling report is used to document and maintain compliance with O.Reg. 419/05. OPG's monitoring results for non-radiological airborne emissions are summarized in sections 3.2.2 and 3.2.3 of this report [18].

2.1.5 Environmental Monitoring Program

OPG's EMP is designed to sample, measure, analyze, interpret and report one or all of the following in the vicinity of the PN Site:

- concentration of nuclear and hazardous substances in environmental media

- effect, or lack of effect, on biological organisms or communities if such potential is predicted by the ERA or required by legislation
- intensity of physical stressors and their potential effect on human health and the environment
- physical, chemical and biological parameters in the environment considered necessary to support the interpretation of the results of the monitoring program

Based on this program, environmental samples from different pathways of the food chain are collected from various offsite locations and analyzed. Data from the program are also used to assess public doses resulting from the routine operation of the Pickering NGS, and to verify predictions made in ERAs.

OPG's annual EMP reports are available on their website [14]. The 2016 EMP results have been submitted to the CNSC and been reviewed by CNSC staff. CNSC staff verified that all treated effluent discharged to the environment complied with licence requirements during the previous licence period. OPG's EMP was designed to be in compliance with CSA N288.4-10 *Environmental Monitoring Programs at Class I nuclear facilities and uranium mines and mills* [10], which addresses monitoring of radiological and non-radiological COPCs, physical stressors, potential biological effects, and pathways for both human and non-human biota. During the continuous operations, stabilization and safe storage with surveillance phases, OPG's EMP will be maintained and updated as needed.

The ERA [4] and PEA [5] submitted in May 2017 did not identify any new effects that would warrant additional monitoring beyond that already captured in the existing EMP, with the exception of an additional two years of thermal monitoring for the proposed licensing period to reassess the risk to Round Whitefish.

2.1.6 Public Dose

Radiological releases to the environment are controlled and monitored by OPG's Effluent Monitoring Program and the EMP. Results of these monitoring and control activities are used to determine dose to members of the public, and ensure that dose to public remains below the regulatory dose limit of 1 mSv per year.

The *Radiation Protection Regulations* [19] require licensees to implement a radiation protection program for protection of workers as well as the public. The focus for radiation protection within the environmental protection framework is on radiological protection of the environment and the public. The *Radiation Protection Regulations* define prescribed dose limits for workers (50 mSv per year) and members of the public (1 mSv-year), and require doses to be monitored by direct measurement or by estimation of the quantities and concentrations of any nuclear substance released as a result of a proposed activity.

OPG continued to ensure the protection of workers and members of the public in accordance with the *Radiation Protection Regulations*. During the licensing period, radiation doses to workers were below the regulatory dose limit of 50 mSv per year. The reported estimated dose to a representative member of the public from the PN Site during the licensing period ranged from 1.1 to 1.5 µSv/year, which was well below the annual public dose limit of 1 mSv per year (1000 µSv/year). Further details on related to the protection of the public are provided in section 3.2.5 outlining details of the HHRA for both nuclear and hazardous substances.

2.1.7 Preliminary Decommissioning Plan

Class 1 facilities like the Pickering NGS are regulated by the CNSC through a phased licensing process, which includes separate licences for site preparation, construction, operation, decommissioning and abandonment. A PDP must be prepared in accordance with CSA Standard *N294-09, Decommissioning of Facilities Containing Nuclear Substances* [13] and submitted to the CNSC every 5 years in accordance with CNSC's Regulatory Document REGDOC-3.1.1 *Reporting Requirements for Nuclear Power Plants* [20] and Regulatory Guide G-*219, Decommissioning Planning for Licensed Activities* [21].

OPG submitted a PDP to the CNSC in January, 2017 [22] in accordance with the requirements mentioned above. The objectives of the Pickering NGS PDP are to outline the activities required to decommission the Pickering NGS in a manner that will ensure that the health, safety and security of workers, the public, Indigenous groups and the environment are protected and restore the site for other uses. The scope of the PDP includes all the associated buildings and structures within the PN Site, not including decommissioning of the PWMF. Decommissioning of the PWMF has a separate PDP, as this facility has its own Class I operating licence.

Decommissioning of the Pickering NGS will occur after the last of the six reactors is shut down and stabilization activities have been completed in preparation for the safe storage phase. Decommissioning of the PWMF will occur after all the used fuel and low- and intermediate-level waste has been moved to a long-term waste management facility. Upon completion of the decommissioning programs, the PN Site will be in a condition that will support an application to the CNSC for a Licence to Abandon. It is OPG's intent to retain ownership of the site throughout the course of the decommissioning activities and subsequent restoration of the site.

In accordance with CSA N294-09 [13], decommissioning activities will proceed according to four phases:

- **Phase 1 - Planning for Decommissioning:** this phase begins as early as possible and continues throughout the lifecycle of the facility. It results in the preparation of a decommissioning strategy and PDP.
- **Phase 2 - Preparation for Decommissioning:** the Pickering NGS entered into this phase when OPG announced its decision not to refurbish the nuclear facility, but instead extend operations to 2024. OPG will defuel and dewater the reactors after the units are permanently shut down and will prepare the structures, systems and components to enter the Storage with Surveillance Phase. During Phase 2, a Detailed Decommissioning Plan (DDP) will be prepared and submitted to the CNSC, according to the applicable regulatory requirement, in preparation for the next licence period beginning in 2028, for which OPG will request a Licence to Decommission from the CNSC.
- **Phase 3 - Execution of Decommissioning:** OPG has chosen a deferred decommissioning strategy for the Pickering NGS, meaning that the PN Site will be in a safe storage state and will be monitored and maintained while the radiation levels in the reactor systems decay. It is assumed that the dismantling of the site will begin after 30 years of safe storage.
- **Phase 4 - Completion of Decommissioning:** When dismantling and demolition activities are complete, restoration of the site will occur and a Licence to Abandon will be requested from the CNSC. A successful application will release OPG from CNSC regulatory oversight, as

outlined in CNSC Regulatory Guide G-219, *Decommissioning Planning for Licence Activities* [21].

It is important to note that decommissioning activities and associated schedules will be addressed in a comprehensive manner, and fully described in a DDP. The DDP is required to be submitted to CNSC in support of an application for a licence to decommission. This licence application would apply for all decommissioning activities including Stage 2, safe storage with surveillance.

2.2 Completed Environmental Assessments

The CNSC has conducted EAs for proposed and ongoing nuclear projects at the PN Site, under the former CEAA 1992 [23]. The purpose of an EA is to identify the possible environmental effects of a proposed project, and determine whether these effects can be mitigated, so that the environment and heath of persons will be protected, before a licence decision can be made. Under the CEAA, a decision must be taken that the project, after implementation of mitigation measures, will not cause significant adverse environmental effects. Under the NSCA, the assessment of the environment is part of the ongoing lifecycle environmental protection framework. No decision is made on the EA itself, as the information is intended to inform and support the regulatory decision being sought.

The following sections provide information on the major environmental reviews completed under the now repealed CEAA 1992, as well as information regarding EA Follow-up Monitoring Programs elements. Under CEAA 1992, an EA follow-up program verifies the accuracy of the predictions of the EA and the effectiveness of the mitigation measures. The CNSC ensures that CEAA follow-up programs within the CNSC's mandate are incorporated within the licensing process.

Table 2.4: EAs completed under CEAA for the Pickering nuclear facility

Project	Regime	EA start date	EA decision date	EA Follow-Up Monitoring Program
Pickering NGS-A Return to Service	CEAA 1992	November 24, 1999	October 3, 2001	Yes
PWMF Phase II Expansion Project	CEAA 1992	July 4, 2002	May 28, 2004	Yes
Pickering A Units 2 and 3Guaranteed Defuelled State	CEAA 1992	February 4, 2008	November 28, 2008	No
Refurbishment and Continued Operation of the Pickering B NGS	CEAA 1992	July 28, 2006	January 26, 2009	Yes (1)

(1) The EA follow-up program was not implemented due to this project being cancelled.

2.2.1 Previous EAs Completed Under the CEAA 1992

Pickering NGS-A Return to service

In late 1999, OPG requested approval from the CNSC to return to service Units 1-4. These reactors had been placed in a non-routine Guaranteed Shutdown State (GSS) at the end of 1997, in order to comply with a licence condition regarding the enhanced shut-down system, and to free up resources to improve the safety and productivity of OPG's other nuclear operations. An EA Screening Report was completed under CEAA 1992 [24]. In October 2001, the Commission concluded that the project, taking into account the appropriate mitigation measures, was not likely to cause significant adverse environmental effects [25]. The EA process identified the need for an EA follow-up program for the Pickering A Return to Service project.

PWMF Phase II EA

In 2002, OPG communicated its intent to expand the capacity of the PWMF by constructing and operating two additional storage buildings (#3 and #4) at the PWMF Phase II site. The proposed expansion was required to accommodate used fuel from the Pickering NGS to the end of its proposed service life. An EA Screening Report was completed under CEAA 1992 [24]. In May 2004, the Commission concluded that the project, taking into account the appropriate mitigation measures, was not likely to cause significant adverse environmental effects [26]. The EA process identified the need for an EA follow-up program for the PWMF Phase II project.

Refurbishment and Continued Operation of the Pickering B Nuclear Generating Station

In June 2006, OPG communicated its intent to refurbish and continue to operate Units 5 to 8 until 2060. The proposed project involved the refurbishment or replacement of major components in each of the four units. An EA Screening Report was completed under CEAA 1992 [27]. In December 2008, the Commission concluded that the project, taking into account the appropriate mitigation measures, was not likely to cause significant adverse environmental effects [28].

The EA process identified the need for an EA follow-up program for the Pickering B Refurbishment and Continued Operation project. However, OPG announced in February 2010 that it would not pursue the refurbishment project. As such, the EA follow-up program was not implemented.

Pickering A Units 2 and 3 Guaranteed Defuelled State

Following EA approval and NSCA licensing requirements of the Pickering NGS-A Return to Service in 2000, Units 1 and 4 were returned to service, however Units 2 and 3 remained in the Guaranteed Shutdown State. In November 2005, OPG advised the CNSC that Pickering A Units 2 and 3 would not be returned to service, while Units 1 and 4 would continue to operate. OPG indicated that it wished to place Units 2 and 3 into a Guaranteed Defuelled State (GDS) from which the units could not be returned to service. This involved physical modifications to deactivate these units and isolate them from the operating Units 1 and 4 and place Units 2 and 3 in a permanent shutdown state. An EA Screening Report was completed under CEAA 1992 [29]. In November 2008, the Commission concluded that the project, taking into account the appropriate mitigation measures, was not likely to cause significant adverse environmental effects [30]. The EA process did not identify the need for an EA follow-up program for the Pickering A Guaranteed Defuelled State project.

2.2.2 Previous EAs Completed Under the NSCA

Pickering Waste Management Facility Licence Renewal

Most recently, OPG applied for a 10-year licence to renew their PWMF Operating Licence. The current operating licence expires on March 31, 2018 [31]. An EA under the NSCA was conducted for this licence application [32]. CNSC staff concluded that OPG has and would continue to make adequate provision for the protection of the environment and the health of persons until the decommissioning and abandonment of the site. A public Commission hearing on the licence application was held on April 13th, 2017 and a decision has yet to be made.

During the hearing, OPG informed the Commission that it was finalizing an updated ERA for the PN Site [4]. The Commission requested that the updated ERA related to the PWMF be made available to the Commission and the public, and be entered into the record of the hearing upon its completion. The Commissioned allowed for supplementary written submissions from intervenors until July 21, 2017. On July 21, 2017 Northwatch submitted a supplementary submission [33] summarizing the organization's positon on the newly submitted information.

OPG submitted a supplementary document on June 21, 2017 [34] with links to their website where both the 2014 and 2017 ERA were publicly available for download. OPG submitted an additional supplementary document on August 21, 2017 [35] providing further information regarding the baseline ERA and the security and safety analysis of the PWMF.

CNSC staff also submitted a supplementary document on October 30, 2017 [36] with staff's evaluation of the 2014 and 2017 ERAs and the other supplemental information submitted to the Commission. The new information provided did not change CNSC staff's original conclusions and recommendations.

The updated ERA and all supplementary submissions were considered by the Commission in their deliberation. On February 7, 2018 a decision was rendered to renew the PWMF Operating Licence until August 31, 2028.

2.2.3 EA Follow-Up Program

EAs conducted at PN Site identified the need for EA follow-up programs in order to verify EA predictions and the effectiveness of mitigation measures. Two EAs conducted under the CEAA 1992 resulted in follow-up and monitoring programs, related to the following projects:

- Pickering NGS-A Return to Service (2001)
- PWMF Phase II Project (2004)

In 2001, OPG submitted an EA Follow-Up and Monitoring Program for the Pickering NGS 'A' Return to Service EA. This follow-up program was tracked through various iterations of the Annual Follow Up and Monitoring Report for Pickering NGS. All items of the program were deemed to be met and the program was officially closed.

In July 2010, OPG submitted the first of two PWMF Phase II EA follow-up reports. The second report dealing with the construction of storage building #4 will be submitted in alignment with the construction schedule. CNSC staff will continue to review the detailed monitoring plans for the EA follow-up program to ensure that the objectives are being met.

2.3 Greenhouse Gas Emissions

Under the federal *Canadian Environmental Protection Act* (CEPA) [37] and the provincial *Climate Change Mitigation and Low-carbon Economy Act* [38], OPG is required to monitor and report on GHG emissions at set thresholds.

Since 2013, nuclear facilities that emit more than the 50,000 tons of CO_2 equivalent (CO_2e) emission reporting threshold on an annual basis must report their GHG emissions. The PN Site has been well below all GHG emission thresholds since 2013. Due to the fact that the GHGs emitted by the PN Site are below federal and provincial reporting requirements, CNSC does not require OPG to report these emissions as part of their licensing conditions.

3.0 STATUS OF THE ENVIRONMENT

The following sections of the EA Report include summaries of project-environment interactions that were assessed by CNSC staff and were deemed to be of specific public, Indigenous and/or regulatory interest including atmospheric, terrestrial, hydrogeological, and aquatic environments and human health, for the licence application by OPG to renew the Pickering NGS operating licence. It should be noted that environmental components are regularly reviewed through annual reporting requirements and CNSC compliance verification activities. These are reported to the Commission, at least annually, in the environmental protection safety and control areas of licensing Commission Member Documents and annual Regulatory Oversight Reports.

3.1 Environmental Effects Assessment – Overview

This section provides a general description of the environment in which the project will be implemented. This characterization of the environment provides reference information which forms the basis for assessing the project's potential effects on the environment and how the environment and human health is protected and will continue to be protected during the Continued Operations, Stabilization and Storage with Surveillance Phases.

In addition, this Environmental Effects Assessment section presents an overview of the assessment of predicted effects of the project on the environment and the health of persons. The assessment of likely effects of the project was carried out in a step-wise manner as follows:

- identifying the potential project-environment interactions (see table 3.1)
- identifying potential environmental and health effects
- determining whether the environment and health of persons are protected

A review was conducted for all components related to the project, but only a selection of topics are presented in detail in this section.

Project-Environment Interactions

Table 3.1 identifies the potential interactions between the project and the environment for the continued operation of the Pickering NGS, as well as the Stabilization and Storage with Surveillance Phases of the project.

Exposure pathways to ecological and human receptors from effluent and emission releases from operations of the Pickering NGS were also assessed. Exposure pathways represent the various routes by which radiological and/or chemical contaminants could enter the receptor's system and the routes of contaminant dispersion from the source to the receptor location or through the food chain to the receptor. Exposure pathways for human receptors to radiological and/or chemical COPCs include inhalation, ingestion and external exposure (e.g., skin contact); for ecological receptors, exposure pathways include direct contact, immersion or ingestion.

Table 3.1: Matrix of project-environment interactions

Physical work and activities	Atmospheric environment			Terrestrial environment		Hydrogeological environment	Aquatic environment			Human environment	
	Air	Dust	Noise	Terrestrial biota and habitat	Soil quality	Groundwater quality	Aquatic biota and habitat	Surface Water quality	Sediment quality	Worker exposure	Public exposure
Continued operations phase											
Operation of reactors, including maintenance and repair											
Reactor systems	●		●	●	●	●	●	●	●	●	●
Cooling water systems				●			●	●	●	●	●
Fuel and fuel handling	●									●	
Waste management											
Management of L&ILW and spent fuel	●			●	●		●	●	●	●	●
Transport of L&ILW to the WWMF	●	●	●							●	
Management of non-nuclear waste	●	●	●							●	
Stabilization Phase											
Removal of nuclear fuel and transfer to the IFBs and AIFB	●									●	
Continued operation and surveillance of the IFBs and AIFB	●									●	
Removal and storage of tritiated heavy water										●	

Physical work and activities	**Atmospheric environment**			**Terrestrial environment**		**Hydrogeological environment**	**Aquatic environment**			**Human environment**	
	Air	**Dust**	**Noise**	**Terrestrial biota and habitat**	**Soil quality**	**Groundwater quality**	**Aquatic biota and habitat**	**Surface Water quality**	**Sediment quality**	**Worker exposure**	**Public exposure**
Reduction of cooling water flow				●			●	●	●	●	●
Auxiliary boiler powered by fuel oil	●									●	
Storage with surveillance phase											
Continued operation and surveillance of the IFBs	●									●	
Transfer of used fuel from the IFBs to the DSCs at PWMF	●			●	●					●	
Monitoring the natural decay of radioactivity within remaining reactor systems										●	
Continued operation of the auxiliary boiler	●		●								

● = Project-environment interactions that have been determined to result in potential effects on the environment and health of persons

Contaminants of Potential Concern

The Pickering NGS emits radiological and non-radiological contaminants to the environment in the normal course of operation. As such, COPCs were selected based on a review of site monitoring data for chemical substances and screened against available screening guidelines that are protective of the environment and human health. All radiological releases and non-radiological releases above environmental and human health guidelines were retained for further analysis. If the concentrations of non-radiological releases were below environmental and human health guidelines, they were not carried forward for further analysis as the concentration would be less than any concentration known to cause adverse effects to ecological or human receptors. All radiological COPCs were carried forward for assessment. Table 3.2 and table 3.3 identify the COPCs that were assessed in this EA Report for ecological and human receptors, respectively, during normal operations. Note that the HHRA focused on off-site members of the public, as on-site workers, contractors and visitors potentially exposed to COPCs are controlled through OPG's existing onsite Health and Safety Management System Program and Radiation Protection Program.

The potential for effects from COPCs exposure was assessed by comparing the exposure level to toxicological, radiological and thermal benchmarks:

For non-radiological COPCs, the potential for ecological effects was assessed by comparing exposure levels to toxicological benchmarks and then characterized in terms of a Hazard Quotient (HQ). A HQ less than 1 indicates a negligible risk to the receptor, while a HQ greater than 1 indicates a potential risk to the receptor that needs to be more closely assessed.

For radiological COPCs, the potential for ecological effects was assessed by comparing exposure level to radiation dose benchmarks. A radiation benchmark of 9.6 milligray/day (mGy/d) and 2.4 mGy/d were selected for aquatic and terrestrial biota, respectively, based on CSA Group Standard N288.6-12 *Effluent Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills* [7].

Thermal benchmarks represent an upper bound of temperature suitable for embryo and larval development. They also include maximum weekly average water temperature (MWAT) criteria relevant to fish spawning, embryo-larval development and growth of juvenile and adult fish. Thermal effects were evaluated against two warm water fish species (Smallmouth Bass and Emerald Shiner) and two cold water fish species (Round Whitefish and Lake Trout).

Table 3.2: Selection of contaminants of potential concern (COPCs) – ecological

Category	Radiological COPCs	Non-radiological COPCs	Physical stressors
Air	Noble gases (represented by argon-41)	None	Noise
Surface water	Tritium, carbon-14, gross beta-gamma (represented by cobalt-60), cesium-134, cesium-137 (Lake Ontario and Frenchman's Bay)	Hydrazine, total residual chlorine, morpholine, copper (Lake Ontario)	Impingement and entrainment Thermal
Groundwater	None	None	None
Stormwater	None	None	None

Category	Radiological COPCs	Non-radiological COPCs	Physical stressors
Sediments	Carbon-14, cesium-134, cesium-137, cobalt-60 (Frenchman's Bay)	Aluminum, bismuth, boron, cadmium, calcium, chromium, copper, lead, manganese, nickel, phosphorous, thorium, tin, zinc, total organic carbon (Frenchman's Bay)	None
Soil	Tritium, carbon-14, cesium-134, cesium-137, cobalt-60	Cyanide, arsenic, copper, lead, zinc and petroleum hydrocarbon F4	None

Table 3.3: Selection of contaminants of potential concern (COPCs) – human

Category	Radiological COPCs	Non-Radiological COPCs	Physical Stressors
Air	Tritium, noble gases, carbon-14, iodine (mixed fission products), mixed beta/gamma particulates (represented by cobalt-60)	Hydrazine	Noise
Surface water	Tritium, carbon-14, gross beta/gamma (represented by cesium-137)	Hydrazine and morpholine	None
Groundwater	None	None	None
Stormwater	None	None	None
Soil	Cesium-134, cesium-137, cobalt-60	None	None

3.2 Environmental Effects Assessment – Current Operations

As noted in section 2.1.1 of this report, OPG submitted an updated site-wide ERA. This site-wide ERA was reviewed and accepted by CNSC and used to populate this section of the EA Report [4]. The following sections discuss the potential impacts during normal operations and provide CNSC staff's conclusions on whether OPG will continue to make adequate provisions for the protection of the environment and human health, for this phase of the project.

3.2.1 Atmospheric Environment

Meteorological parameters (i.e., temperature, wind speed, wind direction) are measured at the PN Site, as these are important for dispersion in the atmosphere. Temperature and precipitation in the vicinity of the PN Site do not differ substantially from the general climatic conditions found in southern Ontario.

Radiological Emissions

Radiological emissions to air from PN Site operations include noble gases, tritium and carbon-14. Argon-41 is the predominant noble gas that is measured around the PN Site because it can be released from the reactor building ventilation. Tritium, in the form of tritiated water vapour, is released from the heavy water system. Carbon-14 is produced from the PN Site operations.

As part of OPG's Effluent Monitoring Program, releases to the atmosphere are collected and are routinely analyzed for tritium, carbon-14 , I-131, Noble Gases and Particulates argon-41 and are compared against DRLs developed by OPG and approved by CNSC to ensure release limits to the environment will not exceed the annual regulatory public dose limit of 1 mSv.. As shown in table 3.4, the average radiological emissions from the PN Site remain at a very small fraction of the DRLs.

Table 3.4: Derived release limits – average radioactive airborne emissions from Pickering nuclear facility

Radionuclide	Average (2011-2015)	% of DRL
Tritium (Bq/year)	$5.16x10^{14}$	0.28
Noble gases (yBq-MeV/a)	$1.32x10^{14}$	0.23
Iodine-131 (Bq/year)	$1.76x10^{7}$	<0.01
Carbon-14 (Bq/year)	$1.84x10^{12}$	0.11
Particulate (Bq/year)	$1.15x10^{7}$	<0.01

Non-Radiological Emissions

The main sources of non-radiological emissions at the PN Site are from the turbines, generators and vehicle traffic on site. These sources release small quantities of carbon monoxide, nitrogen oxides, sulphur dioxide and hydrocarbons. In addition, hydrazine, morpholine and ammonia are used in the feedwater system to prevent corrosion and are released in small quantities through controlled venting.

As outlined in section 2.1.4, non-radiological air emissions from the PN Site are controlled in accordance with provincial ECA requirements. Dispersion modelling was used to predict the maximum concentrations of COPCs at the property line of the PN Site. The dispersion modelling results were obtained from the 2015 Emissions Summary and Dispersion Modelling (EDSM) report for the PN Site. None of the contaminants modelled for the five year period (2011-2015) had exceedances of the MOECC`s point of impingement limits.

Physical Stressor

As part of the updated environmental baseline monitoring program in 2015, a noise monitoring program was carried out to monitor existing ambient noise levels at the PN Site. Physical stressors, such as noise, are relevant to both human and ecological receptors. Maximum sound levels, above the provincial noise criteria, were recorded for brief periods at the PN Site; however, these are likely the result of localized road or human activity in the vicinity of the noise monitoring locations. Periodic noise level exceedances are likely not affecting wildlife in the area, as they are likely accustomed to the levels associated with the urbanized setting around the PN Site.

Conclusion

CNSC staff have evaluated the ERA and reviewed the annual EMP results, noise monitoring program and ERA for the licensing period. CNSC staff conclude that OPG's reported releases of radiological and non-radiological contaminants in the atmospheric environment from the PN Site have remained below CNSC approved DRLs and provincial ECA limits for air emissions during the current licensing period. OPG continues to provide adequate protection of people and the environment from atmospheric releases, including noise.

3.2.2 Terrestrial Environment

Vegetation communities at the PN Site were identified based on the Ontario Ministry of Natural Resources Ecological Land Classification for southern Ontario [39]. In 2009, a Terrestrial Long-term Monitoring Project study was conducted by Toronto and Region Conservation Authority biologists, under contract to OPG, in order to detect changes and trends in the flora and fauna. A summary analysis and report was completed after 5 years of data collection from 2009 to 2013 and results for 2009 to 2015 have been summarized [40, 41].

Terrestrial Habitat

Terrestrial habitat within the vicinity of the PN Site includes small independent forested lots, wetlands systems, and cultural vegetation including farmed land, city parks, and manicured (mown) lawn. Major terrestrial habitat features include wooded areas of Kinsmen Park and Alex Robertson Park, as well as the wetland habitat of Hydro Marsh and Frenchman's Bay. Figure 2 in section 1.2 provides an overview of the regional areas of the PN Site and the location of these features.

A review of all flora and fauna identified within the PN Site was assessed against the *Endangered Species Act* of Ontario list and the federal *Species at Risk Act* (SARA) list (Schedule 1). Four plant species identified as either endangered (butternut tree, red mulberry tree, slender bush clover) or threatened have been identified over the years. All except the butternut tree were last observed in 2000. Two Butternut trees, designated as both nationally and provincially endangered were present along the northern edge of the mixed forest lot north of Kinsmen Park in the 2013 survey.

Frenchman's Bay is a provincially significant wetland and is designated an Environmentally Sensitive Area by the Toronto and Region Conservation Authority. It is a habitat for wetland vegetation, benthic invertebrates, fish, and riparian species such as the muskrat, amphibians, and some birds. Frenchman's Bay is Hydro Marsh's link to Lake Ontario and water from the lake enters the system when the water level rises in Lake Ontario.

Soil Quality

Soil quality is important for species that live or breed within the soil. The PN Site and surrounding area is home to a number of terrestrial species, including plants, mammals, birds, soil invertebrates, reptiles and amphibians, which have the potential to be exposed to contaminants via ingestion, inhalation or through skin contact.

As part of the updated baseline ERA, surficial soil samples were collected from eight locations around the PN Site in 2015. Soil samples were analyzed for polycyclic aromatic hydrocarbons, volatile organic compounds, petroleum hydrocarbons F1 to F4, metals and inorganics, glycol, tritium, gamma emitters (i.e., cesium-137, cesium-134, cobalt-60) and carbon-14. More detail on the results of the monitoring program are provided in the Radiological and Non-Radiological COPCs in the Terrestrial Environment section of this EA Report.

Terrestrial Biota

A compilation of past environmental monitoring, follow-up programs, and historical records reported three amphibian species, seven reptile species, 247 bird species and 23 mammal species occurring within or in the vicinity of the PN Site. Three reptile species, 11 bird species and one insect species at risk with a provincial ranking of threatened or special concern were recorded within or in the vicinity of the PN Site (table 3.5). It should be noted that the species at risk inventory includes incidental observation, migrants and residents and therefore, not all species at risk identified are necessarily breeding within the PN Site. All the avian receptors assessed are considered migratory, and are likely to reside at the PN Site for half of the year. However for the exposure assessment, a conservative approach was taken and their occupancy at the PN site is assumed to be for the whole year.

For soil invertebrates and terrestrial plants, the main exposure pathway is through contact with soil and contaminant uptake from soil via bioaccumulation. The dominant exposure pathways for birds, mammals and turtles is through the uptake of contaminants via the ingestion of water, incidental ingestion of soil or sediment, and ingestion of food.

Terrestrial biota, such as riparian birds (i.e., the Trumpeter Swan, or the Common Tern), the riparian mammal (i.e., Muskrat), and amphibians and reptiles (i.e., Northern Leopard Frog and the Midland Painted Turtle), are considered as aquatic receptors for the purposes of the exposure assessment. The effects of radiological and non-radiological COPCs on these biota are considered and further discussed in section 3.2.4 Aquatic Environment.

Table 3.5 Federal and provincial terrestrial species at risk in and around the Pickering nuclear facility

Common name	Provincial status	Federal species at risk status	Most recent year observed
Amphibians and reptiles			
Snapping Turtle	Special concern	Special concern	2009
Blanding's Turtle	Threatened	Threatened	2006
Northern Map Turtle	Special concern	Special concern	2006
Birds			
Chimney Swift	Threatened	Threatened	2008
Black Tern	Special concern	No status	2008
Common Nighthawk	Special concern	Threatened	2010
Bobolink	Threatened	No status	2006
Peregrine Falcon	Special concern	Special concern	2015
Bald Eagle	Special concern	No status	2007
Barn Swallow	Threatened	Threatened	2015
Bank Swallow	Threatened	Threatened	2008
Eastern Wood Pewee	Special concern	Special concern	2015
Least Bittern	Threatened	Threatened	2013
Horned Grebe	Special concern	Special concern	2015
Insects			
Monarch	Special concern	Special concern	2011
Plants			
Butternut	Endangered	Endangered	2013
Slender Bush-Clover	Endangered	Endangered	2000
Kentucky Coffee-Tree	Threatened	Threatened	2000
Red Mulberry	Endangered	Endangered	2000

Radiological COPCs in the Terrestrial Environment

The dose rate to terrestrial receptors was calculated based on the concentration of radionuclides in the soil. Air immersion and inhalation pathways were not considered as they are minor compared to the ingestion of soil pathway.

As per table 3.2, tritium, carbon -14, cesium-134 and 137, and cobalt 60 were identified as relevant radiological COPCs for soil and the dose was compared to the 2.4 mGy/d radiation benchmark for terrestrial biota.

The 2014 ERA concluded the total radiological dose benchmark was exceeded by the earthworm and the Red-winged Blackbird based on the maximum tritium concentration in site soil. The exceedance was based on localized, elevated tritium concentrations in soil close to the reactor buildings. In 2015, soil data were collected and a site inspection was performed to update the baseline EMP. Based on the inspection, areas without vegetation or organic soil cover were removed from the sampling plan as they do not provide a suitable habitat for terrestrial receptors. As a result the dose and risk assessment results for the 2017 ERA provide a more realistic assessment of existing conditions.

The 2017 ERA found that there were no exceedances of the radiation dose benchmark for terrestrial biota.

Non-Radiological COPCs in the Terrestrial Environment

Based on updated surficial soil samples collected in 2015, a number of COPCs were assessed against soil quality guidelines. These guideline levels were then compared against exposure levels for terrestrial receptors to calculate a HQ, which is the ratio of the concentration of the COPCs (in soil for terrestrial receptors) to the most conservative toxicological benchmark. A HQ that is ≤1, meaning the concentration of the COPCs in the sampled soil was less than or equal to the benchmark, indicates there is no potential risk to terrestrial receptors from exposure.

Based on the values presented in table 3.6, the maximum concentrations of copper, lead and zinc are used in the calculation of the HQ for terrestrial fauna receptors (the earthworm, Meadow Vole, Red-winged Blackbird, and the Red-tailed Hawk) exceeded the HQ. However, these terrestrial receptors, with the exception of the Meadow Vole and earthworm, are highly mobile and are unlikely to be exposed to the maximum concentration for the entire year. As such, an average concentration would be more appropriate to the calculation of the HQ. In this instance, the HQ remains below 1.

Table 3.6: Non-radiological hazard quotients for terrestrial biota

Receptor	Arsenic		Copper		Lead		Zinc		Cyanide		Petroleum hydrocarbon F4	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Earthworm	1.0	0.1	**9.1**	0.8	0.5	0.1	**16**	**1.4**	0.0	0.0	**1.7**	0.5
Terrestrial Plant	**2.2**	0.2	**8.3**	0.7	0.9	0.1	**16**	**1.4**	0.0	0.0	**1.7**	0.5
Meadow Vole	0.8	0.1	**2.8**	0.2	0.0	0.0	0.8	0.1	0.0	0.0	N/A	N/A
Red-winged Blackbird	0.2	0.0	**1.2**	0.1	**1.2**	0.1	**10**	0.9	0.0	0.0	N/A	N/A
Red Fox	0.1	0.0	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.0	N/A	N/A
Red-Tailed Hawk	0.3	0.0	0.8	0.1	**1.1**	0.1	**1.5**	0.1	0.1	0.0	N/A	N/A

Notes: Bold and shaded values indicate a HQ > 1.
N/A denotes that HQs were not calculated because COPC is not of toxicological concern to receptor.

The exceedance of the HQ for some COPCs to the Meadow Vole and the earthworms (i.e., copper for voles, and copper, zinc and petroleum hydrocarbons for earthworms), was primarily due to localized concentrations at one sampling location. Therefore, there may be potentially some localized impacts on individuals found in that area, but the population as a whole is not expected to be impacted.

The higher HQ for zinc for the Red-winged Blackbird is likely due to transfer of the COPC through feeding on earthworms with higher levels of zinc. However this assessment is very conservative since the earthworm was used as the sole food source for the Red-winged Blackbird, which results in an overestimate of exposure. Given that birds are highly mobile, the use of mean (average) exposure concentration is more appropriate than maximum exposure concentration of the COPC. It should also be noted that although the Red-winged Blackbird was used as a surrogate species for the Barn Swallow, which is primarily an aerial insectivore and is unlikely to feed on earthworms, As such, the Barn Swallow is not likely to be impacted at an individual level from PN Site operations.

Terrestrial plants had toxicological benchmark exceedances when maximum soil concentrations were considered for arsenic, copper, zinc, and petroleum hydrocarbon F4s, as well as for mean concentrations of zinc. The potential effects on plants due to exposure of these COPCs is expected to be limited to small areas on the PN Site as these exceedances occurred at only 1 of the 8 soil sampling locations. The Butternut tree, identified as a federally and provincially listed endangered species at risk present in the PN Site area, could be affected by these COPCs; however there are no Butternut trees species in areas with elevated concentrations of the COPCs; therefore, the Butternut tree is not likely to be impacted from PN Site operations.

HQs for exposure of terrestrial mammals and birds to petroleum hydrocarbon F4 were not calculated. The Canadian Council of Ministers of the Environment have indicated that petroleum hydrocarbon F4 is not a toxicological concern for mammals and birds [42].

Physical Stressors in the Terrestrial Environment

Noise levels due to the operation of the PN Site may potentially pose a disturbance to wildlife. As part of the updated baseline environmental program, a noise monitoring program was carried out to monitor existing noise levels. In addition, the PN Site has an ECA issued by the MOECC to help protect the natural environment from emissions, including air and noise. The updated baseline program, together with the ECA and the Refurbishment and Continued Operation of the Pickering B EA Report (2008) [26] concluded that, although some wildlife leave their habitat due to noise levels, most wildlife in the area are likely accustomed to noise levels associated with an urban environment. Furthermore because the PN Site has been fully operational for three decades wildlife in the vicinity have likely already acclimated to the noise levels emitted from the PN Site.

Wildlife collisions with vehicles and bird or bat strikes on buildings have been assessed in prior PN Site EAs and continue to be monitored. The results indicate that mortality rates have remained low and fairly consistent over the years of operation. No federal species at risk were among wildlife collisions recorded. Based on these observations no effects at a population level are expected to result from these losses. For these reasons, the effects of noise and wildlife collisions were not carried forward for further assessment in this report.

Conclusion

The ERA indicates that no radiological exceedances occurred and that the maximum radiological dose rate to any terrestrial receptor was lower than the 2.4 mGy/d radiation dose benchmark for terrestrial biota.

There were a number of exceedances of the HQ when using the maximum concentration of non-radiological COPCs. It was assessed that given the mobility of many of the terrestrial species, exposure to maximum concentrations of the COPCs is unlikely and is overly conservative. The use of mean (average) concentration in the assessment is more representative of exposure. There were also some exceedances (using the maximum and mean concentrations) that are localized and found to be at only certain locations on the PN Site. While these exceedances may have some localized effects to individual receptors, the population as a whole is not expected to be impacted. Furthermore there are no species at risk that are likely to be affected by these exceedances.

At this time there is no planned remediation work for the confirmed areas of localized elevated concentrations of the COPCs, as they are expected to be addressed when the PN site is decommissioned.

CNSC staff reviewed the ERA and the environmental monitoring data and determined the exposure of radiological and non-radiological contaminants to terrestrial biota is within the limits of reasonable risk and that OPG has and will continue to make adequate protection for the terrestrial environment and human health.

3.2.3 Hydrogeological Environment

Groundwater from the PN Site flows from north to south towards one of three surface water bodies in the vicinity of the PN Site - Frenchman’s Bay to the west, Duffins Creek to the east and Lake Ontario to the south. Both Frenchman’s Bay and Duffins Creek flow into Lake Ontario. Groundwater is monitored for radiological and non-radiological contaminants before being discharged to Lake Ontario. Groundwater is not used as a source of potable water on the PN Site.

Groundwater flow in the protected area of the PN facility is significantly controlled by the inactive (non-radiological effluent) Turbine Auxiliary Bay (TAB) foundation drainage sumps. These sumps create a hydraulic sink that captures groundwater below the reactor buildings. The flow into the TAB foundation drains is approximately 25 and 77 m^3/day for Units 1-4 and 5-8, respectively. Groundwater from the TAB is monitored before being discharged to Lake Ontario.

The active drainage system collects active (radiological) effluent waste from the drains in reactor building, reactor auxiliary bay, IFB and PWMF. The active liquid waste is directed to the receiving tanks of the Radioactive Liquid Waste Management System (RLWMS). The activity in the liquid waste may include tritium, carbon-14, gross alpha and gross beta-gamma (e.g., cesium-134, cesium-137, strontium-90, cobalt-60). The RLWMS uses a purification system to purify the waste to reduce radiological and non-radiological contaminants. The waste is sampled and chemically analyzed to ensure it meets radiological and non-radiological limits prior to discharge to Lake Ontario. The current average RLWMS release volume to Lake Ontario is approximately 235 m^3/day. Radioactivity monitors are on the discharge piping to automatically stop discharge flow if the detected activity is above specified limits.

In 2016, groundwater samples from 140 sampling points were collected and analyzed for tritium, with some sampling points also analyzed for other chemicals (e.g., petroleum hydrocarbons). Sampling points included wells, drains, sumps, catch basins and ground tubes. Tritium concentration trends over time at monitored locations show that, in many cases, concentrations have remained nearly constant or decreased which indicates stable or improved environmental performance. In a few cases, tritium concentrations increased unexpectedly over recent years. These unexpected increases were addressed through detailed assessments and corrective actions.

Tritium in groundwater is mainly localized within the PN Site. The foundation drains act as hydraulic sinks that capture most of the tritium plumes in the groundwater. OPG’s annual Groundwater Monitoring Program tracks, monitors and reports on groundwater quality and the results confirm that there is no adverse, off-site migration of tritium. The site concentrations remain low, indicating non off-site impacts.

Radiological COPCs in Groundwater

Between 2013 and 2016, elevated tritium concentrations in groundwater were present in the Units 5-8 IFBs. OPG initiated a project to repair the liner and sump to reduce the potential for IFB water to impact site groundwater quality. The project is expected to be completed by the end of 2017. Elevated tritium concentrations are documented in groundwater associated with the Unit 1 and Units 5-8 foundation drainage sumps due to past facility operations. Through procedural and operational changes, recent samples taken indicate that tritium in the area has declined substantially. As indicated, results from the annual Groundwater Monitoring Program confirm that tritium in groundwater is localized within the PN Site and there is no off-site impact.

Non-Radiological COPCs in Groundwater

Certain groundwater wells were also analyzed for select COPCs, including petroleum hydrocarbons, volatile organic compounds, metals, and chloride due to past historical leakages. Results from groundwater wells closest to the intake channel showed concentrations of COPCs were within federal and provincial water quality guidelines and were consistent with previous groundwater assessments.

Conclusion

As onsite groundwater is not used as a source of drinking (potable) water, there is no direct human health risk from this pathway. Elevated tritium in the groundwater is limited to the protected area and is captured by the foundation sumps which act as hydraulic sinks.

CNSC's staff review of the ERA and the annual groundwater monitoring data indicate that there are elevated tritium concentrations at certain locations on the PN Site but tritium in groundwater does not extend beyond the PN Site. OPG's mitigation measures have ensured no off-site impacts identified at site perimeter locations. CNSC staff will continue to review OPG's groundwater monitoring at potential locations of contamination around the PN Site including near the IFBs, as well as review OPG's corrective action plans for the IFBs.

Based on a review of the ERA and the results from OPG's groundwater monitoring program and annual EMP data, CNSC staff conclude that that OPG's reported radiological and non-radiological releases of COPCs to groundwater from the site perimeter concentrations have remained low and OPG continues to provide adequate protection of the hydrogeological environment.

3.2.4 Aquatic Environment

Surface Water

The PN Site is located on the north shore of Lake Ontario. The shoreline immediately adjacent to the PN Site has been altered by the construction of the CCW intake channel and the two water outfall channels, one on each side of the PN Site (see figure 1.2). All liquid effluent, except domestic sewage and some stormwater drainage, is discharged either into the CCW intake channel or the outfall channels or the forebay into Lake Ontario. The surface water monitoring program for the PN Site provides regular monitoring of radiological COPCs in effluent and surface water in the vicinity of the site. In addition, OPG conducted baseline environmental monitoring for non-radiological contaminants in surface water and sediment in 2015 at the discharge channels and in Frenchman's Bay to support the current ERA. The results are discussed below in the Radiological and non-radiological COPCs in Aquatic Environment section. It should be noted that Frenchman's Bay is highly influenced by urban stormwater runoff and contributions to surface water and sediment concentrations from PN operations are small.

Nearshore lake currents are affected by the existing operation of the Pickering NGS reactor units. Under normal operations, with all six units running, water withdrawal rates from 190 to 220 m^3/s are required to cool down the reactor units. Water withdrawal results in some localized effects, such as fish impingement as well as egg and larvae entrainment at the water intake. The discharge of cooling water also results in a thermal plume that can potentially affect localized fish populations. These effects are discussed below.

Stormwater

Stormwater runoff from the PN Site is collected by the stormwater drainage system, comprised of 19 catchments, and is directed through drainage pathways to Lake Ontario. As part of the updated baseline EMP, a stormwater sampling program was conducted in 2015 in order to characterize the current quality of stormwater runoff released to the PN Site outfalls and stormwater runoff released directly to Lake Ontario. The point of discharge concentrations were compared against provincial water quality guidelines. None of the measured radiological and non-radiological contaminants exceeded provincial guidelines. As such, stormwater quality was not assessed further. However, to address the water quality of stormwater discharging directly to Lake Ontario from the PN Site, CNSC staff, along with Environment and Climate Change Canada (ECCC) staff, recommend that OPG develop a stormwater sampling plan and the results be included in future ERA submissions.

Sediment

As part of the updated baseline EMP, sediment data were collected in the summer of 2015 from Frenchman's Bay to address recommendations in the 2014 ERA to collect sediment and water samples in the northern section of Frenchman's Bay [15]. Frenchman's Bay is a provincially significant wetland and is the closest location to the PN Site that is considered a depositional area. Sediment samples were analyzed for total organic carbon, metals and radionuclides and the results are discussed below in the Radiological and Non-Radiological COPCs in Aquatic Environment sections.

Aquatic Habitat

Spawning habitat for several fish species, such as Lake Trout and Round Whitefish, is found along the exposed shoreline of Lake Ontario. Duffins Creek, Frenchman's Bay and Hydro Marsh also provide spawning and rearing habitat for such species as Northern Pike, Smallmouth Bass and Emerald Shiner. The discharge channels of the PN Site also provides spawning habitat for Smallmouth Bass. The intake forebay provides foraging habitat for a number of fish species, including Smallmouth Bass, Northern Pike and Lake Trout.

Aquatic Biota

More than 90 fish species are known to inhabit Lake Ontario, almost all of which use the nearshore waters for spawning, rearing, feeding and migrations. Table B-2 in appendix B lists the resident and migratory fish species observed within the PN Site. Three fish species at risk, with a provincial or federal ranking of threatened, endangered or extinct were recorded at the PN Site (see table 3.7). Atlantic Salmon in Lake Ontario are likely individuals from the Lake Ontario Atlantic Salmon Restoration Program.

Table 3.7: Fish species at risk observed within the PN Site area

Common name	Provincial ESA status	Federal species at risk status	Most recent year observed
Lake Sturgeon	Threatened	Threatened	2005
American Eel	Endangered	Threatened	2015
Atlantic Salmon (1)	Extinct	Extinct	2015

(1) Atlantic Salmon (Lake Ontario population) is listed as extinct. Atlantic Salmon found in Lake Ontario are likely individuals from the Atlantic Salmon stocking program and are not considered to represent a native Lake Ontario population.

As indicated in section 3.2.2 Terrestrial Environment, some terrestrial species (e.g., riparian birds and mammals, amphibians and reptiles) were assessed as aquatic species for the purpose of the radiological and non-radiological exposure assessments. The Least Bittern (listed as Threatened status both federally and provincially), was recorded on the PN Site. The Common Tern was selected to represent the Least Bittern as a riparian bird that ingests fish and insects.

Zebra mussels and quagga mussels have colonized the nearshore areas in the vicinity of the PN Site and throughout Lake Ontario and are very abundant, including in the vicinity of the water intake and discharge channels of the PN Site.

The main exposure pathway for the aquatic community is through direct contact with water and sediment at the PN Site outfall and/or at Frenchman's Bay.

Radiological COPCs in Aquatic Environment

The levels of tritium as a result of emissions from the PN Site operations on nearby water supply plants varies depending on distance from the station, lake current direction, location and depth of the water supply plant intake pipe and dispersion conditions. The annual EMP results indicate that the average tritium levels at all water supply plants ranged from 3.9 to 5.7 Bq/L, which is well below the Ontario Drinking Water Quality Standard of 7,000 Bq/L.

Dose rates to aquatic and riparian receptors at certain locations were calculated based on the concentration of radionuclides in surface water and sediment. For both surface water and sediment concentrations of radionuclides, dose rates were well below the radiological dose benchmark (9.6 mGy/day for aquatic receptors or 2.4 mGy/day for terrestrial receptors) at the outfall to Lake Ontario or Frenchman's Bay.

As part of OPG's EMP, samples of waterborne emissions are collected and routinely analyzed for tritium, carbon-14 and gross beta/gamma. As per table 3.8, the average waterborne radiological emissions from the PN Site remain a very small fraction of the licensed DRLs. There were no DRL (regulatory limit) exceedances.

Table 3.8: Derived release limits – average radiological COPCs from waterborne emissions from Pickering Nuclear Facility

Radionuclide	Average (2011-2015)	% of DRL
Tritium (Bq/year)	3.24×10^{14}	0.05
Beta-gamma (Bq/year)	2.72×10^{10}	0.04
Carbon-14 (Bq/year)	3.84×10^{9}	0.09

Non- Radiological COPCs in Aquatic Environment

Boiler treatment chemicals including hydrazine and morpholine are used within the feedwater system to prevent corrosion in the boilers and are released to the aquatic environment through the discharge channels.

In addition, sodium hypochlorite is also used to control colonization of the water intake structures by quagga and zebra mussel to ensure safe operations of the reactor units. OPG dechlorinates to limit the residual chlorine input to Lake Ontario.

All effluent except sewage and some stormwater are released into the outfall and into Lake Ontario. For each COPC, the maximum concentration of the effluent was screened against federal and provincial water quality guidelines. These guidelines were compared against exposure levels for aquatic and riparian receptors to calculate a HQ, which is the ratio of the concentration of the COPC (in surface water or sediment) to the most conservative toxicological benchmarks. A HQ that is ≤ 1, meaning the concentration of COPCs in surface water or sediment is less than or equal to the benchmark, indicates there is no potential risk to aquatic or riparian receptors from exposure.

Outfall and Discharge Channels – Surface Water

A surface water monitoring program was conducted in the summer of 2015, as part of the updated baseline EMP, in order to quantify the concentration of COPCs in the discharge channels. As indicated in section 2.1.4, as part of the ECA requirements, effluent is sampled at the outfall of the PN Site for ammonia, hydrazine, morpholine, pH, copper and total residual chlorine. Hydrazine, morpholine and total residual chlorine from the effluent exceeded the surface water quality guidelines and were further compared against toxicological benchmarks. The maximum and mean concentrations of hydrazine, morpholine and total residual chlorine in the outfall did not exceed the toxicological benchmarks. As such, the aquatic community is not likely to be impacted from these COPCs.

There were some HQ exceedances when the maximum concentration of copper was used in the calculation of the HQ for aquatic receptors. The maximum copper concentration in water near the outfall was exceeded for fish (HQ of 2.3) and benthic invertebrates (HQ of 1.5) (see table 3.9 and table 3.10). However, average (mean) copper concentrations in water samples at the outfall were below the toxicological benchmarks (HQ of 0.3 for fish and HQ of 0.4 for benthic invertebrate). As fish are mobile, the exposure to the average concentration is more appropriate in the calculation of the HQ than the maximum exposure concentration of the COPC. Although a few fish and benthic invertebrates may be exposed to the maximum copper concentration, the community as a whole is not likely to be impacted from PN Site operations.

The American Eel is an identified species at risk (listed as provincially endangered and federally threatened). As discussed, the mean water concentration for copper was not exceeded. As eels are mobile, the HQ for mean water concentration is more appropriate than the maximum exposure concentrations. As such, the American Eel is not likely to be impacted from exposure to this COPC from PN Site operations.

Outfall and Discharge Channels – Sediment

Estimated maximum copper concentrations in sediment near the PN Site outfall also slightly exceeded the sediment benchmark for copper (HQ of 1.5), therefore the HQ was above the risk level of 1 for benthic invertebrates. Based on the average (mean) measured copper concentrations near the PN Site outfall (HQ of 0.3), the estimated sediment concentration is below the sediment benchmark for copper and, as such, the benthic invertebrate community as a whole is not likely to be impacted from PN Site operations.

Frenchman’s Bay – Surface Water

Frenchman’s Bay water concentrations were screened against surface water quality guidelines. Maximum concentrations of copper, aluminum, sodium and iron exceeded the surface water quality guidelines and were further compared against toxicological benchmarks. Sodium in water samples did not exceed the toxicological benchmarks.

The maximum measured iron concentration in water at Frenchman's Bay exceeded the benthic invertebrate toxicological benchmark (HQ of 1.9) but the mean measured concentration was below the benchmark (HQ of 0.9) (see table 3.9). Although a few benthic invertebrates may be exposed to these maximum measured concentrations of iron, the community as a whole is not expected to be impacted from PN operations. In addition, the maximum and mean iron concentrations in sediment at Frenchman's Bay did not exceed the sediment benchmarks for benthic invertebrates.

The maximum and mean aluminum concentration for the muskrat and Bufflehead and maximum and mean iron concentration for the Trumpeter Swan, the Bufflehead and the Ring-billed Gull, and the max iron concentration for the Common Tern exceeded the toxicological benchmark for these riparian species for both water and sediment concentrations. However, as these receptors would not reside at Frenchman's Bay exclusively, these HQs are considered very conservative. Combined with the influence of the urban runoff at Frenchman's Bay, it is unlikely that the populations of these receptors will be impacted from PN Site operations.

The Least Bittern was identified as a species at risk on the PN Site and was represented by the Common Tern. As indicated in table 3.9, maximum iron concentration exceedances for the Common Tern were recorded. However due as the Common Tern is highly mobile, the use of mean exposure concentration is more representative than the maximum exposure concentration of the COPC. As such, the Least Bittern is not likely to be impacted from iron exposure in Frenchman's Bay due to PN Site operations.

<u>Frenchman's Bay – Sediment</u>

In sediment samples taken from Frenchman's Bay, several metal COPCs exceeded sediment quality guidelines and were further assessed against toxicological benchmarks. It should be noted that many of the COPCs identified in sediment samples from Frenchman's Bay were not related to the PN Site but due to urban stormwater runoff.

The maximum and mean measured copper concentrations in sediment in Frenchman's Bay exceeded the sediment toxicological benchmarks for benthic invertebrates (HQ greater than 1) (table 3.10). Although the results of the ERA to ecological receptors at Frenchman's Bay indicate copper results above the acceptable risk level, exceedances of toxicological benchmarks are not uncharacteristic for an area such as Frenchman's Bay, since it is highly influenced by urban stormwater runoff. The ERA evaluated the contribution to the overall risk and concluded that the PN Site operations contribute only a small portion of the overall risk to aquatic receptors at Frenchman's Bay.

Table 3.9: Non-radiological hazard quotients for aquatic biota and riparian birds and mammals

Receptors	Hydrazine		Morpholine		Chlorine (TRC)		Copper		Aluminum		Sodium		Iron	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean
PN discharge channel														
Fish	0.0	0.0	0.0	0.0	0.2	0.2	**2.3**	0.3	N/A	N/A	N/A	N/A	N/A	N/A
Benthic Invertebrate	0.1	0.0	0.0	0.0	0.4	0.4	**1.5**	0.4	N/A	N/A	N/A	N/A	N/A	N/A
Ring-billed Gull	Nd	nd	nd	nd	nd	nd	0.1	0.4	N/A	N/A	N/A	N/A	N/A	N/A
Frenchman's Bay														
Fish	0.0	0.0	0.0	0.0	0.2	0.2	0.6	0.4	0.1	0.0	0.8	0.5	0.4	0.2
Frog (Tadpole)	0.0	0.0	0.0	0.0	0.2	0.2	0.6	0.4	0.1	0.0	0.8	0.5	0.4	0.2
Benthic Invertebrate	0.0	0.0	0.0	0.0	0.4	0.4	0.3	0.3	0.1	0.1	0.1	0.1	**1.9**	0.9
Aquatic Plant (Cattail)	0.0	0.0	0.0	0.0	0.2	0.2	**1.1**	0.8	0.6	0.3	0.5	0.3	0.4	0.2
Muskrat	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	**5.2**	**3.0**	N/A	N/A	0.3	0.2
Trumpeter Swan	Nd	nd	nd	nd	nd	nd	0.0	0.0	0.4	0.2	N/A	N/A	**5.2**	**2.7**
Bufflehead	Nd	nd	nd	nd	nd	nd	0.0	0.0	**4.1**	**2.3**	N/A	N/A	**17.3**	**9.9**
Common Tern	Nd	nd	nd	nd	nd	nd	0.0	0.0	0.2	0.1	N/A	N/A	**1.0**	0.6
Ring-billed Gull	Nd	nd	nd	nd	nd	nd	0.1	0.0	0.6	0.4	N/A	N/A	**5.0**	**2.8**

Notes: Bold and shaded values indicate a HQ > 1.
nd denotes that no data were available.
N/A denotes that parameter not applicable to specific area of assessment.
Max and mean HQs for morpholine and TRC are generally equivalent for most receptors since surface water concentrations were generally measured below the detection limit.
The HQs for fish, frog, benthic invertebrate and aquatic plant are based on TRVs for water concentrations. Sodium is considered non-toxic to birds and mammals.

Table 3.10: Non-radiological hazard quotients for Benthic Invertebrates from Sediment TRVs

		Benthic Invertebrate	
		PN discharge channel	**Frenchman's Bay**
Copper	**Max**	**1.5**	**4.6**
	Mean	0.3	**2.8**
Iron	**Max**	N/A	1.0
	Mean	N/A	0.8

Notes: Bold and shaded values indicate a HQ >1.
N/A denotes that parameter not applicable to specific area of assessment.

Physical Stressors

<u>Impingement and Entrainment</u>

Impingement of fish and entrainment of fish eggs and larvae within the PN facility occurs from the use of lake water for CCW. In 2008, the CNSC issued a directive to the Pickering NGS to reduce fish impingement by 80% by 2012. In 2009, a FDS (see figure 1.3) was installed by OPG around the cooling water intake structure to mitigate impingement as an interim measure. Monitoring conducted annually from 2009 to 2011 indicated that the FDS met and exceeded the impingement reduction target each year. As a result, in 2012, the CNSC accepted the FDS as a permanent solution to reduce fish impingement. OPG installs the FDS from spring to fall and monitoring of fish impinged is conducted weekly through the year and OPG provides to the CNSC an annual report on fish impingement results. Since 2010, the FDS has reduced fish losses by at least 53% (table 3.11). The estimated biomass of impinged fish in 2015 was the highest at 8,517 kg (table 3.12) since 2010, the majority from a single impingement event of Alewife in May 2015 [43]. The event occurred during the installation of the FDS, which resulted in the joints coming apart which allowed fish to bypass the FDS and become impinged. CNSC staff acknowledged OPG's corrective actions to prevent reoccurrence of similar events. Excluding the May event, the impingement rate in 2015 would have been approximately 2,553 kg, which is consistent with annual impingement rates observed since 2010. In 2016, the biomass of impinged was estimated to be 1,035 kg, which represents the lowest annual biomass impingement rate observed since monitoring of the FDS began in 2010 and corresponds to a 94% reduction in fish loss compared to 2003-2004 fish losses.

Impingement monitoring data from 2011 to 2015 identified 52 species of fish which may occupy the intake forebay. The most commonly impinged fish species were Alewife, Gizzard Shad, Round Goby, Three-Spine Stickleback, Emerald Shiner and Rainbow Smelt. No SARA species were impinged in 2016; however 112 American Eel, which are threatened under COSEWIC and endangered under Schedule 3 of Ontario's *Endangered Species Act*, were impinged. OPG has a permit issued by the Ontario Ministry of Natural Resources and Forestry (OMNRF) which allows them to impinge American eel. CNSC staff consulted OMNRF regarding the number of American eel impinged. OMNFR indicated that they are aware of the impingement numbers and were of the opinion that the increase in number was a reflection of the success of the OMNRF's stocking program [44].

The FDS is not designed to reduce entrainment, which occurs when fish eggs and early life stages pass through the screenhouse and into the CCW system. Based on CNSC staff's review of the residual impingement and entrainment losses, risks to fish populations are low. However, OPG has proposed three offsetting measures to counterbalance losses such that a net benefit in fisheries productivity is achieved. Fisheries and Oceans Canada (DFO) has been working with OPG to complete the joint *Fisheries Act* authorization (FAA) (a FAA for the NPP operations, as well as a FAA required for the proposed offset projects). CNSC staff have been working closely with DFO and OPG to ensure that OPG comes into compliance with the *Fisheries Act*.

Table 3.11: Impinged percent reduction from 2010-2015

Year of Measurement	2010 Reduction (%)	2011 Reduction (%)	2012 Reduction (%)	2013 Reduction (%)	2014 Reduction (%)	2015 Reduction (%)	2016 Reduction (%)
Total Biomass	74.7	79.2	90.6	83.9	78.3	53.0	94.0

Table 3.12: Impinged fish biomass from 2010-2015

Year of Measurement	2003-04 Biomass (kg)	2010 Biomass (kg)	2011 Biomass (kg)	2012 Biomass (kg)	2013 Biomass (kg)	2014 Biomass (kg)	2015 Biomass (kg)	2016 Biomass (kg)
Total Biomass	18,214.0	4616.5	3782.0	1706.0	2926.0	3953.0	8553.0	1035.0

Thermal Plume

The discharge of warm water during normal operation of the CCW system has the potential to impact fish spawning, egg hatching success and larvae development. A thermal plume exists in the area resulting from current operations of the six reactor units where temperatures are typically on average 2^{o}C above ambient lake water temperature. The spatial extent of the thermal plume ranges from 1.5 to 8 km^2. OPG has an ECA discharge temperature limit for different operating conditions. On occasion, thermal releases from the CCW discharge can increase during algae and ice buildup events at the intake. During these events, some CCW pumps are turned off, to reduce pressure which causes the temperature of the water being released at the outfall to be higher than the provincial regulatory limit for a short time and for which special ECA limits apply. The regulatory approval allows for a maximum difference of 11^{o}C between cooling water going in and coming out of the plant. OPG has implemented mitigation measures, including the installation of a skirt on the FDS and the installation of an ice barrier at the mouth of the intake channel to reduce thermal impact effects at the discharge point.

CNSC staff and Environment and Climate Change Canada (ECCC) staff evaluated the thermal risk assessment to fish. CNSC and ECCC staff verified that OPG's comparison of lake water in the thermal plume of the Units 5-8 discharge channel and reference locations against the maximum weekly average temperature (MWAT) and short-term daily maximum (STDM) criteria relevant to fish spawning, embryo-larval development and growth of juvenile and adult fish for 15 species of fish to determine the HQ values. As previously indicated, a HQ above 1 is indicative of potential adverse effects from the thermal plume. For fish spawning, embryo-larval development, juvenile and adult life stages, the highest HQ were marginally above 1 in the thermal plume, but were similar in the reference locations. As such, it is unlikely that there are any effects arising from the thermal plume in the lake for any life stages for most fish species.

For Round Whitefish, a species known to be particularly sensitive to water temperature during spawning and larval development, the estimated survival loss at the PN Site compared to the reference stations were all below the survival loss of 10% (the threshold for no-effect on Round Whitefish embryo survival) except for one station near the thermal discharge point in 2011-2012. This station represents only 1% of suitable spawning habitat and the survival loss threshold was only exceeded once in 2011-2012. CNSC staff conclude that the thermal plume is not likely to have an adverse effect on embryo development and survival of Round Whitefish and other fish species. However, OPG has committed to conduct two additional years of thermal monitoring (2018-2019 and 2019-2020) to reassess the uncertainties in the thermal risk assessment during the proposed licensing period [45].

Conclusion

Over the previous licensing period no radiological release limits were exceeded and that the maximum radiological dose rate was lower than the 9.6 mGy/d and 2.4 mGy/d radiation dose benchmark for aquatic and terrestrial (riparian) receptors, respectively.

The ERA identified a few exceedances of the HQ of non-radiological COPCs such as aluminum, iron and copper. These incidences of HQs higher than 1 arose for some aquatic and riparian receptors when considered to be exposed to the maximum measured concentrations in the environment. However given the mobility of these species, the communities as a whole are not expected to be impacted. Further, the contribution of the PN Site to the COPC concentrations in question is low relative to the urban stormwater runoff contributions. The ERA indicates that significant environmental risk to aquatic and riparian biota is unlikely and the aquatic environment around the PN Site is and will continue to be protected.

OPG installed a barrier net as part of the FDS in 2009 and the results indicate that the FDS has reduced fish losses by at least 53% and most recently, in 2016, by 94%. In order to address residual impingement and entrainment impacts, OPG is seeking an authorization under the *Fisheries Act* which will offset the impacts from impingement and entrainment. CNSC's review of the monitoring results indicate that fish loss due to impingement and entrainment is having a negligible effect on local fish populations.

CNSC staff conclude that thermal discharge risk to fish communities resulting from operations at the PN Site is a potential local stressor for Round Whitefish and is not expected to be significant (i.e., at the population level). CNSC staff will review thermal plume monitoring data in 2018-19 and 2019-2020 to reduce the uncertainties in the thermal risk assessment and ensure Round Whitefish and other less sensitive species remain protected.

CNSC staff completed environmental compliance verification activities involving the review of releases of nuclear and hazardous substances, the results of OPG's annual monitoring reports, site-specific ERA, , and special studies associated with thermal releases and impingement and entrainment. Based on these compliance activities and technical evaluations, CNSC staff conclude that OPG's Pickering environmental protection program continues to provide adequate protection to the aquatic environment.

3.2.5 Human Environment

The *Radiation Protection Regulations* [19] under the NCSA require licensees to implement radiation protection programs, of which one component includes control of public exposures to radiation so that doses are below the public dose limit and furthermore, kept ALARA. The regulations define the regulatory public dose limit as 1 mSv/year, and require doses to be monitored either by direct measurement or by estimation based on the quantities and concentrations of nuclear substances released as a result of a licensed activity.

OPG completed a HHRA for exposure of human receptors to radiological COPCs as part of the ERA. By accounting for relevant exposure pathways and critical groups of human receptors, radiological dose calculations were performed (as per the methodology outlined in CSA N288.1-08 *Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities* [8]. Note that while workers at the PN Site potentially get exposed to radiological contaminants, these exposures are considered and controlled through OPG's Health and Safety Management System Program and Radiation Protection Program. As such, on-site receptors were not assessed in the HHRA and the focus of the HHRA was only for off-site members of the public.

Off-site members of the public are potentially exposed to low levels of airborne or waterborne contaminants. OPG assessed doses to the potentially most affected offsite members of the public, known as human receptors or critical groups. The HHRA focused on radiological and non-radiological contaminants that have the potential to be present in the PN Site's airborne and liquid effluent. OPG reviews the critical groups and pathway analyses every five years to ensure the public dose accurately reflects the public living near the NGSs.

For this licensing period, the following six groups of human receptors were included in the HHRA:

- C2 Correctional Institution – located approximately 3 km NNE of PN Site, obtains drinking water from Ajax Water Supply Plant (WSP) and does not consume locally produced fruits or vegetables, assumed to be at location 100% of time over at least one year.
- Local Urban Residents – Pickering and Ajax area residents that surround PN site, consume water from the Ajax WSP and a diet composed in part of locally grown produce and an insignificant component of locally caught fish, externally exposed to beach sand at local beaches.
- Local Farms – residents of agricultural farms within 10 km radius of PN site, obtain most water from wells but a portion from Ajax WSP, consume locally grown produce and animal products, externally exposed to beach sand at local beaches.
- Local Dairy Farms – residents of dairy farms within a 20 km radius of PN site, obtains most of water supply from local wells, consume locally grown fruit and vegetables and locally produced animal products, externally exposed to beach sand at local beaches.

- Sport Fishers – non-commercial individuals fishing near PN site outfalls, 0.5 km south of PN Site, assumed to obtain entire amount of fish for consumption from the vicinity of PN Site and spend 1% of time at outfall location where atmospheric exposure occurs.
- Off-site Industrial/Commercial Workers – adult workers whose work location is close to PN Site, at location about 23% of time, consume water from Ajax WSP, closest group is about 1 km NNE of the site.

The receptors closest to the facility are the Sport Fisher, the Urban Resident and the Industrial/Commercial Worker. Within each group of human receptors, three age classes were considered: 0-5 years (infant), 6-15 years (child), and 16-70 years (adult), consistent with CSA N288.1-08 [8]. Site-specific receptor data were used for the exposure assessment where available, and otherwise, default receptor characteristics were obtained from sources outlined in N288.6-12 *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [7]. It should be noted that Indigenous groups were considered in the selection of receptors for the HHRA. OPG engaged with Indigenous communities, councils and organizations during the preparation of the Refurbishment and Continued Operation of the Pickering B NGS EA. The information gathered showed no evidence that indicated use of lands, water or resources for traditional purposes. It may be possible that a few individuals may carry out these activities in a very limited fashion. However, due to urbanization, population density and private lands, these activities would be restricted. As such, OPG bound the health of Indigenous peoples with the assessment for non-Indigenous peoples located closer to the PN Site and who consume local foods to the PN Site as part of their diet.

Radiological COPCs in Human Environment

The following exposure pathways were considered to assess doses to human receptors from radiological COPCs:

- inhalation of air and external exposure to air
- ingestion of water and external exposure to water
- incidental ingestion of soil and sediment
- external exposure to soil and sediment
- ingestion of food

The radiological HHRA presents doses reported in the EMP reports from 2011-2015, which have been reviewed and accepted by CNSC staff. Radiological dose calculations to human receptors were calculated using environmental monitoring data from the EMP and supplemented with modelling, where necessary. The annual dose during the five year period of interest (2011 to 2015) ranged from 0.9 to 1.2 µSv, approximately 0.1% of the regulatory limit of 1 mSv/year (1000 µSv/year). The primary radionuclide pathways contributing to this total dose were inhalation of tritium and external exposure to noble gases. The critical receptor was the local urban resident (adult). As the critical receptor group presumably receives the highest dose other receptor groups near PN Site are also protected.

Non- Radiological COPCs in Human Environment

As indicated in section 3.1.1 Atmospheric Environment, hydrazine is released into the atmosphere through boiler venting and in section 3.1.4 Aquatic Environment, both hydrazine and morpholine are released to the aquatic environment through boiler flushing through the outfall. The HHRA assessed the risk for exposure of human receptors to these non-radiological COPCs.

The following exposure pathways were considered to assess doses to human receptors from hydrazine and morpholine COPCs:

- inhalation (hydrazine) for all six human receptor groups
- water ingestion (hydrazine and morpholine) for the Urban Resident, Correctional Institution, and Industrial/Commercial Worker
- fish ingestion (hydrazine and morpholine) for the Sport Fisher

As there is no complete exposure pathway from onsite groundwater and soil to human receptors, these pathways were not considered in the exposure assessment to human receptors from non-radiological COPCs.

In order to characterize potential risks quantitatively to human receptors, HQs were estimated for potential non-carcinogenic substances (morpholine) through a water and/or fish ingestion pathway. The HQs were compared to an acceptable value of less than 0.2, as recommended in CSA N288.6-12 *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [7]. The Incremental Lifetime Cancer Risks (ILCRs) were estimated for potential carcinogenic substances (hydrazine) through inhalation, water and/or fish ingestion pathway. The ILCRs were compared to an acceptable cancer risk of less than 1 in 1,000,000 (or 1 in 10^{-6}), as recommended in CSA N288.6-12. At both of these risk levels, the health impacts are considered to be negligible.

Risks were modelled for morpholine and hydrazine for the urban resident, correctional institution resident and industrial/commercial worker through drinking water supplied from the Ajax water supply plant (the closest plant to the PN Site). The risk for morpholine was assessed to be below the acceptable risk level of 0.2 for non-cancer and the risk from hydrazine was assessed to be below the acceptable cancer risk level of 10^{-6}. Risks from morpholine and hydrazine for the sport fisher through fish ingestion were also below the acceptable risk level of 0.2 and below the acceptable cancer risk level of 10^{-6}, respectively. Risks to all receptor groups assessed due to inhalation of hydrazine were below the acceptable cancer risk level of 10^{-6}. These dose estimates demonstrate that there are no health effects expected due to exposure of human receptor groups to non-radiological releases of COPCs from the PN Site.

Physical Stressors

Noise is the only physical stressor associated with the PN Site that is of potential concern to human receptors. As mentioned in section 3.2.2 Terrestrial Environment, a noise monitoring program was carried out to determine existing noise levels as part of the updated baseline EMP. The baseline program and the ECA in place for noise emission limits indicate that noise levels in populated urban areas, such as the PN Site, will occasionally exceed the applicable prescribed sound level limit. These elevated sound levels are likely the result of road traffic or human activity in the vicinity of noise monitoring locations. As such, the occasional periods of elevated sound levels are likely not having an adverse effect on human receptors near the PN Site.

Conclusion

The HHRA demonstrates that radiological dose estimates are a small fraction of the public dose limit and that there are no significant risks to human receptors resulting from exposure to non-radiological COPCs (hydrazine and morpholine). As well, noise from activities on the PN Site are not likely to have a direct adverse effect on human receptors. CNSC staff conclude that OPG continues to provide adequate protection of members of the public.

3.3 Environmental Effects Assessment – Stabilization and Storage with Surveillance Phases

The Predictive Effects Assessment (PEA) applies to the Stabilization Phase and the Storage with Surveillance Phase – the time of shutdown to the point where the used fuel has been removed from the Pickering NGS to the PWMF. The PEA includes the entire Stabilization Phase with a focus on the first ten years of the Storage with Surveillance Phase (up to approximately 2038). The PEA was designed to focus on those pathways that may introduce new or modified effects on the environment or the potential to cause an adverse environmental effect. The PEA also evaluated the risk to human and ecological receptors based on future conditions [5].

Stabilization and Storage with Surveillance activities will be conducted in step-wise fashion, with each of the six units moving from full power through cool down and residual heat dissipation to an eventual cold state. Table 1.1 in section 1.2 of this EA Report outlines the main Stabilization and Storage with Surveillance activities. Overall, the transition from operations to the Stabilization and Storage with Surveillance Phases will result in reductions in emissions from the PN Site. Noise, atmospheric emission, waterborne emissions and thermal discharges will be reduced. During both the Stabilization and Storage with Surveillance Phases, OPG's environmental programs will be maintained and updated as needed.

Where Stabilization and Storage with Surveillance activities resulted in environmental emissions that were less than current operational conditions, the current operational conditions were considered the bounding environmental emissions and further evaluation was not warranted as the effects were evaluated in the PN Site ERA.

The PEA includes assumptions concerning future conditions where specific operational details could not be confirmed at this early stage of planning. For example, a strategy to supply adequate heating to the PN Site has not been confirmed so the bounding assumption is that the alternative heating source will be provided by fuel-based boilers. Similarly, OPG is developing a heavy water management plan. For the PEA, the assumption is that heavy water will be stored on-site during the Stabilization and Storage with Surveillance Phases.

Should surface water assumptions and environmental interactions be different than those indicated in the PEA, a reassessment of the environmental risks would be completed by OPG, with mitigation measures as required, which would be part of a future ERA submission.

As part of the future land use plans for the PN Site, the Administration, Engineering Services Buildings and Pickering Nuclear Information Centre will be left in a safe and vacant state when no longer needed. The Engineering Services Building and Pickering Nuclear Information Centre may be leased to future industrial/commercial workers.

As indicated in section 2.1.2, the current PEA included only the Stabilization Phase and the Storage with Surveillance Phase. Future phases and decommissioning activities will be assessed by the CNSC, as part of CNSC's ongoing lifecycle approach to environmental protection and regulatory oversight.

3.3.1 Atmospheric Environment

The PEA screened potential effects of activities taking place during the Stabilization and Storage with Surveillance Phases on the atmospheric environment, including consideration of air quality and noise levels.

3.3.1.1 Radiological Emissions

Activities taking place during the Stabilization and Storage with Surveillance Phases have the potential to affect air quality. The emissions (radiological and non-radiological) from planned activities during these phases are expected to be bound by current operational conditions. Most sources of emissions expected to decrease as the reactor units are shut down.

Stabilization Phase

During the Stabilization Phase, similar to current normal operations, handling of resins and other solid and liquid wastes may result in emissions of radionuclides through venting to the atmosphere. Under normal operations, the atmospheric emissions from these activities are an insignificant portion of operational emissions. These release pathways will continue to be monitored and reported on.

Although temporary increases in atmospheric emissions could occur as a result of dewatering activities, based on previous experiences with dewatering during the shutdown of Pickering NGS Units 2 and 3, radiological emissions are expected to be below current operating levels. Heavy water recovery dryers will be in place to minimize atmospheric emissions during all draining, flushing and drying activities. Reactor Building atmospheric emissions will be subject to filtration and ongoing monitoring throughout the Stabilization Phase.

In general, the airborne radioactive emissions, such as tritium and carbon-14, will decrease during the Stabilization Phase as units are permanently removed from service and will be further reduced in the Storage with Surveillance Phase. Gaseous emissions from potentially active areas will continue to be monitored for radioactivity until it is demonstrated that this monitoring is no longer required.

Storage with Surveillance Phase

The Storage with Surveillance Phase is considered generally bound by current operational conditions for radioactive atmospheric emissions. Low level tritium and carbon-14 emissions are expected due to possible residual sources. Potential sources of tritium releases include ongoing operation of the IFBs, the continued storage of tritiated heavy water, and the ventilation of buildings that may have some residual tritium. There may be some residual sources of carbon-14 that could result in low-level releases, depending on the ventilation demands during the Storage with Surveillance Phase.

Based on removal of various atmospheric emission sources, estimates of tritium and carbon-14 emissions are predicted to decrease during the Storage with Surveillance Phase. It is estimated that there will be an overall tritium emission of 1.77×10^{14} Bq/year during the Storage with Surveillance Phase compared to current emission of 5.2×10^{14} Bq/year. Similarly, carbon-14 emissions are predicted to be no more than 2.96×10^{10} Bq/year compared to current emission of 2.0×10^{12} Bq/year.

The Storage with Surveillance radioactive emissions are predicted to be less than current operations and the assumptions above are considered conservative. The emission sources and pathways will continue to be monitored and routinely reported on an ongoing basis until it can be demonstrated that monitoring is no longer required.

3.3.1.2 Non-Radiological Emissions

Stabilization Phase

In general, the non-radiological emissions will gradually decrease during the Stabilization Phase. Changes to the use and operation of the on-site combustion generators, steam generating boilers for electricity production and the heating steam boilers are the emission sources with the potential for changes in emissions.

During normal operations, hydrazine and morpholine are used within the feedwater system to prevent corrosion in boilers. During the Stabilization Phase, the use of these chemicals will be reduced as units stop production of heat; therefore, current operational conditions are considered bounding.

Steam will become unavailable once all reactor units have been shut down and an alternate building heating supply will be required during the Stabilization and Storage with Surveillance Phases. For the purposes of the assessment, it was assumed that the existing Auxiliary Boiler on-site would be used and be supplemented by an additional heating steam boiler. As a bounding condition, it was assumed that both would operate using fuel oil. The COPC for the additional boiler include nitrogen oxides, sulphur dioxide, carbon monoxide, and particulate matter.

The existing Auxiliary Boiler that is expected to operate during the Stabilization and Storage with Surveillance Phases is expected to be a relatively small contributor to the total facility-wide emission rates of COPCs when compared to other sources. Furthermore, standby generators and other equipment will be removed from service during the course of the Stabilization Phase. The emissions considered as part of the bounding scenarios of the assessment were below relevant limits and therefore, it was concluded that no potential effects of these COPCs are expected on human and ecological receptors beyond the facility fenceline.

Storage with Surveillance Phase

During the Storage with Surveillance Phase, emissions will be further reduced. Therefore, current operations are considered bounding.

3.3.1.3 Noise

Stabilization and Storage with Surveillance activities are expected to result in a reduction or removal of most sources of noise as the reactor units are shut down and facilities are transitioned to a safe storage state. For example, noise emissions are expected to decrease as the reactor and turbine operations are stopped and there is less activity overall at the PN Site. As the overall noise is expected to be reduced, the current operations as assessed in the ERA are determined to be bounding and no further assessment is required.

3.3.1.4 Conclusion

During the Stabilization and Storage and Surveillance phases, it is expected that overall emissions from the facility will be reduced. Changes to controls and monitoring will be made in an informed manner based on the results from OPG's environmental programs.

Based on a review of the PEA, CNSC staff conclude that OPG's predicted releases of radiological and non-radiological contaminants from the PN Site during the transition of the PN Site to safe storage are bound by current operations. Ecological and human receptors are expected to be protected from the atmospheric releases from the facility as a result of activities during this transition.

3.3.2 Terrestrial Environment

In general, the activities associated with the Stabilization and Storage with Surveillance Phases are not expected to result in effects to the terrestrial environment, including soil quality, terrestrial habitat, vegetation and/or fauna. Aside from minor improvements, described below, there are no changes expected to the terrestrial environment in or around the PN Site and any effects are bound by the current operations which have been assessed in the current ERA, see section 3.2.3.

The PEA predicted some minor improvements to soil quality over time, namely in tritium levels as atmospheric emissions decrease in both phases and concurrent natural decay occurs. Also, the soil quality in the areas outside of the protected area is expected to remain in the current condition with potential improvements over time through the reduction of industrial activity.

3.3.2.1 Conclusion

Based on a review of the OPG's PEA for Stabilization and Storage with Surveillance activities, CNSC staff conclude that the assessment of predicted effects to the terrestrial environment as the facility transitions to safe storage is bound by current operations. Terrestrial receptors are not likely to be impacted as a result of activities during this transition.

3.3.3 Hydrogeological Environment

As indicated in the ERA, groundwater flow is significantly influenced by the foundation drainage sumps. During the Stabilization Phase, as bound by current operations, groundwater flow will discharge to the forebay. During the Storage with Surveillance Phase, the inactive and active drainage systems will remain operational in order to manage groundwater in the sumps. Groundwater will be collected and will be re-routed to the RLWMS system rather than the forebay. Discharge pathways will be reconfigured during Storage with Surveillance activities and will be monitored in accordance with OPG's groundwater monitoring program prior to discharge. Over time, it is predicted that tritium, that has a half-life of approximately 12.5 years, in groundwater at the PN Site will be reduced due to decay.

3.3.3.1 Conclusion

Based on a review of the PEA for Stabilization and Storage with Surveillance activities, CNSC staff conclude that the assessment of predicted effects to the hydrogeological environment as the facility transitions to safe storage is bound by current operations. OPG has procedural processes and monitoring programs in place to manage potential effects to groundwater. Ecological and human receptors are not likely to be impacted as a result of activities during this transition.

3.3.4 Aquatic Environment

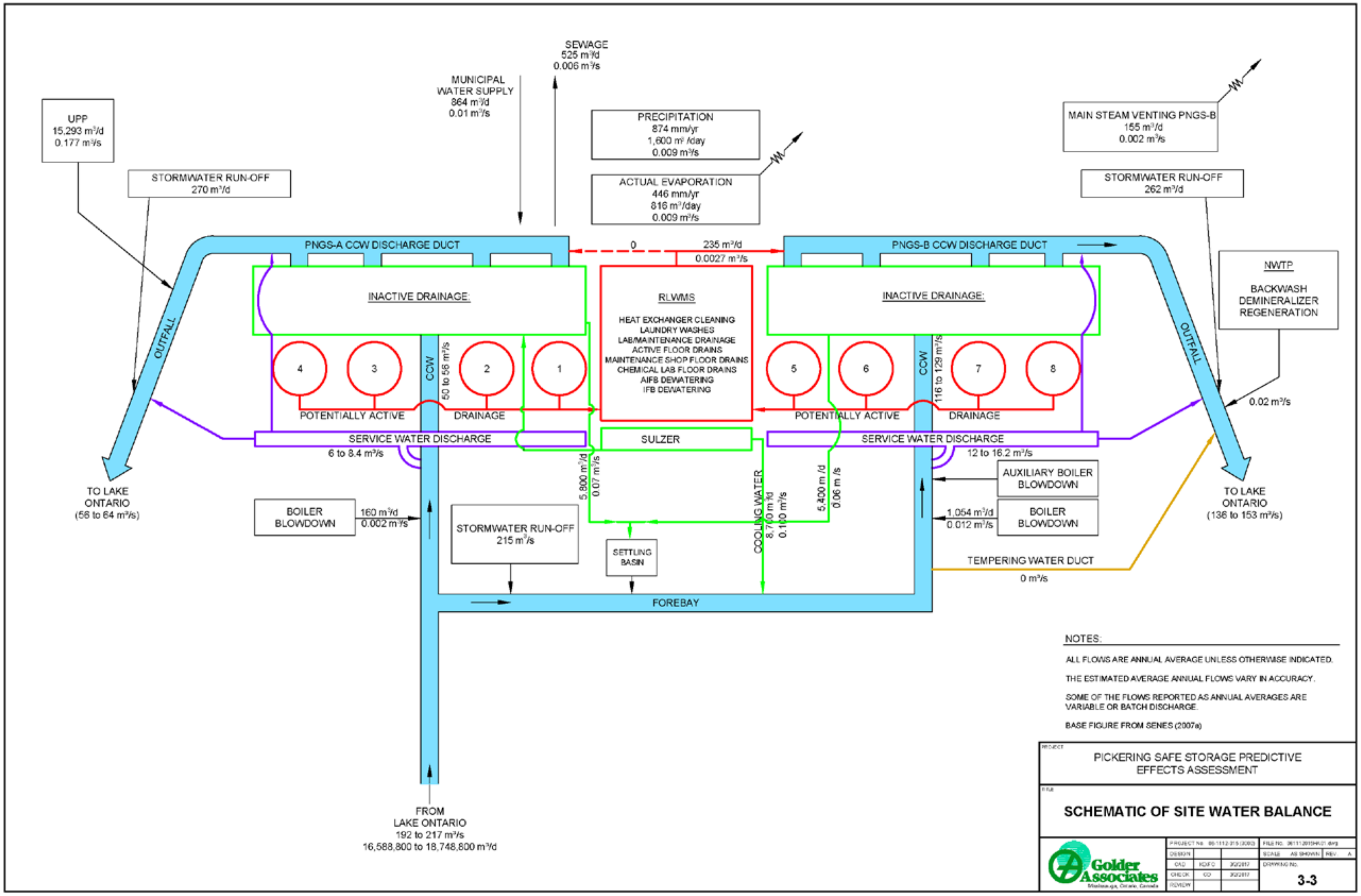
3.3.4.1 Surface Water

Stabilization Phase

As systems are taken out of service, existing operational procedures and approved discharge pathways will be used to drain and vent systems no longer required to support station operations. Such activities will be planned and executed to minimize COPC releases.

One of the main activities during the Stabilization Phase is the substantial reduction in the cooling water flow as reactor units are taken off-line. As indicated in section 3.1.5, during normal operations, the CCW flow is approximately 4,100,000 m^3/day from Units 1-4 and approximately 10,000,000 m^3/day from Units 5-8. At the end stages of the Stabilization Phase, cooling water intake flow may range from 1,600,000 to 2,100,000 m^3/day with two pumps in operation at Units 1-4 and Units 5-8, respectively. This is less than 10% of existing flows (figure 3.1). CCW flows are therefore considered bound by the existing operations.

Figure 3.1: Current water balance at PN site



Storage with Surveillance Phase

Cooling water will still be required for the IFBs and AIFB during the Storage with Surveillance Phase, but will decrease as the fuel cools and requires less heat removal. It is expected that intake and discharge flow will be approximately 50,000 m^3/day. The IFBs and AIFB will continue to have waterborne radiological emissions; similar to current operational conditions, but these radiological emissions will decline as the bays are removed from service. Once the IFBs and AIFB are emptied of used fuel, the bays may be drained, decontaminated and sealed during the Storage with Surveillance Phase.

It is predicted that the substantial reduction in CCW flows will remove or eliminate the potential for impingement and entrainment and the FDS may be removed, following regulatory approval.

During Storage with Surveillance activities, changes and redirection of other water emissions from the PN Site will also occur. As previously indicated, groundwater from the foundation sumps will be redirected to the RLWMS. As well, piping will be modified so all water discharges will be re-routed to the RLWMS, the reactor building water ducts or directly to the Units 5-8 discharge channel. This change will allow for operational and monitoring efficiencies. All discharges from the RLWMS will be in accordance with the MISA limits and discharges from the reactor building ducts and discharge channel will be in accordance with all federal and provincial regulatory limits.

The use of a mobile water treatment system has been proposed in place of the existing water treatment plant at the PN Site. Sulphates, from backwash, may be discharged. Predicted concentrations of sulphate, mixed with the 50,000 m^3/day cooling water were below the radiological and non-radiological screening levels.

The additional heating steam boiler may result in additional boiler blowdown into the Units 5-8 discharge channel. It is predicted that the boiler blowdown discharge will mix with the 50,000 m^3/day cooling water in the discharge channel. Predicted concentrations were below the water quality guidelines.

3.3.4.2 Stormwater

There are no changes to the stormwater runoff anticipated as a result of the Stabilization and Storage with Surveillance activities. Stormwater runoff to the forebay and to the discharge channels will remain unchanged. It is predicted that the stormwater volumes will remain the same during the Storage with Surveillance Phase, with runoff to the discharge channels estimated to be 270 m^3/day and 262 m^3/day for Units 1-4 and Units 5-8, respectively. For Units 5-8, the stormwater runoff was screened assuming mixing of the stormwater with the 50,000 m^3/day of cooling water. Predicted stormwater concentrations were below water quality guidelines.

3.3.4.3 Sediment

As indicated in section 3.1.4.1, there were no predicted COPCs that exceeded sediment quality guidelines. As such, the water quality is not predicted to affect sediment quality.

3.3.4.4 Aquatic Habitat and Communities

Stabilization Phase

During the Stabilization Phase, CCW pumps will be shut down in sequence as each unit is defueled, cooled, drained, dried and placed in safe storage. It is assumed that at least two CCW pumps will be operational during the Stabilization Phase and the FDS will remain in place.

Storage with Surveillance Phase

It is predicted that with the reduced CCW flows and eventual removal of the FDS following regulatory approval, the forebay may become an aquatic habitat in the Storage with Surveillance Phase. As such, forebay water quality has been assessed for potential radiological COPCs.

To predict the water quality of the forebay, a model was developed where stormwater runoff enters the forebay via two stormwater outfalls. Concentrations in stormwater runoff from sampling conducted in 2015 and 2016 were conservatively used as inputs to the model. The predicted concentrations were compared to surface water quality guidelines. No concentrations were above guidelines.

Exposure point concentrations were predicted from radiological emissions during the Storage with Surveillance Phase. Receptor locations of interest were the PN Site outfall, Frenchman's Bay and the PN Site forebay. The estimated exposure point concentrations for the outfall and Frenchman's Bay were assessed for dose resulting from exposure to tritium, carbon-14 and gross beta/gamma (represented by cobalt-60). During Storage with Surveillance activities, the forebay may become habitat for aquatic receptors and the potential impacts were assessed for exposure to tritium, carbon-14, cobalt-60, cesium-134 and cesium-137. There were no exceedances of the radiation dose benchmark of 9.6 mGy/d for aquatic biota at the outfall, Frenchman's Bay or the forebay.

Impingement and entrainment effects were evaluated as part of the Storage with Surveillance Phase. Entrainment is not considered an issue at a flow of 6.5 m^3/second or less, as recommended by the US EPA. As the proposed flow during the Storage with Surveillance Phase when the CCW pumps are no longer used will be 0.58 m^3/second, entrainment is not considered an issue as it is substantially less than the EPA guidelines and current operations.

3.3.4.5 Thermal Plume

During the Stabilization Phase, the areal extent of the thermal plume will decrease until the thermal plume extent is limited to the existing discharge channels. By the end of the Stabilization Phase, the lake near the discharge will be returned to a thermal condition that is more typical of the nearshore zone of Lake Ontario.

3.3.4.6 Conclusion

It is predicted that waterborne emissions will be reduced in the Stabilization and Storage with Surveillance Phases. The discharged COPCs were evaluated against screening levels and all COPCs were found to be below the water quality guidelines. Sediment quality is predicted to be bound by current operations.

Based on a review of the PEA for Stabilization and Storage with Surveillance activities, CNSC staff conclude that the assessment of predicted effects to the aquatic environment as the facility transitions to safe storage is bound by current operations. OPG has procedural processes and monitoring programs in place to manage potential effects to the aquatic environment. Aquatic and riparian receptors are not likely to be impacted as a result of activities during this transition.

3.3.5 Human Environment

As in the ERA for the Continued Operation Phase, an HHRA was completed as part of the PEA in order to assess any changes to the baseline human health conditions that may result from activities associated with the Stabilization and Storage with Surveillance Phases once commercial operations have ended. Human receptor groups considered were similar to those in the ERA (i.e., farms, dairy farms, urban residents, area industrial/commercial workers, sport fishers, correctional institution), and additionally included potential future industrial/commercial workers at the current Engineering Services Buildings. As in the ERA, the health of Indigenous groups was bounded by the assessment for non-Indigenous groups located closer to the PN Site and who consume foods local to PN as part of their diet. Exposure parameters used in the new dose calculations largely remained the same as in the ERA, including use of the same exposure pathways (i.e., inhalation of air and external exposure to air, ingestion of water and external exposure to water, incidental ingestion of soil and sediment, external exposure to soil and sediment, ingestion of food). Dose calculations were updated based on new modelled surface water and airborne concentrations of relevant radionuclides. Note that dose calculations to human receptors in the ERA for existing operations were performed primarily using environmental monitoring data (and supplemented with modelling when necessary) which provides a more realistic dose estimate, whereas dose calculations in the PEA is based solely on modelling from predicted future emissions which provides a more conservative dose estimate.

The PEA for the PN Site did not identify any airborne or waterborne non-radiological COPCs that would exceed applicable screening levels. As such, the predictive HHRA focused only on radiological exposure to human receptors. In addition, the Stabilization Phase was assumed to be bound by the ERA and current operational conditions. Therefore, the predictive HHRA focused only on the Storage with Surveillance Phase.

Relevant exposure pathways and critical groups of human receptors were characterized in order to perform radiological dose calculations as per CSA N288.1-08 methodology [8]. As with current operations, the current radiological dose is compared to the public dose limit of 1 mSv/year (1000 µSv/year), as defined in the *Radiation Protection Regulations* [19]. The maximum predicted dose was estimated to be 2.1 µSv/year to a potential future industrial/commercial worker at the current Engineering Services Buildings. Note that this future industrial/commercial worker critical group was not assessed in the ERA. The calculated doses for all other groups of human receptors were below 2.1 µSv/year. Therefore, the public dose estimates for human receptor groups in the Storage and Surveillance Phase is, at most, approximately 0.2% of the regulatory public dose limit of 1 mSv/year.

3.3.5.1 Conclusion

Based on a review of the predictive HHRA, CNSC staff conclude that health effects due to exposure of human receptors to potential radiological and non-radiological releases attributable to these activities are unlikely.

4.0 CNSC Independent Environmental Monitoring Program

The CNSC has implemented its IEMP to verify that the public and the environment around licensed nuclear facilities are protected. It is separate from, but complementary to the CNSC's ongoing compliance verification program. The IEMP involves taking samples from public areas around the facilities, and measuring and analyzing the amount of radiological and non-radiological contaminant substances in those samples. CNSC staff collect the samples and sends them to the CNSC's state-of-the-art laboratory for testing and analysis.

4.1 IEMP at Pickering Nuclear Generating Station

The 2014, 2015, and 2017 IEMP sampling plans for the PNGS focused on both radiological and non-radiological contaminants. Site-specific sampling plans were developed based on OPG's approved EMP and the CNSC's regulatory experience with the site. In 2014, 2015, and 2017, samples were collected in publicly accessible areas outside the PNGS perimeter and included air particulate, vegetation, lake water, soil and sediment, and foodstuff from a local farm outside of the PNGS perimeter fence. The site-specific sample plans are reviewed by CNSC staff on an ongoing basis to continuously improve and refine the plans to meet the objectives of the program.

CNSC staff sampled the following in the vicinity of PNGS:

- air (4 locations in 2014, 3 locations in 2015 and 3 locations in 2017)
- water (5 locations in 2014, 5 locations in 2015 and 5 locations in 2017)
- soil (7 locations in 2014, 6 locations in 2015 and 6 locations in 2017)
- sediment (2 locations in 2014, 2 locations in 2015 and 2 locations in 2017)
- vegetation (6 locations in 2014, 6 locations in 2015 and 6 locations in 2017)
- milk (1 location in 2014, 1 location in 2015 and 1 location in 2017)
- foodstuff (4 locations in 2017)

CNSC staff take a sample of water from Lake Ontario near Pickering Nuclear Power Plant in 2017

Samples collected were analyzed by qualified laboratory specialists in the CNSC's state-of-the-art laboratory in Ottawa, using appropriate protocols. CNSC staff measured the following:

- radioactive particulates – such as cesium-137, tritiated water, gross alpha and gross beta
- hazardous substances – such as hydrazine and morpholine

Figures 4.1 to 4.3 provide an overview of the PNGS and sample locations for the 2014, 2015, and 2017 IEMP sampling campaigns.

Figure 4.1: Location overview of the PNGS and 2014 sample locations

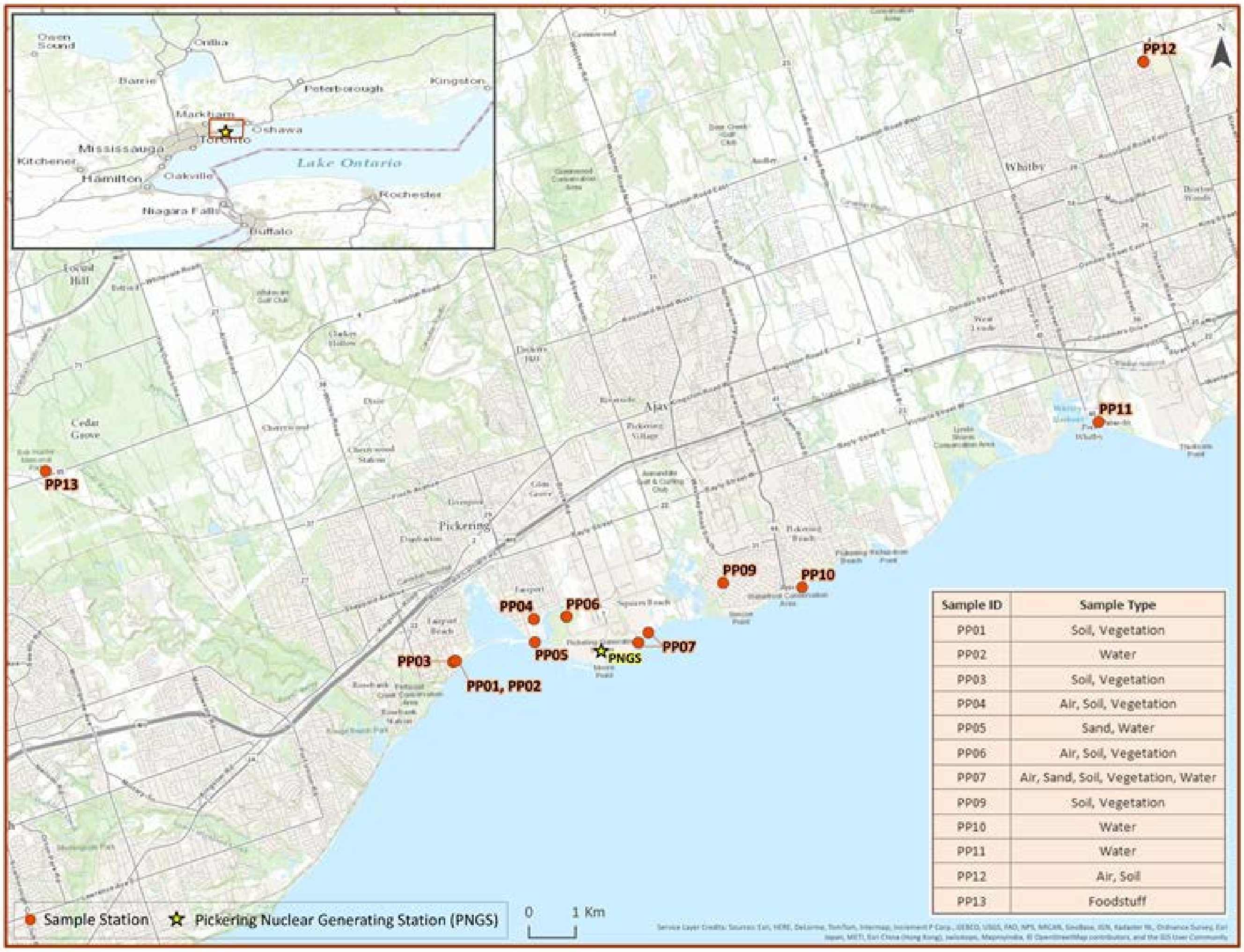
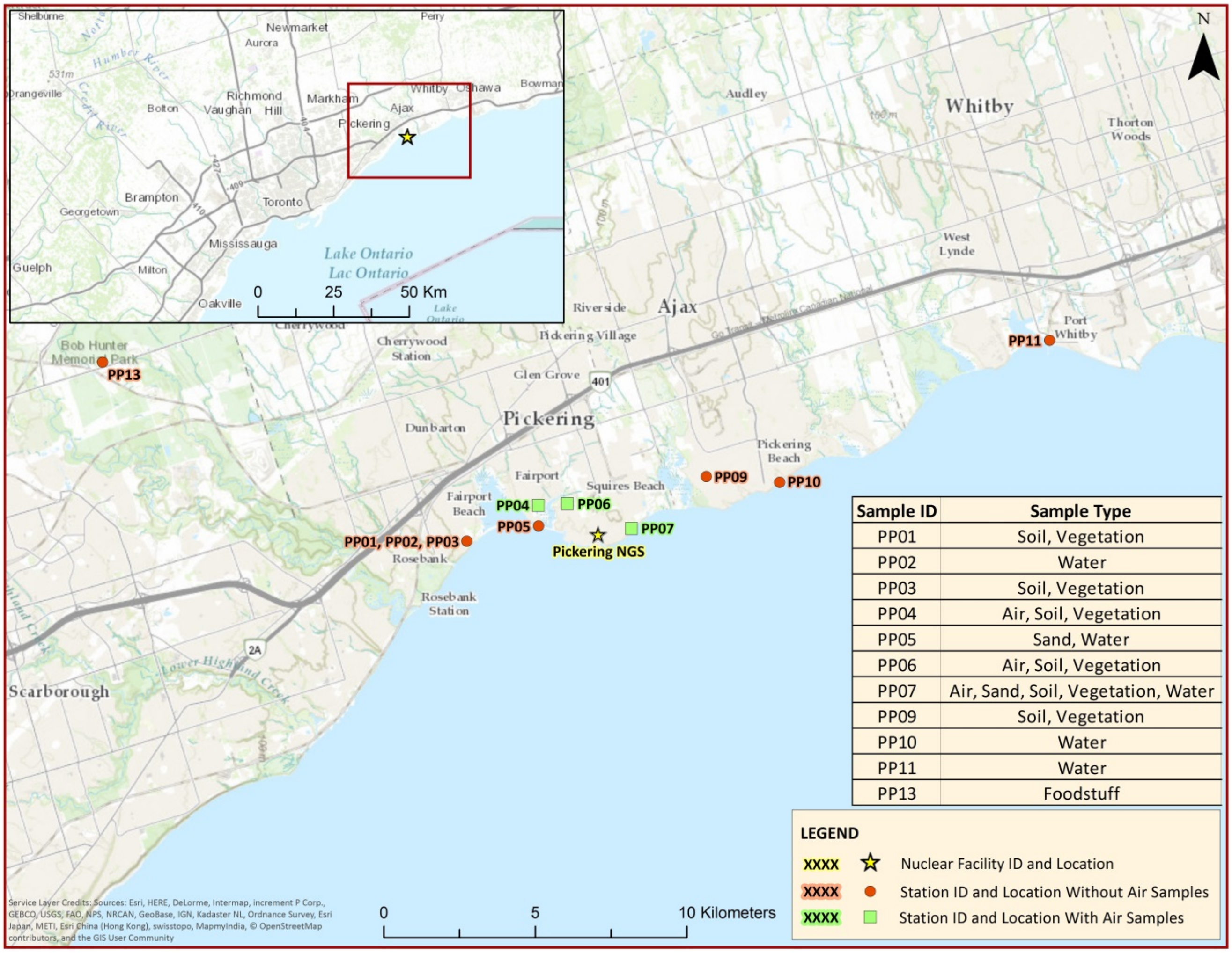
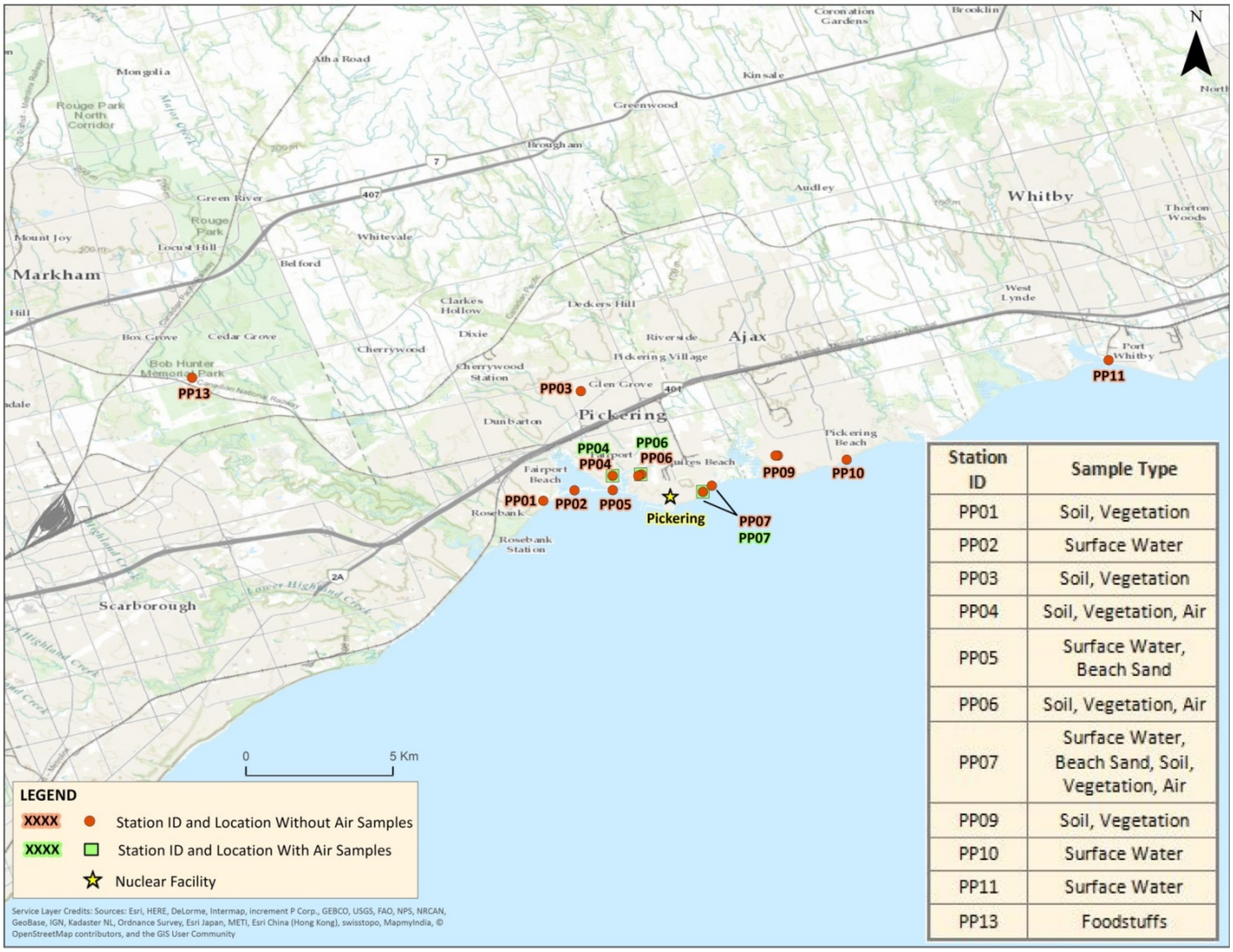


Figure 4.2: Location overview of the PNGS and 2015 sample locations



Sample ID	Sample Type
PP01	Soil, Vegetation
PP02	Water
PP03	Soil, Vegetation
PP04	Air, Soil, Vegetation
PP05	Sand, Water
PP06	Air, Soil, Vegetation
PP07	Air, Sand, Soil, Vegetation, Water
PP09	Soil, Vegetation
PP10	Water
PP11	Water
PP13	Foodstuff

Figure 4.3: Location overview of the PNGS and 2017 sample locations



4.2 Results

The measured radioactivity and concentrations in all samples were below available guidelines and CNSC reference levels. CNSC reference levels are based on conservative assumptions about the exposure that would result in a dose of 0.1 mSv/year.

Appendix 1 provides the range of results from the 2014, 2015, and 2017 IEMP sampling campaigns. The full IEMP results are available through a public-friendly dashboard [46] on the CNSC website [47].

The IEMP results confirm that the public and the environment around the PNGS are protected, and that there are no expected health impacts. These results are consistent with the results submitted by OPG confirming that the licensee’s environmental protection program protects the health of persons and the environment.

5.0 Other Regional Monitoring

There are several regional monitoring programs carried out by other levels of government, which the CNSC has reviewed in order to assess whether the environment and health of persons around the PN Site are protected. A summary of the programs' findings are provided below.

Ontario Ministry of Environment and Climate Change's Drinking Water Surveillance Program

The Drinking Water Surveillance Program (DWSP) provides water quality information for selected municipal drinking water systems for scientific and research purposes through the monitoring of analytes including organic, inorganic and radiological parameters (i.e., tritium, gross alpha and gross beta) [48]. The water supply plants in the DWSP in closest proximity to the PN site include, in increasing distance from PN Site; F.J. Horgan (~9 km), R.C. Harris (~23 Km), Toronto Island (~33 Km) and R.L Clarke (~43 Km).

The most recent dataset from the DWSP is for 2012. Radioactivity levels were measured for both Lake Ontario intake waters (raw) and water treated at the drinking water plant (treated water). The 2012 results and the range over the last 10 years ((2003-2012) are presented in Table 5.1 for comparison to the provincial water guideline of 7,000 Bq/L for tritium and federal screening levels of 0.5 Bq/L for gross alpha and 1.0 Bq/L for gross beta.

The results show that tritium, gross alpha and gross beta radioactivity levels have all been well below their respective drinking water standard or screening levels. These results are comparable to the results obtained from the CNSC's IEMP sampling campaigns around the PN Site, where measured radioactivity levels in water samples were also below standards and screening levels (see section 4.0 and Appendix 1).

Table 5.1: Drinking water surveillance program results of radionuclide activity in water sampled from stations associated with the Pickering surveillance area for 2012 and the ten year range (2003 – 2012)

Measured radioactivity levels (Bq/L) in lake intake waters (raw) and treated waters for 2012 and the ten year range (2003-2012)						
Sampling Period	Tritium		Gross alpha		Gross beta	
	Raw	Treated	Raw	Treated	Raw	Treated
Drinking Water Standard[(1a)] or Screening Level [(1b)]						
	7000		0.5		1.0	
F.J. Horgan Drinking Water Supply Plant [(2)]						
2012	5.0	5.0	< 0.04	< 0.04	0.04	0.04
Ten year range	<5.0 – 9.3	<5.0 – 8.2	< 0.04	< 0.04 - 0.07	< 0.04 - 0.07	< 0.04 - 0.07
R.C. Harris Drinking Water Supply Plant [(3)]						
2012	5.0	5.0	< 0.04	< 0.04	0.06	0.06
Ten year range	<5.0 – 7.2	<5.0 – 7.1	< 0.04	< 0.04	0.05 – 0.07	0.04 – 0.07
Toronto Island Drinking Water Supply Plant[(4)]						
2012	<5.0	<5.0	0.06	0.05	0.06	0.05
Ten year range	<5.0	<5.0 – 5.3	< 0.04	< 0.04	0.05 – 0.07	0.05 – 0.08
R. L. Clark Drinking Water Supply Plant[(5)]						
2012	5.3	6.6	< 0.04	< 0.04	0.05	0.06
Ten year range	<5.0 – 8.0	<5.0 – 6.6	< 0.04	< 0.04	< 0.04 – 0.08	< 0.04 – 0.07

(1) a) Ontario Drinking Water Quality Standards Regulation 169/03 [49]
b) Health Canada Guideline Technical Document: Radiological Parameters [50]
(2) No data reported for 2006, two sampling events in 2009.
(3) No data reported for 2005.
(4) No data reported for 2005 and 2009, two sampling events in 2006.
(5) No "raw" samples reported for 2008, two sampling events in 2006 and 2010.

Ontario Ministry of Labour's Ontario Reactor Surveillance Program

The objective of the Ontario Reactor Surveillance Program **(**ORSP) is to establish, operate and maintain a radiological surveillance network to assess radiological concentrations around designated major nuclear facilities in the province [51]. The ORSP monitors the air, water and food around nuclear power plants for radioactivity.

The purpose of the ORSP is to assure the public living and working in the vicinity of nuclear facilities that their health, safety, welfare and property is not affected by emissions from nuclear facilities. The most recent ORSP report, produced by the Ontario Ministry of Labour in 2014, concluded that the public in the vicinity of major nuclear facilities in Ontario can be assured that their health, safety, welfare and property are not adversely affected by emissions from the nuclear facilities.

The ORSP's core surveillance focuses on air and drinking water with the most recently posted dataset from 2012. For the PN Site, air is monitored at 4 locations within the Toronto/Pickering

Surveillance Area (see figure 5.1). For water monitoring, as there are no water supply plants within the Pickering/Toronto surveillance area, the same four drinking water supply plants previously discussed with the DWSP were also monitored as part of the ORSP. Note that the Ajax water treatment plant pictured in figure 5.1 is part of the Darlington surveillance area.

A derived survey criteria (DSC) was calculated to represent radioactivity levels in specific media (e.g., water and air) that would result in a dose at or below 0.1 mSv/year, which is an order of magnitude lower than the regulatory public dose limit of 1 mSv.

Table 5.2 outlines the 2012 ORSP results for particulates in air (gross beta, cesium-137 and iodine-131) and tritium in air (HTO (tritiated water)). These results indicate that particulates and tritium in air are reporting below their respective DSC. In addition, these results are consistent with the results obtained through the CNSC's IEMP sampling results, with result below the CNSC's IEMP reference levels (see section 4.0 and Appendix 1).

Table 5.2: Summary of the 2012 ORSP median measurements for particulates and tritium in air

	Particulate in Air				Tritium in Air	
	No. of Samples[1]	Gross-beta ($\mu Bq/m^3$)	Cs-137 ($\mu Bq/m^3$)	I-131 ($\mu Bq/m^3$)	Sample No.	HTO (Bq/m^3)
Derived Survey Criteria	---	100,000	1,000,000	600,000	---	700
Pickering	47	770	< 80	< 80	33	1.6

[1] Monthly sampling, data not available for every month/station

At each of the four participating drinking water supply plants, daily collections were combined to form a weekly sample for tritium analyses. The ORSP reports the combined median value for the Pickering/Toronto surveillance area as 4.3 Bq/L. The majority of the 2012 analyses from the four water supply plants were below the minimum detection concentration of < 5 Bq/L. All of the water supply plants reported maximum concentrations less than 9 Bq/L, which is well below the provincial drinking water standard of 7,000 Bq/L, and consistent with both the DWSP results and the CNSC's IEMP sampling results.

The weekly samples were combined to form quarterly composites for the analyses of gamma emitters (cobalt-60, iodine-131, cesium-134 and cesium-137), as well as for gross alpha and gross beta. The ORSP reports the combined median value for the Pickering/Toronto surveillance area, which are summarized in Table 5.3. The results indicate that the analyses for gamma emitters and gross alpha and beta are all well below the DSC and consistent with both the DWSP and the CNSC's IEMP sampling results.

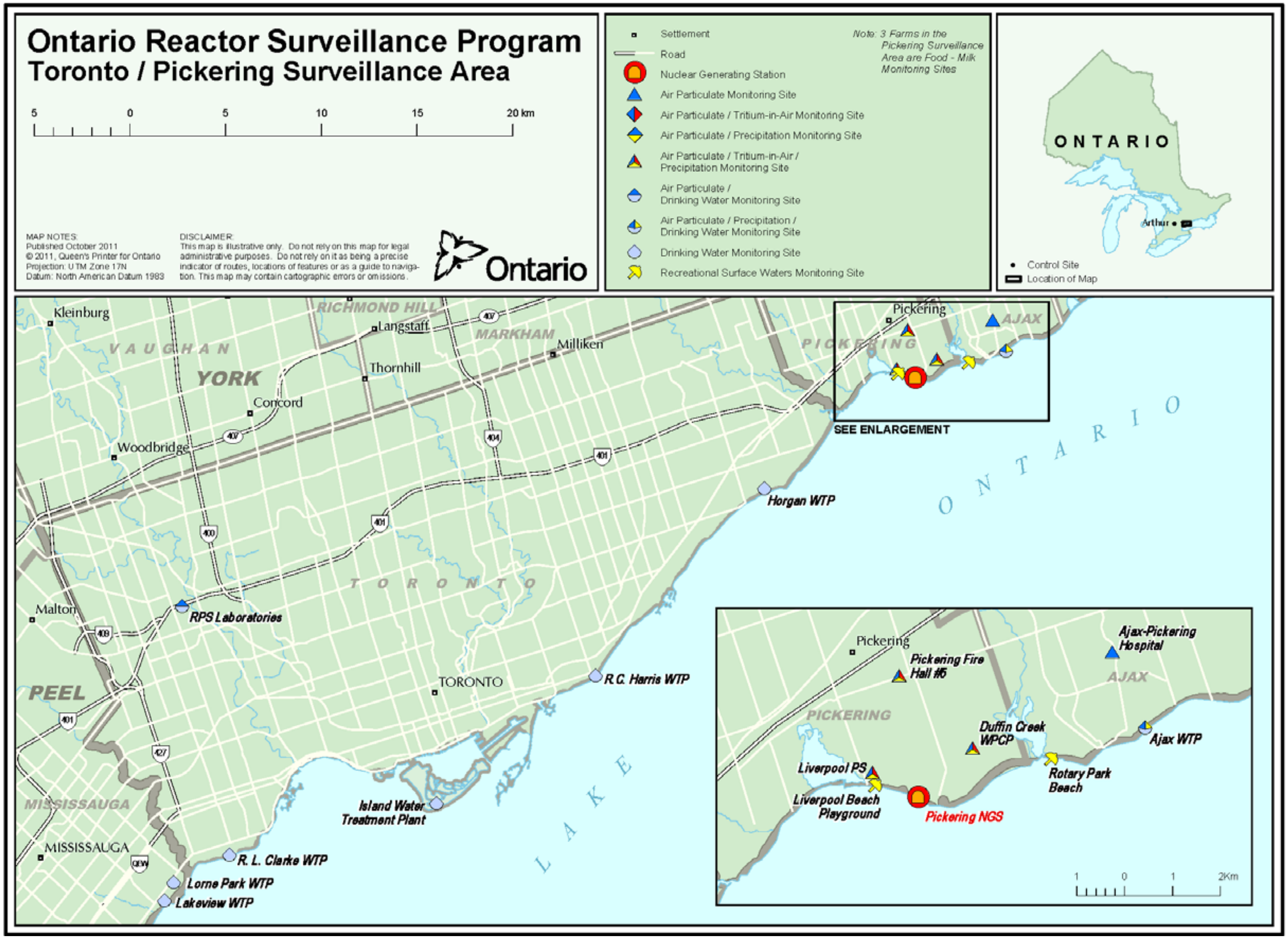
Table 5.3: Summary of 2012 ORSP sampling of drinking water annual median for gamma emitters, gross alpha and gross beta

	No. of Samples	Gamma Emitters				Gross alpha (Bq/L)	Gross beta (Bq/L)
		Co–60 (Bq/L)	I–131 (Bq/L)	Cs–134 (Bq/L)	Cs–137 (Bq/L)		
DSC (1)	---	2	6	7	10	0.5	1.0
Pickering	16	< 0.2	< 0.6	< 0.7	< 1.0	< 0.04	0.06

(1) Derived Surveillance Criteria is for drinking water equal to the Ontario provincial drinking water standards Regulation 169/03 [49] and the Health Canada screening level for gross alpha and beta.

To supplement the core surveillance program associated with air and drinking water, the ORSP also monitors precipitation, surface water, milk and vegetation. This data is collected as a baseline for emergency planning, the maintenance of technical and laboratory skills required for emergency response (emergency and post-emergency environmental sampling) and is of value for scientific studies (e.g., precipitation monitoring has been used to develop radionuclide transport models for the Great Lakes and studies of basin hydrology). The results for these other parameters were below the minimum detectable concentration of <5 Bq/L.

Figure 5.1: ORSP map of Toronto/Pickering surveillance area - monitoring sites for air and drinking water



Health Canada's Fixed Point Surveillance Program

In 2000, Health Canada complemented the Canadian Radiological Monitoring Network [52] with the Fixed Point Surveillance (FPS) system [53]. The FPS functions as a real-time radiation detection system designed to monitor public dose from radioactive materials in the air, including atmospheric releases associated with nuclear facilities and activities both nationally and internationally. Monitoring stations continuously measure gamma radioactivity levels from ground-deposited (ground-shine) and airborne contaminants.

Health Canada measures the radiation dose rate as Air KERMA (Kinetic Energy Released in unit MAss of Material) reported as nanogray per hour (nGy/h) of absorbed dose. These measurements are conducted every 15 minutes at 79 sites of its FPS network across the country. Air KERMA is also measured for three radioactive noble gases associated with nuclear fission which may escape into the atmosphere during normal operation of nuclear facilities. These three noble gases are Argon-41, Xenon-133 and Xenon-135.

The Health Canada website reports the external absorbed dose from all gamma sources (natural and artificial) as well as the external gamma dose from the three monitored noble gases as nanoGray per month. CNSC staff worked with Health Canada to convert the absorbed dose rate to an effective dose, reported in millisievert (mSv) per year, which allows for comparison to annual background dose estimates and the regulatory public dose limit (table 5.4).

The 2016 results for external gamma doses reported for the FPS network near the PN site is similar to the Canadian average for natural background (range of 0.007 to 0.027 mSv/year) [54]. These results indicate that external gamma dose at these stations is not significantly influenced by activities of the PN Site. Further evidence of this is provided by the extremely low activity levels reported for the noble gases, as outlined in table 5.4. All of the results are significantly below the public dose limit of 1 mSv.

Table 5.4: Annual external gamma doses (mSv/year[1]) for 2016 at the Fixed Point Surveillance network monitoring stations associated with the Pickering NGS.

Monitoring Stations near Pickering NGS	External Gamma Dose			
	All Gamma Sources	Monitored Noble Gases (Fission Products)		
		Air KERMA Argon-41	Air KERMA Xenon-133	Air KERMA Xenon-135
Montgomery Road	0.013	0.00032	0.000007	0.0000064
Kinsmen Park	0.013	0.00019	0.000004	0.0000040
Liverpool Road	0.013	0.00008	0.00000005	0.0000004
East Boundary	0.017	0.00017	0.000003	0.0000027
Central Maintenance	0.010	0.00028	0.000006	0.0000056
Beachpoint Promenade	0.010	0.00007	0.000000	0.0000002
CMS Storage Yard	0.008	0.00042	0.000011	0.0000100
Alex Robertson Road	0.017	0.00015	0.000004	0.0000040

[1] Assumptions: adult located at monitoring station for 24 hours a day, 365 days per year. Air KERMA in nanoGray corrected. Total Dose: 0.69 Sv for every Gray of absorbed dose measured: Argon-41: 0.74; Xenon-133: 0.75; Xenon-135: 0.67.

6.0 RECOMMENDATIONS and CONCLUSIONS

CNSC staff reviewed and assessed OPG's environmental protection measures against regulatory requirements. Furthermore, CNSC staff completed regular compliance verification activities (e.g., inspections, audits, reviews) to ensure OPG's environmental protection measures continue to meet CNSC regulatory requirements.

CNSC staff also reviewed OPG's licence application and the documents submitted in support of the application, including the most recent ERA, PEA, annual environmental monitoring reports, as well as the findings of CNSC's Independent Environmental Monitoring Program (IEMP), the PDP and past EA reports under CEAA 1992 and the NSCA. CNSC staff conclude that the ERA and PEA are satisfactory and meet both the CNSC's regulatory requirements and CSA Group standard N288.6-12 *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills* [7].

CNSC staff reviewed the results from other regional monitoring programs conducted by other levels of government, which substantiate CNSC staff's conclusion that the environment and health of persons are protected from operations at the PN Site. CNSC staff also conducted IEMP sampling around the PN site in 2014, 2015 and 2017. Both the regional monitoring results and the IEMP results confirm that the public and the environment around the PN Site are protected and that there are no health impacts as a result of facility operations. These results are consistent with the results submitted by OPG, demonstrating that the licensee's environmental programs protect the health of persons and the environment.

This EA under the NSCA focused on items of current public and regulatory interest, including physical stressors, releases to air, groundwater and surface water from ongoing operations and activities related to the stabilization and storage with surveillance phases. CNSC staff conclude that the potential risk from physical stressors and radiological and non-radiological COPCs releases to the atmospheric, terrestrial, hydrogeological, aquatic and human environment are low to negligible.

CNSC staff requested the ERA be updated to provide clarification and/or additional information on some issues. CNSC recommend that OPG provide, through modifications and/or enhancements of their existing EMP or through updates to the ERA, the following:

- monitor the thermal plume for two seasons. CNSC staff recommend that OPG conduct thermal monitoring in 2018 and adapt its thermal management strategy based on the 2018 results
- OPG should provide hatch dates in the analysis of the effects on Round Whitefish for future ERA submissions

CNSC staff will review the implementation of these recommendations through review of the EMP reports submitted annually to the CNSC and/or through revisions of the ERA.

This EA under the NSCA conducted for the renewal of the Pickering NGS Power Reactor Operating Licence concludes that OPG has and will continue to make adequate provision for the protection of the environment and the health of persons. The implementation of the recommendations outlined above do not affect these conclusions as CNSC staff will continue to verify and ensure that, through ongoing licensing and compliance activities and reviews, the environment and the health of persons are protected and will continue to be protected during the 10-year licensing period.

The information provided in this EA Report supports the recommendation by CNSC staff to the Commission to renew OPG’s power reactor operating licence for the PN Site (PROL48.03/2018) for a period of ten years.

ACRONYMS

Acronym	Term
AIFB	Auxiliary Irradiated Fuel Bay
ALARA	As Low As Reasonably Achievable
CCW	Condenser cooling water
CEAA	*Canadian Environmental Assessment Act*
CEPA	*Canadian Environmental Protection Act*
CNSC	Canadian Nuclear Safety Commission
COPCs	Contaminants of potential concern
CSA	Canadian Standards Association
DRL	Derived Release Limit
DSCs	Dry storage containers
EA	Environmental Assessment
ECA	Environmental Compliance Approval
EcoRA	Ecological risk assessment
EMP	Environmental Monitoring Program
EMS	Environmental Management System
ERA	2017 Environmental Risk Assessment
ERA	Environmental Risk Assessment
FDS	Fish Diversion System
GHG	Greenhouse Gas
HHRA	Human health risk assessment
HQ	Hazard Quotient
IEMP	Independent Environmental Monitoring Program
IFBs	Irradiated fuel bays

NGS	Nuclear Generating Station
NSCA	*Nuclear Safety and Control Act*
OPG	Ontario Power Generation Inc.
PDP	Preliminary Decommissioning Plan
PEA	Predictive Effects Assessment
PN Site	Pickering Nuclear Site
PWMF	Pickering Waste Management Facility
MWAT	Maximum weekly average temperature

REFERENCES

[1] Ontario Power Generation, *Application for the Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence* of PROL 48.03/2018, August 2017, e-Doc: 5328792

[2] CNSC, *Nuclear Power Reactor Operating Licence Pickering Nuclear Generating Station*, PROL 48.00/2018, e-Doc: 4085322

[3] CNSC, Regulatory Document, *REGDOC-2.3.3: Periodic Safety Reviews*, April 2015, http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/REGDOC-2-3-3-Periodic-Safety-Reviews-eng.pdf

[4] EcoMetrix Incorporated/ Golder Associates Ltd, *Environmental Risk Assessment Report for Pickering Nuclear*, April 2017, Prepared for Ontario Power Generation, e-Doc: 5241180

[5] Golder Associates Ltd and EcoMetrix Incorporated, *Predictive Effects Assessment for Pickering Nuclear Safe Storage*, April 2017, Prepared for Ontario Power Generation, e-Doc: 5241181

[6] CNSC, Regulatory Guide, *REGDOC-2.9.1: Environmental Principles, Assessments and Protection Measures*, December 2016, http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/REGDOC-2-9-1-Environmental-Principles-eng.pdf

[7] CSA Group, CSA N288.6-12, *Environmental risk assessment at Class I nuclear facilities and uranium mines and mills*, 2012

[8] CSA Group, CSA N288.1-08, *Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities*, Update No.1, May 2011

[9] CSA Group, CSA N288.1-14, *Guidelines for Calculating Derived Release Limits for Radioactive Material in Airborne and Liquid Effluents for Normal Operation of Nuclear Facilities*, Update No.2, 2014

[10] CSA Group, CSA N288.4-10, *Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills*, Update No.2, 2015

[11] CSA Group, CSA N288.5-11, *Effluent Monitoring Program at Class I Nuclear Facilities and Uranium Mines and Mills*, 2011

[12] CSA Group, CSA N288.7-15, *Groundwater protection programs at class I nuclear facilities and uranium mines and mills*, 2015

[13] CSA Group, CSA N294-09, *Decommissioning of Facilities Containing Nuclear Substances*, Update No.1, 2014

[14] Ontario Power Generation, *News and Media – Reports – Nuclear Reports and Publications*, https://www.opg.com/news-and-media/pages/reports.aspx

[15] CNSC, *Regulatory Oversight Report for Canadian Nuclear Power Plants*, http://nuclearsafety.gc.ca/eng/reactors/power-plants/regulatory-oversight-report-npp/index.cfm

[16] EcoMetrix Incorporated, *Environmental Risk Assessment Report for Pickering Nuclear*, January 2014, Prepared for Ontario Power Generation, e-Doc: 4622886

[17] Ontario Ministry of the Environment and Climate Change, *O. REF. 2015/95: Effluent Monitoring and Effluent Limits – Electric Power Generation Sector*, 1990, https://www.ontario.ca/laws/regulation/950215

[18] Ontario Ministry of the Environment and Climate Change, *O. REF. 2015/95: Air Pollution – Local Air Quality*, 1990, https://www.ontario.ca/laws/regulation/050419

[19] Government of Canada, *Radiation Protection Regulations (SOR/2000-203)*, http://laws-lois.justice.gc.ca/eng/regulations/SOR-2000-203/index.html

[20] CNSC, Regulatory Document, *REGDOC-3.1.1: Reporting Requirements for Nuclear Power Plants, version 2*, April 2016, http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/REGDOC-3-1-1-v2-Reporting-Requirements-for-Nuclear-Power-Plants-eng.pdf

[21] CNSC, Regulatory Document, *REGDOC G-219: Decommissioning Planning for Licensed Activities*, June 2000, http://nuclearsafety.gc.ca/eng/acts-and-regulations/regulatory-documents/index.cfm

[22] Ontario Power Generation, *Preliminary Decommissioning Plan – Pickering Stations A & B*, December 2016, e-Doc: 5178605

[23] Government of Canada, *Canadian Environmental Assessment Act*, 1992, http://laws.justice.gc.ca/eng/acts/c-15.2/20100712/P1TT3xt3.html

[24] CNSC, *Environmental Assessment for Return to Service of the Pickering A Nuclear Generating Station*, 2000, e-Doc: 3006924

[25] CNSC, *Record of Proceedings, Including Reasons for Decision – Application for an Amendment to the Operation Licence for the Pickering Nuclear Generating Station A*, 2001,

[26] CNSC, *Record of Proceedings, Including Reasons for Decision – Environmental Assessment Screening Report on the Proposed Expansion of the Pickering Waste Management Facility (Phase 2)*, 2004, http://www.nuclearsafety.gc.ca/eng/the-commission/pdf/Decision-OPG-PWMF-e.pdf

[27] CNSC, *Screening Report for the Proposed Environmental Assessment of the Pickering Nuclear Generating Station B Refurbishment and Continued Operations Project*, December 2008, e-Doc: 3297610

[28] CNSC, *Record of Proceedings, Including Reasons for Decision – Screening Environmental Assessment of the Pickering Nuclear Generating Station B Refurbishment and Continued Operations Project, Pickering, Ontario, 2008,*

[29] CNSC, *Proposed Environmental Assessment Screening Report Regarding the Proposal to Place Pickering A Unites 2 and 3 Into a Guaranteed Defuelled State*, 2008, e-Doc: 3310080

[30] CNSC, *Record of Proceedings, Including Reasons for Decision – Environmental Assessment Screening Report for the Proposal to Place Pickering A Units 2 and 3 Into a Guaranteed Defuelled State*, 2008, http://nuclearsafety.gc.ca/eng/the-commission/pdf/2008-11-28-Decision-OPG-CMD08-H137-e-Edocs3312912.pdf

[31] CNSC, *Waste Facility Operating Licence – Pickering Waste Management Facility WFOL-WA-350.02/2018*, e-Doc: 4002929

[32] CNSC, *Environmental Assessment Report: Ontario Power Generation Inc. Pickering Waste Management Facility Licence Renewal*, 2017, e-Doc: 5164324

[33] Northwatch, *Supplementary Information: Submission from Northwatch on the 2014 and 2017 Environmental Risk Assessments*, July 2017, e-Doc: 5303899

[34] OPG, *CMD 17-H5 1B Supplementary Written Submission from OPG – 2014 and 2017 ERAs*, June 2017, e-Doc: 5279838

[35] OPG, *CMD 17-H5 1C Supplementary Written Submission from OPG for the Continuation of the April 13, 2017 Public Hearing*, August 2017, e-Doc: 5322644

[36] CNSC, *CMD 17-H5 B Supplementary Submission from CNSC Staff for Continuation of Public Hearing on OPG PWMF*, October 2017, e-Doc: 5376085

[37] Government of Canada, *Canadian Environmental Protection Act*, 1999, http://laws-lois.justice.gc.ca/PDF/C-15.31.pdf

[38] Legislative Assembly of Ontario, *Climate Change Mitigation and Low-carbon Economy Act*, 2016, http://www.ontla.on.ca/bills/bills-files/41_Parliament/Session1/b172ra.pdf

[39] Golder Associates Ltd., *Terrestrial Environment Technical Support Document Refurbishment and Continued Operation of Pickering B Nuclear Generating Station Environmental Assessment*, 2007.

[40] Toronto and Region Conservation Authority, *Ontario Power Generation Terrestrial Long-Term Monitoring Project*, 2015

[41] Toronto and Region Conservation Authority, *Ontario Power Generation Terrestrial Long-Term Monitoring Project (Year 5)*, 2014

[42] Canadian Council of Ministers of the Environment, *Canada-Wide Standard for Petroleum Hydrocarbons (PHC) in Soil: Scientific Rationale Supporting Technical Document*, 2008

[43] Ontario Power Generation, *Report on Pickering Nuclear 2015 Fish Impingement and Entrainment Monitoring Results*, 2016, e-Doc: 5012107

[44] CNSC, *Review of the 2016 Results of Impingement and Entrainment Monitoring Program*, 2017, e-Doc: 5356830

[45] Ontario Power Generation, *Pickering Nuclear: Responses to CNSC and ECCC Comments on the Environmental Risk Assessment – Action Item 2017-48-11645 Closure Request*, 2017, e-Doc: 5349920

[46] CNSC, *Independent Environmental Monitoring Program (IEMP) Webpage*, 2017, http://www.nuclearsafety.gc.ca/eng/resources/maps-of-nuclear-facilities/iemp/index-iemp.cfm

[47] CNSC, *Home Webpage*, 2017, http://www.nuclearsafety.gc.ca/eng/

[48] Ministry of Environment and Energy (Ontario), *Drinking Water Surveillance Program*, 2013, https://www.ontario.ca/data/drinking-water-surveillance-program

[49] Government of Ontario, *O. Reg. 169/03: Ontario Drinking Water Quality Standards*, 2003, https://www.ontario.ca/laws/regulation/030169

[50] Health Canada, Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Radiological Parameters, https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-radiological-parameters.html

[51] Ontario Ministry of Labour, *Nuclear Reactor Surveillance Program 2012 Report to the Assurance Monitoring Group*, September 2014, https://www.labour.gov.on.ca/english/hs/pubs/rpms/index.php

[52] Government of Canada, *Canadian Radiological Monitoring Network*, March 2014, https://www.canada.ca/en/healcanada/services/environmental-workplace-health/environmental-contaminants/environmental-radiation/canadian-radiological-monitoring-network.html

[53] Health Canada, *Radiation Dose Data from the Fixed Point Surveillance Network*, 2016, https://www.canada.ca/en/health-canada/services/environmental-workplace-health/environmental-contaminants/environmental-radiation/fixed-point-surveillance-network/dose-data-fixed-point-surveillance-network.html

[54] UNSCEAR, 2010, *Sources and Effects of Ionizing Radiation: UNSCEAR 2008 Report. Volume I:—Report to the General Assembly with Scientific Annexes*, New York, NY: United Nations, ISBN 978-92-1-142274-0

[55] Health Canada, *Guidelines for Canadian Drinking Water Quality*, 2017, https://www.canada.ca/en/health-canada/services/environmental-workplace-health/reports-publications/water-quality/guidelines-canadian-drinking-water-quality-summary-table-health-canada-2012.html

[56] Canadian Council of Ministers of the Environment, *Water Quality Guidelines for the Protection of Aquatic Life*, 2014, http://ceqg-rcqe.ccme.ca/en/index.html#void

[57] Canadian Council of Ministers of the Environment, *Canadian Environmental Water Quality Guidelines*, 2014, http://ceqg-rcqe.ccme.ca/en/index.html

[58] Ontario Ministry of Environment and Energy, *Provincial Water Quality Objectives*, February 1999, https://www.ontario.ca/page/water-management-policies-guidelines-provincial-water-quality-objectives#section-7

Appendix 1: Summary of the PN Site IEMP results for 2014, 2015 and 2017

Radionuclide	Range of measured radioactivity			Guideline or CNSC reference level[1]
Water				
	2014	2015	2017	
Tritiated water (HTO) (Bq/L)	3.9 – 40	5.7 – 24.3	3.5 – 30.4	7,000[3]
Gross Beta (Bq/L)	<0.12[2]	<0.08[2]	<0.1[2] – 0.23	1[4]
Gross Alpha (Bq/L)	N/A[5]	<0.04[2]	<0.1[2] – 0.17	0.5[4]
Cesium-137 (Bq/L)	<0.24[2]	<0.24[2]	<0.25[2]	10.0[3]
Cobalt-60 (Bq/L)	<0.28[2]	<0.28[2]	<0.28[2]	12.1[3]
Aluminum (µg/L)	N/A[5]	N/A[5]	2.21 – 89.97	100[7]
Ammonia (mg/L)	N/A[5]	N/A[5]	<0.1[2]	0.3[7]
Cadmium (µg/L)	N/A[5]	N/A[5]	<0.08[2]	0.09[7]
Copper (µg/L)	N/A[5]	N/A[5]	0.99 – 2.38	2[7]
Hydrazine (µg/L)	N/A[5]	N/A[5]	<0.1[2]	2.6[8]
Iron (µg/L)	N/A[5]	N/A[5]	1.74 – 7.1	300[7]
Morpholine (mg/L)	N/A[5]	N/A[5]	<0.1[2]	4[9]
Total Dissolved Solids(mg/L)	N/A[5]	N/A[5]	179 – 212	500[7]
Zinc (µg/L)	N/A[5]	N/A[5]	0.84 – 1.65	30[7]
Air (Bq/m^3)				
Tritiated water (HTO)	<2[2]	<2[2]	<1.9[2] – 4.9	340[1]
Tritiated hydrogen (HT)	<2[2]	<2[2]	<1.9[2]	5,100,000[1]
Air particulate (cesium-137)	<0.0005[2]	<0.000065[2]	<0.000051[2]	2.56[1]
Air particulate (cobalt-60)	N/A[5]	<0.000072[2]	<0.000065[2]	0.228[1]
Iodine cartridge (iodine-131)	N/A[5]	<0.000047[2]	<0.00063[2]	0.228[1]
Soil (Bq/kg dry weight)				
	2014	2015	2017	
Cesium-137	2.11 – 4.73	1.26 – 5.93	2.07 – 2.93	58.6[1]
Cobalt-60	<0.94[2]	<1.09[2]	<1.03[2]	14[1]
Sediment (Bq/kg dry weight)				
	2014	2015	2017	
Cesium-137	<0.81[2]	0.25 – 0.39	<0.55[2]	37,300[1]
Cobalt-60	<0.94[2]	<0.59[2]	<0.54[2]	14[1]
Milk (Bq/kg fresh weight)				
	2014	2015	2017	
Tritiated water (HTO)	6.8	6.7	11.1	5,560[1]
Organically bound tritium (OBT)	2.5	<1.5[2]	<1.5[2]	2,260[1]
Cesium-137	N/A[5]	<0.25[2]	N/A[5]	24.5[1]
Cobalt-60	N/A[5]	<0.32[2]	N/A[5]	10.9[1]
Rhubarb (Bg/kg fresh weight)				
	2014	2015	2017	
Tritiated water (HTO)	N/A[5]	N/A[5]	15.4	104,000[1]
Organically bound tritium (OBT)	N/A[5]	N/A[5]	<1.5[2]	45,200[1]

Radionuclide	Range of measured radioactivity			Guideline or CNSC reference level(1)
Peas (Bg/kg fresh weight)				
	2014	2015	2017	
Tritiated water (HTO)	N/A(5)	N/A(5)	7.8	104,000(1)
Organically bound tritium (OBT)	N/A(5)	N/A(5)	<1.5(2)	45,200(1)
Berries (Bg/kg fresh weight)				
	2014	2015	2017	
Tritiated water (HTO)	N/A(5)	N/A(5)	12.8	123,000(1)
Organically bound tritium (OBT)	N/A(5)	N/A(5)	<1.5(2)	50,300(1)
Potatoes (Bg/kg fresh weight)				
	2014	2015	2017	
Tritiated water (HTO)	N/A(5)	N/A(5)	7.4	279,000(1)
Organically bound tritium (OBT)	N/A(5)	N/A(5)	<1.5(2)	121,000(1)
Vegetation (Bg/kg fresh weight)				
	2014	2015	2017	
Tritiated water (HTO)	10.2 – 118.7	N/A(5)	17.2 – 520.4	10,900(1)
Organically bound tritium (OBT)	<1.5(2) – 17.6	N/A(5)	1.7 – 15.8	73,000(1)
Cesium-137	N/A(5)	<2.7(2)	<3(2)	52(1)
Cobalt-60	N/A(5)	<3.3(2)	<3.3(2)	605(1)

(1) The concentration required for a hypothetical person (most exposed member of a critical group) to receive an effective whole body dose of 0.1 mSv/year due to exposure to the given radionuclide. Reference levels calculated based on conservative assumptions using CSA Standard N288.1-14 [9]
(2) The < symbol indicates that a result is below the detection limit for laboratory analysis
(3) Health Canada Guidelines for Canadian Drinking Water Quality [55]
(4) Health Canada Guidelines for Canadian Drinking Water Quality screening level [55]
(5) Samples for this contaminant, radionuclide particulate or iodine not taken this year.
(6) Tritiated water concentrations in soil are presented on a fresh-weight basis. This indicates the concentration in bulk soil, for which tritiated water is contained in the soil pore water.
(7) Canadian Council of Ministers of the Environment's Water Quality Guidelines for the Protection of Aquatic Life [56]
(8) Canadian Federal Environmental Quality Guideline [57]
(9) Ontario Water Quality Objectives [58]

PART TWO

Part Two provides all relevant information pertaining directly to the licence, including:

1. Any proposed changes to the conditions, licence period, or formatting of an existing licence;
2. The proposed licence;
3. The proposed Licence Conditions Handbook; and
4. The current licence.

PROPOSED LICENCE CHANGES

Overview

The proposed Pickering NGS Power Reactor Operating Licence (PROL) has been revised from the current PROL to include new licence conditions requiring OPG to implement and maintain the results of the Periodic Safety Review, to maintain pressure tube fracture toughness sufficient for safe operation; and to implement and maintain plans for the end of commercial operation. Additionally, there have been some minor modifications to licence conditions to improve clarity and for consistency with standardized licence conditions.

Licence Conditions

Power Reactor Operating Licence

The new proposed Pickering PROL is based on the standard PROL template developed by CNSC staff. This standard PROL template ensures that standardized licence conditions are used for all CNSC licensees and provides regulatory consistency.

The standardized PROL differs from the current Pickering PROL. The format of the standardized PROL is slightly different and uses a LC numbering convention that conforms to the numbering conventions used by the CNSC for SCAs and REGDOCs. More significantly, the standardized PROL does not contain direct references to the majority of CNSC regulatory documents and CSA standards. Rather, the REGDOCs and standards have been included as compliance verification criteria in the LCH. This change is made possible by the requirement for licensees to operate in accordance with the licensing basis (LC G.1). The exceptions are RD-204 and REGDOC-3.1.1 which are retained in the PROL for the reasons described below:

- Sections 9(2) and 9(3) of the *Class I Nuclear Facilities Regulations* explicitly state that the requirements for qualifications, training, examinations and requalification tests supporting the certification of personnel are to be specified in the licence. As a result, RD-204 (the regulatory document that specifies these requirements) must be referenced in the PROL; and
- Section 29(3) and (31(2) of the *General Nuclear Safety and Control Regulations* (GNSCR) explicitly state that reporting requirements that are identified directly in the licence supercede the reporting requirements in GNSCR section 29(1), 29(2) and 31(1). As a result, REGDOC-3.1.1 (the regulatory document that specifies reporting requirements) must be referenced in the PROL.

The proposed PROL structured to include the following parts:

I) Licence number (PROL 48.00/2028)
II) Licensee (Ontario Power Generation Inc.)
III) Licence period (September 1, 2018 to August 31, 2028)
IV) Licensed activities (what the licence authorizes the licensee to do)

V) Explanatory notes (which provide PROL clarifications and make reference to the LCH)
VI) The licence conditions (LCs) for the 14 SCAs and Nuclear Facility-Specific LCs

The proposed Pickering NGS PROL contains two facility-specific LCs retained from the current licence regarding cobalt-60 and the import and export of nuclear substances occurring as contaminants in laundry, packaging, shielding or equipment.

CNSC staff propose 4 new facility-specific LCs. The first is for the implementation of the results of the Periodic Safety Review. The second LC is for the maintenance of Units 2 and 3 in the safe storage phase. The third requires OPG to maintain pressure tube fracture toughness sufficient for safe operation and the fourth new facility-specific LC requires OPG to implement and maintain plans for the end of commercial operation of all Pickering units.

The significant changes in the proposed Pickering PROL are shown in Table 12.
The proposed licensed activities remain essentially unchanged from those in the current PROL; they have been reordered in the proposed PROL to reflect, to the extent possible, the order of activities including verbs describing activities that are included in Paragraph 26(a) of the *Nuclear Safety and Control Act* (*NSCA*). In addition, the activities in the proposed PROL were revised to reduce duplication for some activities in the current PROL. The details of the significant changes are included in the table below for ease of comparison.

Table 12: Proposed Licence Changes

Current PROL	Proposed PROL	Reason for change
Licensed Activities		
(i) Operate the Pickering Nuclear Generating Station (hereinafter “the nuclear facility”) 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.	(i) operate the Pickering Nuclear Generating Station (hereinafter “the nuclear facility”) at a site located in the City of Pickering, in the Regional Municipality of Durham, in the Province of Ontario	The phrase “operate units 2 and 3 in the safe storage phase” was moved from activity (i) to a new facility-specific LC 15.2 to more accurately reflect the requirements and expectations associated with maintaining Units 2 and 3 in a safe storage state.
(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].	(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)	No change
(iii) Import and export nuclear substances, except controlled nuclear substances, that are required for,	(iii) import and export nuclear substances, except controlled nuclear substances, that are	No change.

Current PROL	Proposed PROL	Reason for change
associated with, or arise from the activities described in [i].	required for, associated with, or arise from the activities described in (i)	
(iv) Possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in [i].	(viii) possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in (i)	No change. Moved from activity (iv) to activity (viii).
(v) 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.	(ix) 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	No change. Moved from activity (v) to activity (ix).
(vi) Possess, produce, manage, transfer and store Cobalt-60. (vii) Possess, manage and store Cobalt-60 sealed sources.	(iv) possess, transfer, produce, package, manage, and store Cobalt-60	The current PROL activities (vi) and (vii) were combined into the proposed activity (iv), which was simplified to not refer to sealed sources given that Cobalt-60 and Cobalt-60 sealed sources are both nuclear substances. In addition, the activity for "package" was added to better align with paragraph 26 (a) of the NSCA. Essentially, the activities for Cobalt remain the same. The LCH continues to describe the control measures for both Cobalt-60 and Cobalt-60 sealed sources.
(viii) Possess, transfer, manage and store heavy water from other nuclear facilities.	(v) possess, transfer, manage and store heavy water from other nuclear facilities	No change, Moved from activity (viii) to activity (v).
(ix) Possess, transfer, package, manage, store and export nuclear substances, except controlled nuclear substances, from the Western Waste Management Facility.	(vii) possess, transfer, export, package, manage and store nuclear substances, except controlled nuclear substances, from the Western Waste Management Facility	No change. Moved from activity (ix) to activity (vii).
	(vi) transport Category II	This activity is currently fully

Current PROL	Proposed PROL	Reason for change
	nuclear material by road vehicle from the nuclear facility spent fuel bay to the onsite waste storage facility	authorized under the Pickering Waste Management Facility Operating Licence (WFOL-W-4-350.02/2018); however, it was added under the proposed PROL for clarity and to capture current practice.
Licence Conditions		
LC 1.1 to 1.7	LCs G.1 to G.6	Adoption of standardized general LCs G.1 to G.6 in place of LC 1.1 to 1.7. Note: LC 1.3 was withdrawn in December 2014, with the inclusion of REGDOC-3.1.1 in the licence.
LC 1.8: The licensee shall, in the event of any conflict or inconsistency between licence conditions, codes or standards or regulatory documents referenced in this licence, direct the conflict or inconsistency to the Commission, or a person authorized by the Commission, for resolution.		This requirement is captured under LC G.1 In addition, the standardized LCH content for the proposed LC G.1 also addresses "inconsistency" from the current LC 1.8 by providing some clarity around issues such as CNSC REGDOCs and CSA standards.
LC 2.1 to 3.2	LCs 1.1 to 2.2	Adoption of standardized LC numbering and wording.
LC 3.3: The licensee shall implement and maintain a training program that includes certification training, examinations and tests for positions requiring certified personnel in accordance with CNSC regulatory document RD-204 CERTIFICATION OF PERSONS WORKING AT NUCLEAR POWER PLANTS. Persons appointed to the following positions shall be certified: (i) Responsible Health Physicist (ii) Authorized Nuclear	LC 2.3: The licensee shall implement and maintain training programs. LC 2.4: The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document RD-204, *Certification of Persons Working at Nuclear Power Plants*. Persons appointed to the following positions require certification: (i) Responsible Health Physicist; (ii) Shift Manager;	The current PROL LC 3.3 was split into new proposed LCs 2.3 and 2.4 to allow better separation of the training program and the certification program. The training program applies to all workers including certified staff. Although the current LC did include training programs for all workers, the bulk of the LC was related to certification. By creating a separate condition for each program better allows for clarity in compliance verification criteria for both programs in the LCH. There is no change with respect to overall content.

Current PROL	Proposed PROL	Reason for change
Operator (iii) Control Room Shift Supervisor (iv) Shift Manager.	(iii) Control Room Shift Supervisor; and (iv) Authorized Nuclear Operator.	
LCs 4.1 to 5.1	LCs 3.1 to 4.1	Adoption of standardized LC numbering and wording.
LC 5.2: The licensee shall ensure that design and analysis computer codes and software used to support the safe operation of the nuclear facility are in accordance with CSA standard N286.7 QUALITY ASSURANCE OF ANALYTICAL, SCIENTIFIC AND DESIGN COMPUTER PROGRAMS FOR NUCLEAR POWER PLANTS		This requirement is captured under LC 4.1 CSA standard N286.7 is one of the licensing basis publications under LC 4.1
LCs 6.1 to 6.2	LCs 5.1 to 5.2	Adoption of standardized LC numbering and wording.
LC 6.3: The licensee shall implement and maintain an environmental qualification program in accordance with CSA standard N290.13 ENVIRONMENTAL QUALIFICATION OF EQUIPMENT FOR CANDU NUCLEAR POWER PLANTS	LC 5.3: The licensee shall implement and maintain an equipment and structure qualification program.	With the adoption of standardized LC numbering and wording the current LC 6.3 was broadened in scope to better reflect current practice. The proposed LC now includes equipment and structure qualification rather than just environmental qualification, which is only one type of equipment qualification. Equipment and structure qualification were previously covered under the LC 6.1 for the design program. It should be noted that the design program LC continues to include qualification programs and that the proposed LC 5.3 is used to allow for added clarity in the LCH.
LCs 7.1 to 9.1	LCs 6.1 to 8.1	Adoption of standardized LC numbering and wording.

Current PROL	Proposed PROL	Reason for change
LC 10.1: The licensee shall implement and maintain programs to ensure environmental protection in accordance with: (i) CSA standard N288.1 GUIDELINES FOR CALCULATING DERIVED RELEASE LIMITS FOR RADIOACTIVE MATERIAL IN AIRBORNE AND LIQUID EFFLUENTS FOR NORMAL OPERATION OF NUCLEAR FACILITIES, (ii) CSA standard N288.4 ENVIRONMENTAL MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS. In addition, the licensee shall undertake specific measures to control releases of nuclear and hazardous substances in accordance with applicable limits and to monitor effluents.	LC 9.1: The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.	The current LC 10.1 and LC 10.2 were combined as the proposed LC 9.1 as part of the adoption of the standardized LC numbering and wording.
LC 10.2: The licensee shall have a set of environmental action levels for nuclear substances. When the licensee becomes aware that an environmental action level has been reached, the licensee shall notify the Commission within seven days.		
LCs 11.1 to 15.1	LCs 10.1 to 14.1	Adoption of standardized LC numbering and wording.
Station-specific LC		
	LC 15.1: The licensee shall implement the Integrated Implementation Plan.	OPG has conducted a Periodic Safety Review (PSR) in support of licence renewal. This proposed station-specific LC captures the requirements for the

Current PROL	Proposed PROL	Reason for change
		licensee to implement the results of the PSR, as documented in the Integrated Implementation Plan.
	LC 15.2: The licensee shall maintain Units 2 and 3 in the safe storage phase.	This proposed LC was added to compliment the licence activity (i) to "operate the nuclear facility", which also includes a facility that has units in safe storage. The addition of this proposed LC adds additional clarity regarding the compliance verification criteria for units in safe storage, which are now included in the proposed LCH. See also above discussion on activities.
	LC 15.3: The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.	This proposed LC was added to strengthen the oversight for aging of pressure tubes.
LC 16.1: The licensee shall implement and maintain a program for Cobalt-60 to cover activities described under Part IV) (v) and (vi) of this licence. The licensee shall provide a written report upon receipt of a Cobalt-60 sealed source.	LC 15.5: The licensee shall implement and maintain a Cobalt-60 program for activities described under Part IV) of this licence.	The reporting requirement was removed the proposed LC as it is now covered by REGDOC-3.1.1. Specific details of the reporting are provided as compliance verification criteria in the LCH. The current LC 16.1 is incorrect as a result of a recent amendment to PROL 48.04/2018, which added/revised the activities relating to laundry. At the time it was overlooked that the change in the activity numbering impacted LC 16.1, which should refer to activities (vi) and (vii) rather than activities (v) and (vi). Therefore, the proposed LC was revised to remove specific references to activities, which is consistent with the other conditions in the PROL.
LC 16.2: The licensee shall implement and maintain a continued operations plan and	LC 15.4: The licensee shall implement and maintain plans for the end of	This proposed LC was added to reflect that OPG is reaching end of commercial operation, which

Current PROL	Proposed PROL	Reason for change
a sustainable operations plan. The licensee shall confirm to the Commission, in writing and no later than June 30, 2017, the end date of commercial operations of all Pickering units.	commercial operations of all Pickering units.	includes important control measures that are documented in the LCH. The proposed LCH details the updated CNSC requirements and expectations related licensee plans for end of commercial operation. The compliance verification criteria also included a requirement for OPG to confirm the final shutdown dates of the Pickering units.
LC 16.3: The licensee shall obtain the written approval of the Commission, or written consent of a person authorized by the Commission, prior to the removal of any established regulatory hold point.		CNSC staff do not recommend a hold point for this licence.
LC 16.4: The licensee shall limit the activities of import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment.	LC 15.6: The licensee shall limit the import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment.	Grammatical changes.

Licence Conditions Handbook

The proposed Pickering NGS Licence Conditions Handbook (LCH) is based on CNSC staff's standard LCH template. It provides regulatory consistency by including the same sections within each SCA. The format for the sections of the LCH which provide explanation of the LCs (General and Sections 1 to 15) includes:

- The licence condition
- The preamble section outlining the legal requirements
- The Compliance Verification Criteria (CVC) section ("shall" statements), including the Licensee documents that require Notification of Change and the Licensing Basis publications
- The Guidance section ("should" statements)

To ensure that OPG operates within the Commission-approved licensing basis, the Pickering NGS LCH contains references to program documents that are programmatic in nature or process documents only when those documents contain limits or control measures. This ensures that changes made to programs, operating limits and control measures undergo regulatory scrutiny, but allows the licensee to manage its programs within the boundaries set by its management system.

The Commission considers the LCH during licence renewal and maintains oversight of it by receiving annual updates of major LCH changes through the NPP Regulatory Oversight Report. The NPP Regulatory Oversight Report is prepared annually by CNSC staff.

Licence Period

OPG requested in its licence application [1] the renewal of the PROL for Pickering NGS for a period of ten years, from September 1, 2018 to August 31, 2028.

Over the ten year period, OPG plans to implement the result of the PSR, with a target completion date of 2020. OPG has also declared that Pickering NGS will end commercial operation by December 31, 2024. The licence period will include the activities necessary to transition the units to a state of safe storage by 2028.

PROPOSED LICENCE

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PDF Ref.: e-Doc #######
Word Ref.: e-Doc 5189303
File / Dossier: 2.01

NUCLEAR POWER REACTOR OPERATING LICENCE

PICKERING NUCLEAR GENERATING STATION

I) LICENCE NUMBER: **PROL 48.00/2028**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act* this licence is issued to:

Ontario Power Generation Inc.
700 University Avenue
Toronto, Ontario
M5G 1X6

III) LICENCE PERIOD: This licence is valid from September 1, 2018 to Month Day, 2028, unless suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

(i) operate the Pickering Nuclear Generating Station (hereinafter “the nuclear facility”) 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) import and export the nuclear substances, except controlled nuclear substances, that are required for, associated with, or arise from the activities described in (i);

(iv) possess, transfer, produce, package, manage, and store produce Cobalt-60;

(v) possess, transfer, manage and store heavy water from other nuclear facilities;

(vi) transport Category II nuclear material by road vehicle from the nuclear facility spent fuel bay to the onsite waste storage facility;

(vii) possess, transfer, export, package, manage and store nuclear substances, except controlled nuclear substances, from the Western Waste Management Facility.

(viii) possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in (i); and

(ix) 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) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The Pickering NGS Licence Conditions Handbook (LCH) provides compliance verification criteria used to verify compliance with the conditions in the licence. The LCH also provides information regarding delegation of authority, applicable versions of documents and non-mandatory guidance on how to achieve compliance.

VI) CONDITIONS:

G. **General**

G.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(i) the regulatory requirements set out in the applicable laws and regulations;
(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence;
(iii) the safety and control measures described in the licence application and the documents needed to support that licence application;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (CNSC, hereinafter "the Commission").

G.2 The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

G.3 The licensee shall control the use and occupation of any land within the exclusion zone.

G.4 The licensee shall provide, at the nuclear facility and at no expense to the Commission, suitable office space for employees of the Commission who customarily carry out their functions on the premises of that nuclear facility (onsite Commission staff).

G.5 The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

G.6 The licensee shall implement and maintain a public information and disclosure program.

1. Management System

1.1 The licensee shall implement and maintain a management system.

2. Human Performance Management

2.1 The licensee shall implement and maintain a human performance program.

2.2 The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facility.

2.3 The licensee shall implement and maintain training programs.

2.4 The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document RD-204, *Certification of Persons Working at Nuclear Power Plants*.

Persons appointed to the following positions require certification:

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

3. Operating Performance

3.1 The licensee shall implement and maintain an operations program, which includes a set of operating limits.

3.2 The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or prior written consent of a person authorized by the Commission.

3.3 The licensee shall notify and report in accordance with CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

4. Safety Analysis

4.1 The licensee shall implement and maintain a safety analysis program.

5. Physical Design

5.1 The licensee shall implement and maintain a design program.

5.2 The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency.

5.3 The licensee shall implement and maintain an equipment and structure qualification program.

6. Fitness for Service

6.1 The licensee shall implement and maintain a fitness for service program.

7. Radiation Protection

7.1 The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

8. Conventional Health and Safety

8.1 The licensee shall implement and maintain a conventional health and safety program.

9. Environmental Protection

9.1 The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

10. Emergency Management and Fire Protection

10.1 The licensee shall implement and maintain an emergency preparedness program.

10.2 The licensee shall implement and maintain a fire protection program.

11. Waste Management

11.1 The licensee shall implement and maintain a waste management program.

11.2 The licensee shall maintain a decommissioning plan.

12. Security

12.1 The licensee shall implement and maintain a security program.

13. Safeguards and Non-Proliferation

13.1 The licensee shall implement and maintain a safeguards program.

14. Packaging and Transport

14.1 The licensee shall implement and maintain a packaging and transport program.

15. Nuclear Facility-Specific

15.1 The licensee shall implement the Integrated Implementation Plan.

15.2 The licensee shall maintain Units 2 and 3 in the safe storage phase.

15.3 The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.

15.4 The licensee shall implement and maintain plans for the end of commercial operations of all Pickering units.

15.5 The licensee shall implement and maintain a Cobalt-60 program for activities described under Part IV) of this licence.

15.6 The licensee shall limit the import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment.

SIGNED at OTTAWA ________________________

____

Michael Binder
President
CANADIAN NUCLEAR SAFETY COMMISSION

PROPOSED LICENCE CONDITIONS HANDBOOK

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Canada's Nuclear Regulator

CNSC CCSN

e-DOC 5189658 (Word)

e-DOC 5470820 (PDF)

LICENCE CONDITIONS HANDBOOK

LCH-PR-48.00/2028-R000

PICKERING NUCLEAR GENERATING STATION
NUCLEAR POWER REACTOR OPERATING LICENCE

LICENCE # PROL 48.00/2028

DRAFT

Canadian Nuclear Safety Commission

Commission canadienne de sûreté nucléaire

Canada

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Licence Conditions Handbook **Effective: Month day, 2018**

LCH-PR-48.00/2028-R000

Pickering Nuclear Generating Station

Nuclear Power Reactor Operating Licence

PROL-48.00/2028

SIGNED at OTTAWA this X[th] day of month 20XX

____

Gerry Frappier, Director General

Directorate of Power Reactor Regulation

CANADIAN NUCLEAR SAFETY COMMISSION

Revision History

Effective Date	Revision	Word e-Doc and Version	Description of the Changes	CAF e-Doc
Month day, 20XX	0	5189658 v??	Original Document	N/A

TABLE OF CONTENT

INTRODUCTION

The general purpose of the Licence Conditions Handbook (LCH) is to identify and clarify the relevant parts of the licensing basis, CNSC document INFO-0795, *Licensing Basis Objectives and Definitions* (2010), for each licence condition (LC). This will help ensure that the licensee conducts the activities described in the licence in accordance with the licensing basis for the facility. The LCH should be read in conjunction with the regulatory requirements, the licence and licence application and supporting documents.

The LCH is organized in accordance with the CNSC's Safety and Control Area (SCA) Framework (e-Doc 3410839). The SCA Framework includes fourteen SCA areas, their definitions and specific areas. The licensee may request a copy of this document at any time.

The licensing basis described in this LCH applies to the facility known as the Pickering Nuclear Generating Station or Pickering NGS. The licensing basis is a key input to establish compliance verification activities for the Pickering NGS in accordance with the CNSC Power Reactor Regulatory Program Compliance Verification Strategy, e-Doc 5115523.

Pickering NGS consists of eight units; Units 1 to 4 are at times referred to as Pickering NGS-A, and Units 5 to 8 may be called Pickering NGS-B. This distinction is due to the different times of construction and differences in design. The LCH sometimes refers to Pickering NGS-A (or Units 1 to 4) and/or Pickering NGS-B (or Units 5 to 8) as the licensing conditions and requirements may be specific to a Unit or to a combination of Units.

The LCH typically has three parts under each LC: the Preamble, Compliance Verification Criteria (CVC), and Guidance. The Preamble explains, as needed, the regulatory context, background, and/or history related to the LC. CVC are criteria used by CNSC staff to verify and oversee compliance with the LC. Guidance is non-mandatory information, including direction, on how to comply with the LC.

Throughout the licence, the statement "consent of a person authorized by the Commission" reflects the fact that the Commission may delegate certain authority (hence "consent") to CNSC staff. Unless otherwise indicated in the CVC of specific LCs in this LCH, the delegation of authority by the Commission to act as a "person authorized by the Commission" is only applied to the incumbents of the following positions (source: Record of Decision for licence renewal issued Month 20XX, e-Doc XXXXXXX):

- Director, Pickering Regulatory Program Division
- Director General, Directorate of Power Reactor Regulation
- Executive Vice-President and Chief Regulatory Operations Officer, Regulatory Operations Branch

Current versions of the licensee documents listed in this LCH are tracked in the document "OPG Pickering NGS PROL Written Notification Documents in LCH" (e-Doc 4027172), which is controlled by the Pickering Regulatory Program Division (PRPD) and is available to the licensee upon request.

This LCH includes appendices A to E which contain acronyms, a glossary of terms and lists of LCH-related documents.

More information on the LCH is available in e-Doc 4967591.

GENERAL

G. GENERAL

G.1 Licensing Basis for the Licensed Activities

Licence Condition G.1:

The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, defined as:

(i) the regulatory requirements set out in the applicable laws and regulations;

(ii) the conditions and safety and control measures described in the facility's or activity's licence and the documents directly referenced in that licence;

(iii) the safety and control measures described in the licence application and the documents needed to support that licence application;

unless otherwise approved in writing by the Canadian Nuclear Safety Commission (CNSC, hereinafter "the Commission").

Preamble:

Paragraph 24 (1) of the *Nuclear Safety and Control Act* (*NSCA*) states "The Commission may establish classes of licences authorizing the licensee to carry on any activity described in any of paragraphs 26 (a) to (f) that is specified in the licence for the period that is specified in the licence."

Paragraph 26 (a) of the *NSCA* states "Subject to the regulations, no person shall, except in accordance with a licence,

(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;

(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance;

(c) produce or service prescribed equipment;

(d) operate a dosimetry service for the purposes of this Act;

(e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or

(f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada."

The standardized licence conditions, organized by Safety and Control Areas (SCAs), apply to all the licensed activities. Specific licence conditions were added for nuclear facility-specific activities, if required. The licensed activities are explained in more detail below:

Nuclear Facility

Activity (i) in the licence authorizes the licensee to operate the Pickering NGS. There is a number of specific licence conditions, with applicable sections of the LCH, that provide additional context to what is meant by “operate” for Pickering NGS, namely:

- LC 15.1 describes that the results of the Periodic Safety Review (PSR) shall be implemented;
- LC 15.2 describes which units shall be maintained in the safe storage phase;
- LC 15.3 describes the requirement to maintain pressure tube fracture toughness sufficient for safe operation; and
- LC 15.4 describes the requirement for plans for the end of commercial operations (ECO).

Nuclear Substances

Activity (ii) in the licence authorizes the licensee to possess, transfer, use, package, manage and store nuclear substances and activity (iii) in the licence authorizes the licensee to import, export nuclear substances, except controlled nuclear substances.

The licence was recently amended to include the activities for import and export for contaminants in laundry, packaging, shielding or equipment, which are not controlled nuclear substances. In addition, a new activity (vii) was included in an amendment to authorize additional activities to possess, transfer, export, package, manage and store nuclear substances from the Western Waste Management Facility for laundry from the Western Waste Management Facility. See CMD 17-H109 (e-Doc 5251787), CMD 17-H109.A (e-Doc 5338229) and the Record of Decision (e-Doc 5373857) for more information related to these amendments.

Licence conditions that relate to activities (ii), (iii) and (vii) include:

- LC 11.1 describes the waste management program;
- LC 14.1 describes the packaging and transport program;
- LC 15.6 describes the importing and exporting of contaminants in laundry, packaging, shielding or equipment.

Activity (iv) in the licence authorizes the licensee to possess, transfer, produce, package, manage and store Cobalt-60. Activity (v) in the licence authorizes the licensee to possess, transfer, manage and store heavy water, which was added as an amendment in 2016. See CMD 16-H111 (e-Doc 5035292) and the Record of Decision (e-Doc 5089672) for more information related to this amendment. Licence conditions that relate to activities (iv) and (v) include:

- LC 3.1 describes the heavy water management program at Pickering NGS, which includes the management of heavy water from other facilities; and
- LC 15.5 describes the Cobalt-60 production program at Pickering NGS.

Transport of Nuclear Material

Activity (vi) in the licence authorizes the licensee to transport Category II nuclear material i.e. fuel by road from Pickering NGS spent fuel bay to the onsite waste storage facility, The Pickering waste storage facility is licenced separately from the Pickering NGS licence (WFOL-W4-350.02/2018 – e-Doc 4002929). This activity is addressed as part of LC 14.1, which describes the packaging and transport program.

Prescribed Equipment and Prescribed Information

Activities (viii) in the licence authorizes the licensee to possess and use prescribed equipment and prescribed information related to the operating Pickering NGS i.e. activity (i). Activity (ix) authorized the licensee to possess, use, manage and store enriched uranium as required for the fission chambers for Pickering NGS Units 1 and 4 Shutdown System Enhancement, including spares. Licence conditions that relate to these activities include:

- LC 12.1 describes the security program, which includes site access control and measures to prevent loss or illegal use, possession or removal of nuclear substances, prescribed equipment or prescribed information; and
- LC 13.1 describes the safeguards program, which specifies for the import and export of controlled nuclear substances, equipment and information a separate authorization is required from the CNSC. Additionally, it describes reporting requirements for all fissionable and fertile substances.

Compliance Verification Criteria:

Licensee Documents		
Document #	**Title**	**Prior Notification**
P-CORR-00531-05055	Letter, Randy Lockwood to M. A. Leblanc, “Application for Renewal of Pickering Nuclear Generating Station Power Reactor Operating Licence”, August 28, 2017, e-Doc 5328792.	N/A
P-CORR-00531-05087	Letter, Randy Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – Preliminary List of CNSC Regulatory Documents and CSA Standards”, August 11, 2017, e-Doc 5320044.	N/A
P-CORR-00531-05140	Email, Susan Ebata to A. Viktorov, “Documents referred to in P-CORR-0531-05055”, September 1, 2017, e-Doc 5333436.	N/A
P-CORR-00531-05223	Letter, Randy Lockwood to M. A. Leblanc, “Supplementary Information to the Application for Renewal of the Pickering Nuclear Generating Station Power Reactor Operating Licence”, December 11, 2017, e-Doc 5414520.	N/A

P-CORR-00531-05228	Letter, Randy Lockwood to A. Viktorov, “Application Requirements for Power Reactor Operating Licence Renewal – CNSC Regulatory Documents and CSA Standards”, December 14, 2017, e-Doc 5417613.	N/A
P-CORR-00531-18933	Letter, Heather Ferguson to A. Viktorov, N. Riendeau, K. Glenn, “Gap Analysis and Implementation Plan for Compliance with CSA Standard N288.7-15”, December 14, 2017, e-Doc 5421310.	N/A
P-CORR-00531-18966	Letter, Heather Ferguson to A. Viktorov, N. Riendeau, K. Glenn, “Gap Analysis and Implementation Plan for Compliance with CSA Standard N288..3.4-13”, December 14, 2017, e-Doc 5421300.	N/A
P-CORR-00531-05193	Letter, Randy Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – Compliance with Standard CSA N285.4-14”, December 15, 2017, e-Doc 5419126.	N/A
P-CORR-00531-05213	Letter, Randy Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – Update to CNSC Regarding Use of CSA N285.8-15 Fitness for Service Assessment of Pressure Tubes”, December 15, 2017, e-Doc 5419124.	N/A
P-CORR-00531-05188	Letter, Randy Lockwood to A. Viktorov, “Pickering NGS: Application Requirements for Power Reactor Operating Licence Renewal – Update on the CSA N293-12 Implementation Plan”, December 15, 2017, e-Doc 5419135.	N/A

INFO-0795, section 2, defines the licensing basis in three parts. Part i) of the licensing basis consists of the regulatory requirements set out in the applicable laws and regulations.

Besides the *NSCA* and its associated Regulations, licensees are subject to other applicable laws and regulations including, but not limited to, the following:

- Canadian Environmental Assessment Act
- Canadian Environmental Protection Act
- Nuclear Liability and Compensation Act
- Transportation of Dangerous Goods Act
- Radiation Emitting Devices Act
- Access to Information Act

- Canada/IAEA Safeguards Agreement
- National Building Code of Canada

The safety and control measures mentioned in the LC under Parts (ii) and (iii) of the licensing basis include important aspects of analysis, design, operation, etc. They may be found in high-level, programmatic licensee documents but might also be found in lower-level, supporting documentation. They also include safety and control measures in licensing basis publications (e.g., CNSC regulatory documents or CSA standards) that are cited in the licence, the application, or in the licensee's supporting documentation. CNSC regulatory documents are abbreviated as REGDOC(s) and CSA standards are abbreviated as CSA followed by the applicable document number and title.

Licensing basis publications are listed in tables in this LCH under the most relevant LC. All "shall" or normative statements in licensing basis publications are considered compliance verification criteria (CVC) unless stated otherwise. If any "should" or informative statements in licensing basis publications are also considered CVC, this is explained under the most relevant LC.

The licensee documents and licensing basis publications may cite other documents that also contain safety and control measures (i.e., there may be safety and control measures in "nested" references). There is no predetermined limit to the degree of nesting at which relevant safety and control measures may be found.

Not all details in referenced documents are necessarily considered to be safety and control measures.

- Details that are not directly relevant to safety and control measures for facilities or activities authorized by the licence are excluded from the licensing basis.
- Details that are relevant to a different safety and control area (i.e., not the one associated with the main document) are only part of the licensing basis to the extent they are consistent with the main requirements for both safety and control areas.

In the event of any perceived or real conflict or inconsistency between two elements of the licensing basis, the licensee shall consult CNSC staff to determine the approach to resolve the issue.

In case of a conflict between CSA standards, CNSC will consult with CSA Group before reaching a conclusion on the resolution.

This LC is not intended to unduly inhibit the ongoing management and operation of the facility or the licensee's ability to adapt to changing circumstances and continuously improve, in accordance with its management system. Where the licensing basis refers to specific configurations, methods, solutions, designs, etc., the licensee may propose alternate approaches as long as they remain, overall, in accordance with the licensing basis and have a neutral or positive impact on health, safety, the environment, security, and safeguards. However, the licensee shall assess changes to confirm that operations remain in accordance with the licensing basis.

Changes to certain licensee documents require written notification to the CNSC, even if they are in accordance with the licensing basis. Further information on this topic is provided under LC G.2.

For unapproved operation that is not in accordance with the licensing basis, the licensee shall take action as soon as practicable to return to a state consistent with the licensing basis, taking into account the risk significance of the situation.

In the event that the Commission grants approval to operate in a manner that is not in accordance with existing licensing basis, this would effectively revise the licensing basis for the facility. The appropriate changes would be reflected in the CVC of the relevant LC.

Guidance:

When the licensee becomes aware that a proposed change or activity might not be in accordance with the licensing basis, it should first seek direction from CNSC staff regarding the potential acceptability of this change or activity. The licensee should take into account that certain types of proposed changes might require significant lead times before CNSC staff can make recommendations and/or the Commission can properly consider them. Examples of these types of changes are discussed under various LCs in this LCH. Guidance for notifications to the CNSC related to licensee changes are discussed under LC G.2.

G.2 Notification of Changes

Licence Condition G.2:

The licensee shall give written notification of changes to the facility or its operation, including deviation from design, operating conditions, policies, programs and methods referred to in the licensing basis.

Preamble:

CNSC staff track, in e-Doc 4027172, the version history of licensee documents that require notification of change (with the exception of security-related documents).

Compliance Verification Criteria:

Written notification (WN) is a written letter or electronic communication from a person authorized to act on behalf of the licensee to a CNSC delegated authority.

The licensee shall notify the CNSC of changes to identified licensee documents. The LCH identifies them under the most relevant LC. However, the licensee documents identified in the LCH only represent the minimum subset of documents that require notification of change. For any change that is not captured as a change to a document listed in the LCH, the licensee shall notify CNSC of the change in licensing basis documents if the change may negatively impact designs, operating conditions, policies, programs, methods, or other elements that are integral to the licensing basis. For example, if a licensee document identified in the CVC refers to another document, including a third-party document, without citing the revision number of that document, if that document changes and the licensee uses the revised version, the licensee shall determine if it is necessary to notify the CNSC of the change.

The documents needed to support the licence application may include documents produced by third parties (e.g., reports prepared by third party contractors). Changes to these documents require written notification to the CNSC only if the new version continues to form part of the licensing basis. That is, if the licensee implements a new version of a document prepared by a third party, it shall inform the CNSC of the change(s), per LC G.2. On the other hand, if a third party has updated a certain document, but the licensee has not adopted the new version as part of its safety and control measures, the licensee is not required to inform the CNSC that the third party has changed the document.

Licensee documents tabulated in the CVC of the LCH are subdivided into two groups having different requirements for notification of change – ones that require prior written notification of changes and those that require written notification at the time of implementation. For the former type, the licensee shall submit the document to the CNSC prior to implementing the change. Typically, the requirement is to submit the proposed changes 30 days prior to planned implementation; however, the licensee shall allow sufficient time for the CNSC staff to review the change proportionate to its complexity and the importance of the change. If change modified a document which requires formal CNSC staff acceptance, additional time should be allowed. For the latter type, the licensee need only submit the document at the time of implementing the change.

Written notifications shall include a summary description of the change, the rationale for the change, expected duration (if not a permanent change), and an explanation of how the licensee has concluded that the change remains in accordance with the licensing basis (e.g., an evaluation of the impact on health, safety, security, the environment and Canada's international obligations). A copy of the revised WN document shall accompany the notification.

Changes that are not clearly in the safe direction may require Commission approval in accordance with LC G.1.

The licensee shall notify the CNSC in writing when it plans to implement a new licensing basis publication, including the date by which implementation of the publication will be complete. The notice shall indicate the corresponding changes to licensee documents listed in CVC of the LCH.

Guidance:

A list of criteria that could help determine if a change would be in accordance with the licensing basis is provided in Appendix A of CNSC internal document "*Overview of assessing licensee changes to documents or operations*", e-Doc 4055483. Such criteria would also be used if the change requires CNSC staff acceptance, due to other requirement in the licensing basis.

For proposed changes that would not be in accordance with the licensing basis, the Guidance for LC G.1 applies.

G.3 Land Use and Occupation

Licence Condition G.3:

The licensee shall control the use and occupation of any land within the exclusion zone.

Preamble:

The exclusion zone is an area, immediately surrounding a nuclear facility where no permanent habitation is allowed. The siting guide used at the time of design of Pickering NGS (AECB-1059, e-Doc 3000249) stipulated an exclusion zone that extended at least 914 metres (3000 feet) from the reactor core.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
NK30-D0A-10200-0001	Building Development Site Plan	No
NA44-SR-01320-00001	Pickering A Safety Report (Part 1)	No*
NK30-SR-01320-00001	Pickering B Safety Report (Part 1)	No*

**Updates to facility descriptions are required every 5 years or when requested by the CNSC in accordance with REGDOC-3.1.1 (LC 3.3).*

The licensee shall ensure that the use and occupancy of land within the exclusion zone does not compromise the safety and control measures in the licensing basis. Specifically, the licensee shall consider emergency preparedness and ALARA when controlling land use within the exclusion zone. This applies to land the licensee occupies as well as to land occupied by others.

The licensee shall not permit a permanent dwelling to be built within the exclusion zone. "Permanent dwelling" refers to housing that is meant to be fixed. The licensee may erect, for a short time without prior notification, a temporary dwelling (e.g., a trailer).

OPG's document NK30-D0A-10200-0001, *Building Development Site Plan*, describes the exclusion zone and identifies the parcels of land within the exclusion zone that are controlled but not owned by OPG. The licensee shall notify the CNSC of changes to the use and occupation of any land within the exclusion zone.

OPG has an agreement with the City of Pickering for fire protection and community emergency management, which describes mutual aid arrangements for on-site and off-site emergencies (P-CORR-00531-04586, e-Doc 4891727). The agreement describes how resources are combined to help safeguard the community in the event of a major incident.

The response agreement and assurance of fire response shall be maintained as per the agreement, as amended from time to time. OPG shall notify the CNSC of any changes to the agreement with the City of Pickering.

See LC 10.1 and 10.2 for more information on emergency management and fire protection.

Guidance:

There is none provided.

G.4 Office for CNSC On-Site Inspectors

Licence Condition G.4:

The licensee shall provide, at the nuclear facility and at no expense to the Commission, suitable office space for employees of the Commission who customarily carry out their functions on the premises of that nuclear facility (onsite Commission staff).

Preamble:

CNSC staff require suitable office space at the nuclear facility in order to satisfactorily carry out its regulatory activities.

Compliance Verification Criteria:

Any changes of accommodation shall be made based on discussion and subsequent agreement between the CNSC and the licensee.

Suitable office space is office space that is separated from the remainder of the building in which it is located by walls or other suitable structures.

Guidance:

There is none provided.

G.5 Financial Guarantees

Licence Condition G.5:

The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission.

Preamble:

The *General Nuclear Safety and Control Regulations* requires under paragraph 3(1)(l) that a licence application contain a description of any proposed financial guarantee relating to the activity to be licensed.

The licensee is responsible for all costs of implementing the proposed decommissioning plans (see LC 11.2) and providing an appropriate financial guarantee that is acceptable to the Commission.

Ontario Power Generation Inc. (OPG) maintains a consolidated financial guarantee to cover the future decommissioning of all of its Class I and waste nuclear substance licence facilities, and the long-term management of used fuel and low- and intermediate-level radioactive waste. The current financial guarantee for OPG was accepted by the Commission on November 27, 2017. OPG conducted a complete decommissioning cost estimate review as part of the 5-year Ontario Nuclear Funds Agreement reference plan update cycle. Gaps identified between the preliminary decommissioning plan and CSA N294-09, *Decommissioning of facilities containing nuclear substances*, that could impact on the decommissioning costs were addressed by OPG in the cost estimate review (LC 11.2).

The acceptance of proposed financial guarantee is a subject of a separate Commission proceeding not related to the licence renewal process. The OPG consolidated financial guarantee includes:

- Segregated funds established pursuant to the Ontario Nuclear Funds Agreement between OPG, the Province of Ontario and the CNSC effective January 1, 2018 to December 31, 2022; and
- A trust fund for the management of used fuel established pursuant to the *Nuclear Fuel Waste Act*.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Document Title**	**Prior Notification**
N/A	CNSC Financial Security and ONFA Access Agreement between OPG, the Province of Ontario and the CNSC effective January 1, 2018 (Commission Decision e-Doc 5400969 and CMD 17-H11 e-Doc 5306917).	Yes
W-STD-WM-0003	Nuclear Liability Management – Update of Cost Estimates for the Ontario Nuclear Funds	No

	Agreement and Financial Guarantee Processes	

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CSA	N294	Decommissioning of facilities containing nuclear substances	2009	2013-09-01

The financial guarantee for decommissioning the nuclear facility shall be reviewed and revised by the licensee every five years or when the Commission requires or following a revision of the preliminary decommissioning plan that significantly impacts the financial guarantee.

The next full update to the 5 year reference plan for financial guarantee purposes is expected in 2022.

The licensee shall submit annually to the Commission a written report confirming that the financial guarantees for decommissioning costs remain valid and in effect and sufficient to meet the decommissioning needs. The licensee shall submit this report by the end of Februa ry of each year, or at any time as the Commission may request.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	G-206	Financial Guarantees for the Decommissioning of Licensed Activities	2000
CNSC	G-219	Decommissioning Planning for Licensed Activities	2000

G.6 Public Information and Disclosure

Licence Condition G.6:

The licensee shall implement and maintain a public information and disclosure program.

Preamble:

A public information and disclosure program (PIDP) is a regulatory requirement for licence applicants and licensees under the *Class I Nuclear Facilities Regulations*, paragraph 3(j), which requires that a licence application contain a description of a program to inform persons living in the vicinity of the site of the general nature and characteristics of the anticipated effects on the environment, health and safety of persons.

The primary goal of the PIDP, as it relates to the licensed activities, is to ensure that information related to the health, safety and security of persons and the environment, and other issues associated with the lifecycle of nuclear facilities are effectively communicated to the public.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-STD-AS-0013	Nuclear Public Information Disclosure	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	RD/GD-99.3	Public Information and Disclosure	2012	2013-09-01

Where the public has indicated an interest to know, the PIDP shall include a commitment to and disclosure protocol for ongoing, timely communication of information related to the licensed facility during the course of the licensing period.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	REGDOC-3.2.2	Aboriginal Engagement	2016

OPG should submit annually a report summarizing the public outreach events and developments involving Pickering NGS.

1 SCA – MANAGEMENT SYSTEM

1.1 Management System

Licence Condition 1.1:

The licensee shall implement and maintain a management system.

Preamble:

Safe and reliable operation requires a commitment and adherence to a set of management system principles and, consistent with those principles, the establishment and implementation of processes that achieve the expected results. CSA N286, *Management system requirements for nuclear facilities*, contains the requirements for a management system throughout the life cycle of a nuclear power plant and extends to all safety and control areas.

A management system brings together in a planned and integrated manner the processes necessary to satisfy requirements and to carry out licensed activity in a safe manner. Management system requirements provide direction to management to develop and implement management practices and controls. The elements of a management system include areas such as organization structure and culture, resources, equipment, and information. The management system must satisfy the requirements set out in the regulations made pursuant to the *Nuclear Safety and Control Act*, the licence and the measures necessary to ensure that safety is paramount.

An adequately established and implemented management system provides CNSC staff with confidence and evidence that the licensing basis under which the Commission made its decision and had issued a licence, remains valid.

The management system SCA includes the following specific areas (SpAs):

- Management system;
- Organization;
- Performance assessment, improvement and management review;
- Operating experience (OPEX);
- Change management;
- Safety Culture;
- Configuration management;
- Records management;
- Management of contractors; and
- Business continuity.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Management System		
N-POL-0001	Nuclear Safety Policy	No
N-CHAR-AS-0002	Nuclear Management System	Yes
N-PROG-AS-0001	Managed Systems	No
Organization		
N-STD-AS-0020	Nuclear Management Systems Organizations	No
OPG-PROC-0166	Organization Design Change	No
Performance Assessment, Improvement and Management Review		
N-PROG-RA-0010	Independent Assessment	No
N-PROC-RA-0097	Self-Assessment and Benchmarking	No
N-PROC-RA-0023	Fleetview Program Health and Performance Rating	No
Operating Experience (OPEX)		
N-PROG-RA-0003	Corrective Action	No
N-PROC-RA-0035	Operating Experience Process	No
N-PROC-RA-0022	Processing Station Conditions Records	No
Change Management		
N-PROG-MP-0001	Engineering Change Control	No
OPG-PROC-0166	Organization Design Change	No
OPG-PROC-0178	Controlled Document Management	No
Safety Culture		
N-STD-AS-0023	Nuclear Safety Oversight	No
OPG-PROG-0010	Health and Safety Management System Program	No
N-PROC-AS-0077	Nuclear Safety Culture Assessment	No
Configuration Management		
N-STD-MP-0027	Configuration Management	No

N-STD-OP-0024	Nuclear Safety Configuration Management	No
Records Management		
OPG-PROG-0001	Information Management	No
Management of Contractors		
OPG-PROG-0009	Items and Services Management	No
N-PROC-MM-0021	Supply Inspection	No
Business Continuity		
N-PROG-AS-0005	Business Planning	No
N-PROC-AS-0080	Nuclear Business Planning	No
OPG-PROG-0033	Business Continuity Program	No
OPG-PROG-0039	Project Management	No
OPG-PROG-0010	Safety Management System Program	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CSA	N286	Management system requirements for nuclear facilities	2012	2016-11-07

Management System

OPG's management system is defined in N-CHAR-AS-0002, *Nuclear Management System*, which takes its authority from N-POL-0001, *Nuclear Safety Policy*.

The management system SpA includes the following review topics and requirements from CSA N286:

- Management system – Defined and implemented (Clauses 4.1, 4.1.1);
- Management system – Based on a set of principles (Clauses 4.1.2 (a) to (l)); and
- Graded approach (Clause 4.1.3).

The management system documentation shall contain sufficient detail to demonstrate that the described processes stated directly or by reference provide the needed direction to comply with the conditions stated in the Power Reactor Operating Licence (PROL) or licence and the criteria herein.

Organization

The organization SpA includes the following review topics and requirements from CSA N286:

- Organizational structure (Clause 4.4 (a));
- Authorities, accountabilities and responsibilities (Clause 4.4 (b));
- Internal and external interfaces (Clause 4.4 (c)); and
- Decisions (Clause 4.4 (d)).

The licensee shall document the organizational structure for safe and reliable conduct of licensed activities and shall include all positions with responsibilities for the management and control of the licensed activity.

The licensee's organization, including names of persons assigned to positions, is also subject to the requirements of Paragraph 15(c) of the *General Nuclear Safety and Control Regulations*, which requires the licensee to inform the CNSC of organizational changes within 15 days. In addition, there are annual reporting requirements in accordance with REGDOC 3.1.1 *Reporting Requirements for Nuclear Power Plants.* See LC 3.3 for more information on REGDOC 3.1.1.

Performance Assessment, Improvement and Management Review

The performance assessment, improvement and management review SpA includes the following review topics and requirements from CSA N286:

- Assessment and self-assessment (Clauses 4.11 and 4.11.1);
- Independent assessment (Clauses 4.11, 4.11.2 (a) and (b)); and
- Continual improvement (Clauses 4.13 (a) – (e)).

Operating Experience (OPEX)

The operating experience (OPEX) SpA includes the following review topics and requirements from CSA N286:

- Problem identification and resolution (Clauses 4.9, 4.9 (a) to (d));
- Actions employed to control and resolve problems (Clause 4.9);
- Experience is identified and collected (Clause 4.12 (a));
- Experience is reviewed for relevance and significance (Clause 4.12 (b));
- Actions to prevent recurrence (Clause 4.12 (c));
- Initiate improvements (Clause 4.12 (d)); and
- Experience is made available (Clause 4.12).

Change Management

The change management SpA includes the following review topics and requirements from CSA N286:

- Change (Clauses 4.10 and 4.10 (a) – (g));
- Completion Assurance (Clause 7.11 and 7.11.1); and
- Turnover (Clause 7.11.2 and 7.11.2 (a) – (e)).

Safety Culture

Clause 4.2 of CSA N286 contains requirements related to the understanding and promotion of safety culture.

Licensees shall ensure that the management of the organization supports the safe conduct of nuclear activities. The licensee shall ensure that sound nuclear safety is the overriding priority in all activities performed in support of the nuclear facilities and has clear priority over schedule, cost and production. The framework, guiding principles and accountabilities for nuclear safety oversight is governed by N-STD-AS-0023, *Nuclear Safety Oversight*, which summarizes the licensee's internal and external processes used for oversight and assessment. The requirements for such oversight are described in CSA N286.

Configuration Management

Configuration management shall be incorporated into all aspects of purchasing, construction, commissioning, operating, and maintenance documentation so that the as-built configuration of the facility is aligned with the design and safety analysis in accordance with CSA N286 Clause 7.5. This includes the establishment of processes for making the identification and labelling of structures, systems and components and identification and marking of items to control their use and establish traceability where required.

With regard to modifications, the design basis for the plant should be documented and maintained to reflect design changes to ensure adequate configuration management. See LC 5.1, 5.2 and 5.3 for more information regarding the plant design. The design basis should be maintained to reflect new information, operating experience, safety analyses, and resolution of safety issues or correction of deficiencies. The impacts of the design changes should be fully assessed, addressed and accurately reflected in the safety analyses prior to implementation.

Records Management

The records management SpA includes the following review topics and requirements from CSA N286:

- Documentation of the management system (Clause 4.7.1);
- Information (Clause 4.7.2 (a - d));
- Documents (Clause 4.7.3 (a-f)); and
- Records (Clause 4.7.4 (a-g)).

Management of Contractors

The management of contractors SpA includes the following review topics and requirements from CSA N286:

- The Supply Chain Process (Clause 7.6 and 7.6.1);
- Purchasing Requirements (Clause 7.6.2 (a - l));
- Supplier Acceptability (Clauses 7.6.3.1 to 7.6.3.5);
- Provision of the purchasing requirements to suppliers (Clause 7.6.4);

- Supplier selection and award (Clause 7.6.5);
- Supplier-customer relationship (Clause 7.6.6 (a-e);
- Verification Services (Clause 7.6.7);
- Receipt and Inspection of Items (Clauses 7.6.8 and 7.6.8.1 to 7.6.8.2)
- Segregation and disposition of problem items (Clause 7.6.9);
- Storage and Handling (Clause 7.6.10 (a-e); and
- Planning for replacement parts (Clause 7.6.11 (a-g).

Business Continuity

The business continuity SpA includes the following review topics and requirements from CSA N286:

- Business Planning (Clause 4.3 and 4.3 (a) to (f));
- Pandemic;
- Resources (Clauses 4.5 and 4.5.1); and
- Financial Resources (Clause 4.5.3).

The licensee implements and maintains a "Nuclear Pandemic Plan", to support minimum shift complement staffing and makes provisions should a labour dispute arise by implementing and maintaining strike contingency documentation, "Guideline for Maintaining Staff in Key Positions When Normal Station Access is Impeded" (refer to LC 2.2).

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
Management System			
CSA	N286.0.1	Commentary on N286-12 Management System	2014
Configuration Management			
CSA	N286.10	Configuration Management for High Energy Reactor Facilities	2016

Safety Culture

The management system should be used to promote and support a healthy safety culture. The CNSC recognizes the following characteristics that form the framework for a healthy safety culture:

- Safety is a clearly recognized value;
- Accountability for safety is clear;
- Safety is integrated into all activities;
- A safety leadership process exists, and
- Safety culture is learning-driven.

The licensee should conduct self-assessments of safety culture periodically. The assessment method should be documented and the framework should include links to the safety culture characteristics listed above.

CNSC staff encourage OPG management to continue to foster a healthy safety culture to ensure that OPG staff understand the influence that safety culture has over all other organizational processes and its role in maintaining and improving safety performance.

2 SCA – HUMAN PERFORMANCE MANAGEMENT

The human performance management SCA includes the following SpAs:

- Human performance program (LC 2.1);
- Personnel training (LC 2.3);
- Personnel certification (LC 2.4);
- Initial certification and requalification tests (LC 2.4);
- Work organization and job design (LC 2.2); and
- Fitness for Duty (LC 2.1).

2.1 Human Performance Program

Licence Condition 2.1:

The licensee shall implement and maintain a human performance program.

Preamble:

Paragraph 3(d.1) of the *Class I Nuclear Facilities Regulations* requires that a licence application contain the proposed human performance program for the activity to be licensed, including measures to ensure workers' fitness for duty.

The human performance program addresses and integrates the range of human factors that influence human performance, including but not limited to:

- The provision of qualified workers;
- The reduction of human error;
- Organizational support for safe work activities;
- The continuous improvement of human performance; and
- Monitoring hours of work.

It is important that the licensee continuously monitors human performance, takes steps to identify human performance weaknesses and mechanisms that will improve human performance and reduce the likelihood of nuclear safety events that are attributable to human performance.

Human factors are factors that influence human performance as it relates to the safety of a nuclear facility or activity over all design and operations phases. These factors may include the characteristics of the person, task, equipment, organization, environment, and training. The consideration of human factors in issues such as interface design, training, procedures, and organization and job design may affect the reliability of humans performing tasks under various conditions.

CNSC Regulatory Policy P-119, *Policy on Human Factors*, describes how the CNSC will take human factors into account during its licensing, compliance and standards-development activities.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Human Performance Program		
N-PROG-AS-0002	Human Performance	No
P-PLAN-01900-00005	Pickering Human Performance Strategic Plan	No
N-STD-OP-0002	Communications	No
N-STD-OP-0012	Conservative Decision Making	No
Fitness for Duty		
N-PROC-OP-0047	Limits of Hours of Work	Yes

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	REGDOC-2.2.4	Fitness for Duty: Managing Worker Fatigue	2017	2019-01-01
CNSC	RD-363	Nuclear Security Officer Medical, Physical, Psychological Fitness	2008	2013-09-01

Human Performance Program

The human performance program is an integrated approach of strategies, policies, processes and practices that considers a broad range of human and organizational factors. The human performance program interfaces with other programs with regard to human factors aspects. These interfaces are captured below as review topics and requirements.

Fitness for Duty

REGDOC-2.2.4 *Fitness for Duty: Managing Worker Fatigue*, was published March 21, 2017. As detailed in OPG letter N-CORR-00531-18759 (e-Doc 5355839), OPG has developed a plan to fully implement REGDOC-2.2.4 by January 1, 2019.

The licensee shall also monitor and control the fitness for duty of its workers at all times by implementing and maintaining N-CMT-62808-00001, *Continuous Behaviour Observation Program*, which covers aspects related to fitness for duty.

Fitness for duty requirements for certified staff are described in Section 11 of RD-204, which is a published document under LC 2.4.

Nuclear Security Officer Medical, Physical and Psychological Fitness

The licensee shall, in accordance with RD-363, ensure that the required documentation and necessary medical, physical, and psychological certification of a person is obtained before authorizing that person to act as a nuclear security officer.

Hours of Work

In order to establish, maintain and improve human performance, the licensee shall monitor and control the work hours and shift schedules of nuclear workers. All workers (including casual construction trades) in safety sensitive positions performing safety-related tasks or working on safety-related systems (defined in REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*) are subject to these hours of work and scheduling limits.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	G-323	Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement	2007
CNSC	REGDOC-2.2.4	Fitness for Duty, Volume II: Managing Alcohol and Drug Use	2017

The Human performance program should address and integrate the range of human and organizational factors that influence human performance, which include, but may not be limited to the following:

- the provision of qualified staff
  - certification and training
  - staffing
  - minimum shift complement
  - fitness for duty
    - hours of work
    - fatigue management
- the reduction of human error
  - human factors in design
  - procedures development
  - procedural compliance
  - work protection and work permit systems
  - shift turnover

- pre- and post-job briefings
- human actions in safety analysis
- safe work strategies/practices

- organizational factors that influence safety performance through support of safe work activities
  - organization and management processes and safety culture

- the continuous improvement of human performance

In addition to certified personnel, the licensee should implement and maintain fitness for duty requirements for all workers, including security personnel. Oversight requirements should also be identified for supervisors of certified and security personnel. Licensees should have in place a documented fitness-for-duty program that provides confirmation that any person filling a minimum shift complement position does not have a physical or mental limitation that would make the person incapable of performing the duties of the applicable position, as stated in G-323, Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities: Minimum Staff Complement.

2.2 Minimum Shift Complement

Licence Condition 2.2:

The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facility.

Preamble:

The minimum shift complement specifies the numbers of qualified staff that are required to operate and maintain unit(s) safely under all operating states including normal operations, anticipated operational occurrences, design basis accidents and emergencies.

This licence condition ensures the presence at all times of a sufficient number of qualified workers to ensure safe operation of the nuclear facility, and to ensure adequate emergency response capability.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Work Organization and Job Design		
P-INS-09100-00003	Pickering Minimum Shift Complement	Yes
P-INS-09260-00008	Duty Crew Minimum Complement Assurance	Yes
N-INS-03490-10003	Minimum Shift Complement Resources, Qualifications and Procedures Required for Responding to Resource Limiting Events	No

Work Organization and Job Design

Minimum Shift Complement (MSC)

The licensee's minimum shift complement (MSC) documentation, P-INS-09100-00003, *Pickering Minimum Shift Complement*, and P-INS-09260-00008, *Duty Crew Minimum Complement Assurance*, describes the minimum number of workers with specific qualifications required for the most resource-intensive conditions under operating states, design basis accidents and emergencies and the measures in place to mitigate the impact of any MSC violations until minimum complement requirements are restored.

The licensee shall operate the nuclear facility in accordance with these documents and shall monitor and keep records of each shift's complement.
The MSC is considered part of the licensing basis. The following table summarize the facility's MSC. This table is taken from P-INS-09100-00003. In the event of a discrepancy between this table, below, and

the licensee documentation upon which they are based, the licensee documentation shall be considered the authoritative source (assuming that the licensee has followed its own change control process).

Work Group/Position	Position Certified by the CNSC	Number Required
PNGS-A Shift Manager	Yes	1
PNGS-A Control Room Shift Supervisor	Yes	1
PNGS-A Field Shift Operating Supervisor	No	1
PNGS-A Shift Advisor Technical Support	No	1
PNGS-A Authorized Nuclear Operator	Yes	4
PNGS-A Supervising Nuclear Operator	No	4
PNGS-A Nuclear Operators (2 Critical Safety Parameter qualified, 1 Self-Contained Breathing Apparatus qualified)	No	8
PNGS-B Shift Manager	Yes	1
PNGS-B Control Room Shift Supervisor	Yes	1
PNGS-B Field Shift Operating Supervisor	No	1
PNGS-B Shift Advisor Technical Support	No	1
PNGS-B Authorized Nuclear Operator	Yes	6
PNGS-B Supervising Nuclear Operator	No	4
PNGS-B Nuclear Operators (3 Critical Safety Parameter qualified, 1 Self-Contained Breathing Apparatus qualified)	No	8
PNGS-B Fuel Handling Major Panel Operator*	No	1
PNGS-B Fuel Handling Nuclear Operator*	No	1
Control Maintenance Shift Control Technician (1 Self-Contained Breathing Apparatus qualified)	No	2
Shift Mechanical Maintainer (1 Self-Contained Breathing Apparatus qualified)	No	2
Out of Plant Coordinator (Days only, 12hr/day, 7 days/wk)	No	1
Off Site Survey Team Captain (Days only, 12/hr/day, 7 days/wk)	No	1
Off Site Survey Team (Days only, 12/hr/day, 7 days/wk)	No	2
In Plant Coordinator	No	1

Work Group/Position	Position Certified by the CNSC	Number Required
Shift Resource Coordinator	No	1
In-Plant Survey Team	No	2
Chemical Laboratory Technician	No	2
Shift Emergency Response Manager	No	1
Emergency Response Maintainer	No	6
TOTAL		**65**

***One of either the Fuel Handling Major Panel Operator or the Fuel Handling Nuclear Operator must be Critical Safety Parameter qualified.**

Control Room Staffing

In conjunction with the minimum shift complement for the facility, the licensee shall maintain adequate control room staffing. The licensee shall have the following certified personnel at all times:

- In the Pickering NGS-A main control room, an authorized nuclear operator in direct attendance at each of the control panels of units 1 and 4.
- In the Pickering NGS-B main control room, an authorized nuclear operator in direct attendance at each of the control panels of units 5 to 8.

"In direct attendance" means the certified person must physically be in the direct line of sight and in close proximity to the control room panels to continuously monitor, recognize and differentiate panel displays, alarms and indications.

A certified person shall be in a position to rapidly respond, in accordance with his/her role, to changing unit conditions, at all times, as described in OPG document, P-INS-09100-00003.

The minimum certified personnel requirements for the main control room that this condition imposes do not apply where this minimum cannot be met due to emergency conditions that could cause an unwarranted hazard to personnel in the main control room, in which case the licensee shall place the reactor(s) in a safe shutdown state and the nuclear facility in a safe condition.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
Work Organization and Job Design			
CNSC	G-278	Human Factors Verification and Validation Plans	2003

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	G-323	Ensuring the Presence of Sufficiently Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement	2007

G-278, *Human Factors Verification and Validation Plans*, describes the elements of effective human factors verification and validation planning, including a suggested format for documenting these elements. A verification and validation plan documents the set of activities within a specific project that will be carried out to demonstrate that the human factors considerations of the project conform to accepted human factors principles. This will ensure that the licensee enables personnel to perform their tasks safely and to meet operational goals.

G-323, *Ensuring the Presence of Sufficient Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement*, describes the CNSC recommended approach for defining the minimum shift complement and sets out the key factors that CNSC staff will take into account when assessing whether the licensee has made, or the applicant will make, adequate provision for ensuring the presence of a sufficient number of qualified staff.

The adequacy of the minimum shift complement should be determined through a systematic analysis of the most resource-intensive conditions under all operating states, design basis accidents, and emergencies. The results of the analysis should then be validated to determine the degree to which the minimum shift complement facilitates the achievement of the overall safety goals.

OPG has implemented the Minimum Complement Coordination Program (MCCP) to monitor the minimum shift complement at Pickering NGS at all times, which helps to ensure that even short-term violations are prevented.

The licensee should provide a rolling five year profile of certified operators on an annual basis.

2.3 Training Programs

Licence Condition 2.3:

The licensee shall implement and maintain training programs.

Preamble:

There is none provided.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Personnel Training		
N-PROG-TR-0005	Training	No
N-PROC-TR-0008	Systematic Approach to Training	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	REGDOC-2.2.2	Personnel Training	2014	2016-11-07

Personnel Training

As defined by the *General Nuclear Safety and Control Regulations*, a worker is a person who performs work that is referred to in a licence. Workers include contractors and temporary employees; therefore, training requirements apply equally to these types of workers as to the licensee's own employees.

This licence condition provides the regulatory requirements for the development and implementation of training programs for workers. It also provides the requirements for training programs and processes necessary to support responsibilities, qualifications and requalification training of persons at the nuclear facility.

REGDOC-2.2.2 also provides the requirements necessary to support initial certification training and renewal of certification training of persons for the positions listed in LC 2.4, and as required by RD-204.

The licensee shall ensure that all workers are qualified to perform the duties and tasks required of their position.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	REGDOC-2.2.2	Human Performance Management Personnel Training, Version 2	2016

2.4 Certification Programs

Licence Condition 2.4:

The licensee shall implement and maintain certification programs in accordance with CNSC regulatory document RD-204, *Certification of Persons Working at Nuclear Power Plants*.

Persons appointed to the following positions require certification:

(i) Responsible Health Physicist;

(ii) Shift Manager;

(iii) Control Room Shift Supervisor; and

(iv) Authorized Nuclear Operator.

Preamble:

The licensee's documentation describes the authority and responsibilities of certified positions.

This licence condition provides the regulatory requirements for the initial certification, the renewal of certification and training of persons for the positions listed in the licence condition.

It also provides the requirements regarding the program and processes necessary to support the certification and training of persons at the nuclear facility.

As defined by the *General Nuclear Safety and Control Regulations*, workers include contractors and temporary employees who perform work that is referred to in the licence. Training and certification requirements apply equally to these types of workers as to the licensee's own employees.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Personnel Certification (includes Certified Positions)		
N-PROG-TR-0005	Training	No
N-PROC-TR-0008	Systematic Approach to Training	No
N-MAN-08131-10000-CNSC-031	Responsible Health Physicist	Yes
N-MAN-08131-10000-CNSC-007	Shift Manager, Pickering Nuclear	Yes
N-MAN-08131-10000-CNSC-010	Authorized Nuclear Operators	Yes

N-MAN-08131-10000-CNSC-028	Control Room Shift Supervisor, Pickering Nuclear	Yes
Initial Certification Examinations and Requalification Tests		
N-INS-08920-10004	Written and Oral Initial Certification Examination for Shift Personnel	No
N-INS-08920-10002	Simulator-Based Initial Certification Examinations for Shift Personnel	No
N-INS-08920-10001	Requalification Testing of Certified Shift Personnel	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	RD-204	Certification of Persons Working at Nuclear Power Plants	2008	2013-09-01

Personnel Certification and Initial Certification Examinations and Requalification Tests

<u>Training and Certification for Staff Appointed to Certified Positions</u>

The licensee shall implement and maintain a certification training and examination program in accordance with RD-204, including any transitional provisions. RD-204 defines the requirements regarding certification of persons working at NPP in positions that have a direct impact on nuclear safety.

Certified personnel shall carry out their authorities and responsibilities as per their respective role documents.

The licensee shall ensure persons appointed to the position of responsible health physicist, authorized nuclear operator, control room shift supervisor or shift manager, at the nuclear facility hold a certification for the position to which they have been appointed, in accordance with the requirements of the *Nuclear Safety and Control Act*.

Each personnel certification is issued for a specific plant design (i.e., the Pickering NGS-A side (units 1 to 4) or the Pickering NGS-B side (units 5 to 8)). A person shall be appointed <u>only</u> to the units for which the certificate has been issued.

The Senior Health Physicist referred to in RD-204 is equivalent to the Responsible Health Physicist position at Pickering NGS-A (units 1 to 4) and Pickering NGS-B (units 5 to 8).

The Plant Shift Supervisor referred to in RD-204 is equivalent to the Shift Manager position at Pickering NGS-A (units 1 to 4) and Pickering NGS-B (units 5 to 8). Any person who holds a certification as Shift Manager shall also be qualified to act in the Control Room Shift Supervisor position.

The Control Room Shift Supervisor position may also be filled by a certified Shift Manager.

The Reactor Operator referred to in RD-204 is equivalent to the Authorized Nuclear Operator position at Pickering NGS-A (units 1 to 4) and Pickering NGS-B (units 5 to 8).

When applying for certification or renewal of certification of a person for the positions listed, the licensee shall submit the information required pursuant to section 9 of *Class I Nuclear Facilities Regulations* and shall confirm that the person meets the relevant certification requirements applicable to that position, specified in RD-204.

The authorities and responsibilities of the certified positions listed above are considered safety and control measures. Any changes to them will be reviewed by CNSC staff to confirm they remain within the licensing basis in accordance with LCs G.1 and G.2, in consultation with the designated officer to certify and decertify persons referred to in sections 9 and 12 of the *Class I Nuclear Facilities Regulations* and the Director of the Personnel Certification Division.

Until further notification, the incumbent in paragraphs 25.2.6 and 26.7 of RD-204 may either be a certified:

a) Control Room Shift Supervisor (CRSS) who is working in the certified position of CRSS (duty CRSS), or
b) Shift Manager (SM) who is assigned to work in the certified position of CRSS (duty CRSS)

and must be qualified to evaluate the performance of the candidate as per section 6.0 of RD-204.

Until the revision of RD-204, the procedures specified in section 6.0 shall include the qualification requirements specifying the prerequisite knowledge and level of experience required for the certified incumbent to effectively monitor and evaluate candidate knowledge and performance in that position.

Note: Paragraph 13.1.6 of RD-204 will be amended during the next regulatory document revision to align with the written requalification test requirements in CNSC document, Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Revision 2. In the interim, for RD-204 paragraph 13.1.6, CNSC staff will apply the following compliance criteria: “The person must have successfully completed written requalification tests equivalent in number to those referred to in the NPP licence that the person would have had to take during the period of absence, if the person had continued to work in the position.”

<u>Conduct of Examinations and Tests for Certified Personnel</u>

Currently, the following three CNSC internal documents contain the requirements for administering the certification examinations and requalification tests required by RD-204:

- CNSC-EG1, Rev.0: “*Requirements and Guidelines for Written and Oral Certification Examinations for Shift Personnel at Nuclear Power Plants*”,
- CNSC-EG2, Rev.0: “*Requirements and Guidelines for Simulator-based Certification Examinations for Shift Personnel at Nuclear Power Plants*”, and
- CNSC document: “*Requirements for the Requalification Testing of Certified Shift Personnel at Nuclear Power Plants, Revision 2*”.

Guidance:

There is none provided.

3 SCA – OPERATING PERFORMANCE

The operating performance SCA includes the following SpAs:

- Conduct of licensed activity (LC 3.1);
- Procedures (LC 3.1);
- Reporting and trending (LC 3.3);
- Outage management performance (LC 3.1);
- Safe operating envelope (LC 3.1); and
- Severe accident management and recovery (LC 3.1, LC 3.2); and
- Accident management and recovery (LC 3.1, LC 3.2).

3.1 Operations Program

Licence Condition 3.1:

The licensee shall implement and maintain an operations program, which includes a set of operating limits.

Preamble:

The operations program establishes safe, uniform, and efficient operating practices within the nuclear facility, under all operating conditions (routine and non-routine), and provides the ability to ensure the facility is operated in accordance with the licensing basis.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Conduct of Licensed Activity		
N-PROG-OP-0001	Nuclear Operations	Yes
N-STD-OP-0036	Operational Decision Making	No
N-PROG-AS-0008	Heavy Water Management	No
N-PROG-MA-0019	Production Work Management	No
N-STD-OP-0011	Operations Performance Monitoring	Yes
Procedures		

N-STD-AS-0002	Procedure Use and Adherence	No
N-STD-AS-0014	Requirements for Technical Procedures	No
Outage Management Performance		
N-PROC-MA-0013	Planned Outage Management	No
N-PROC-MA-0049	Forced Outage Management	No
N-STD-OP-0025	Heat Sink Management	No
N-STD-OP-0009	Reactivity Management	No
N-STD-OP-0021	Control of Fuelling Operations	No
Safe Operating Envelope (SOE)		
N-STD-MP-0016	Safe Operating Envelope	Yes
See list of Written Notification Documents in the LCH, e-Doc 4027172	Operational Safety Requirements are licensing basis documents subject to notification of change in accordance with LC G.2.	Yes
NA44-OPP-03600	Pickering NGS-A Operating Policies and Principles	Yes
NK30-OPP-03600	Pickering NGS-B Operating Policies and Principles	Yes
N-STD-MP-0020	Margin Management	No
(Severe) Accident Management and Recovery		
N-STD-OP-0017	Response to Transients	No
N-STD-MP-0019	Beyond Design Basis Accident Management	Yes

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	REGDOC-2.3.2	Accident Management: Severe Accident Management Programs for Nuclear Reactors	2013	TBD
CSA	N290.15	Requirements for the safe operating envelope for nuclear power plants	2010 (reaffirmed 2015)	2013-09-01

Conduct of Licensed Activity

The conduct of licensed activity SpA includes the following review topics and requirements from CSA N286:

- Operations program;
- Plant status control (Clauses 7.9.3 and 7.9.3 (a-f)); and
- Infrequently performed operations (Clauses 7.9.8 and 7.9.8 (a-e).

Heavy Water Management

OPG manages heavy water for Pickering NGS in accordance with the N-PROG-AS-0008, Heavy Water Management. As well, the Pickering NGS licence was amended on September 29, 2016 to add a licensed activity to allow Pickering NGS to possess, transfer, manage and store heavy water from other nuclear facilities, such as Darlington NGS during its refurbishment and while Darlington Tritium Removal Facility operational improvements are underway. More information is available in CMD 16-H111, e-Doc 5001701.

Procedures

Plant operations shall be performed in accordance with procedures that contain information and direction for operating workers on understanding and performing their work. Use and adherence direction shall be provided to the operating workers.

Temporary procedures may be issued when existing permanent procedures do not apply to the work being planned. Temporary procedures shall be periodically reviewed for applicability and cancelled when no longer required.

OPG’s procedure development and use program shall ensure that procedures are current, periodically reviewed and updated, as required, and consistent across the site.

Outage Management Performance

The outage management performance SpA is not uniquely covered in the management system, CSA N286; however, many of the requirements of the management system, as well as other requirements in the licensing basis, are especially important during outages and should be considered together in determining the effectiveness of outage management performance. Consequently, the outage management performance SpA includes, as a minimum, the following review topics:

- Management system (LC 1.1);
- Regulatory undertakings (LC 3.3);
- Fitness for service (LC 6.1);
- Radiation protection (LC 7.1);
- Conventional health and safety (LC 8.1);
- Heat sinks;
- Reactivity management; and

- Guaranteed shutdown state (GSS).

The maintenance program, see SpA for Maintenance under LC 6.1, shall include provisions for the management of planned outages.

OPG is to make outage-related information (including Level 1 and Level 2 Outage Plans, detailing all major work on safety related structures, systems and components to be carried out during the planned outage) available to CNSC staff.

Regulatory Undertakings

Section 16 of Table A.1 of REGDOC- 3.1.1 (LC 3.3) requires the licensee to submit specific reports or notifications of regulatory undertakings, as follows:

- A notification of all regulatory undertaking to be completed during the outage 60 days prior to the outage;
- A notification of changes to the notification of regulatory undertakings within 5 business days; and
- An outage completion assurance statement confirming all regulatory undertakings were completed within 30 days after the outage.

Heat Sinks

Heat sinks are combination of systems or portions of systems that contribute to conveying heat to the atmosphere or body of water. The goal of the heat sink systems is to provide heat removal from the heat source (reactor core, pump heat, etc).

The outage heat sink management defines the strategy to ensure the plant is safe throughout the outage duration when the normal heat sinks (those used at high power) may not be available. The outage is considered to be terminated when the normal heat sinks are re-established as part of the plan to proceed to sustained high power operation.

Reactivity Management and Guaranteed Shutdown State (GSS)

The guaranteed shutdown state (GSS) is an application of physical barriers and procedural controls during an outage to guarantee that a shutdown reactor remains in sub-critical status.

In 2012, the Commission approved (e-Doc 3906406) the implementation of the Rod Based Guaranteed Shutdown State (RBGSS) for the Pickering NGS-B units, as described in CMD 12-H103 (e-Doc 3851015). RBGSS is established through the application of physical barriers and procedural controls guaranteeing that the shutoff rods, control rods and adjuster absorber rods remain in-core to ensure a sub-critical reactor status. In addition to the inserted rods, a concentration of at least 3.5 ppm of Gadolinium (Gd) nitrate is maintained in the moderator as a neutron "poison" providing additional defence-in-depth. To ensure that at least 3.5 ppm of Gd is maintained at all times in the moderator, 4 ppm of Gd will be added prior to declaring the RBGSS in effect.

OPG has also requested the use of the Rod Based Guaranteed Shutdown State with a drained moderator (RBGSS-DM). OPG performed and submitted an analysis of the RBGSS-DM, indicating that computed sub-criticality margin with rods insertions is adequate to accommodate the estimated uncertainties in the analysis with a wide safety margin for transition from RBGSS to RBGSS-DM and back to RBGSS. During this transition there is no Gadolinium in the moderator. CNSC staff concluded that the RBGSS-DM analysis is bound by the RBGSS analysis. CNSC concurrence with this non-standard RBGSS is provided for the Pickering NGS-B units in e-Doc 4808561.

The licensee shall provide prior WN for changes to operations or procedures for the Rod Based Guaranteed Shutdown State in accordance with LG G.2.

Safe Operating Envelope (SOE)

Operating Policies and Principles (OP&Ps)

The operating policies and principles (OP&P):

- define the operating rules, within which the station will be operated, maintained and modified;
- specify the authorities of the station staff positions to make decisions within the defined boundaries; and
- identify and differentiate between actions where discretion may be applied and where jurisdictional authorization is required.

The operating policies and principles shall provide framework for the safe operation and shall, as a minimum, reflect the safety analyses that have been previously submitted to the Commission.

The licensee shall at all times maintain and operate the nuclear facility within the limits of the OP&Ps and SOE. If operation outside the operating boundaries as defined in the OP&Ps and SOE is discovered, the licensee shall take immediate action to return the facility within the boundaries of safety analyses in a safe manner.

Safe Operating Envelope (SOE)

The SOE is considered part of the licensing basis. The SOE is defined in CSA N290.15 as "the set of limits and conditions within which the nuclear generating station must be operated to ensure compliance with the safety analysis upon which reactor operation is licensed and which can be monitored by or on behalf of the operator and can be controlled by the operator." The safe operating limits are derived from the safety analysis limits.

The SOE consists of a number of parameters:

- Safe operating limits;
- Conditions of operability;
- Actions and action times; and
- Surveillances.

Such parameters are currently documented in several types of station documents such as the Operating Policies and Principles (OP&P), Operational Safety Requirements (OSR), Instrument Uncertainty Calculations (IUC), the Abnormal Incidents Manual and surveillance documentation.

The limits and conditions defined in the OSRs, including any requirements for corrective or mitigating actions and action times, are specified in the applicable operations and maintenance tests, procedures and processes to ensure compliance with the SOE.

The IUCs are considered to be part of the licensing basis for SOE, but are not licensee documents that require notification of change; however, the licensee shall provide WN of changes to IUCs if the change negatively impacts the licensing basis.

Power Limits

Power limit specifications set limits on parameters that affect reactor core, channel, and fuel bundle powers, to ensure compliance with limits imposed by the design and safety analyses. The magnitude of the initial reactor power, channel powers and bundle powers in the reactor prior to an accident are the fundamental parameters determining whether fuel or fuel channel failure will occur during anticipated transients and the postulated Design Basis Accidents (DBA).

The reactors shall only be operated in states considered in, or bounded by the safety analyses (refer to LC 4.1). The power limits are described below for Pickering NGS.

For Pickering NGS-A (Units 1 and 4):

- The total power generated in any one fuel bundle shall not exceed the Channel-Specific Bundle Power Limits outlined in Figure A.30.4 of the Pickering NGS-A Operating Policies and Principles.
- The total power generated in any fuel channel shall not exceed the Channel-Specific Channel Power Limits outlined in Figure A.30.3 of the Pickering NGS-A Operating Policies and Principles under steady-state operating conditions.
- The total thermal power from the reactor fuel shall not exceed **1744 megawatts** under steady-state operating conditions.

For Pickering NGS-B (Units 5-8):

- The total power generated in any one fuel bundle shall not exceed the Channel-Specific Bundle Power Limits outlined in Figure A.30.1 of the Pickering NGS-B Operating Policies and Principles.
- The total power generated in any fuel channel shall not exceed **6100 kilowatts** under steady-state operating conditions.
- The total thermal power from the reactor fuel shall not exceed **1744 megawatts** under steady-state operating conditions.

The reactor, channel and bundle power limits are considered safety and control measures, which form part of the licensing basis.

Other Limits

OPG is expected to provide program updates on the enhanced neutron overpower protection (E-NOP) methodology until it is accepted by CNSC staff. The currently installed trip set points for neutron overpower protection (NOP) to account for heat transport system aging at Pickering NGS are valid as follows (e-Doc 5201089):

- Pickering Units 1, 4 – December 31, 2018 or 6010 Effective Full Power Days; and
- Pickering Units 5-8 – April 30, 2019 or 10300 Effective Full Power Days.

Integrated Accident Management and Recovery (Severe Accident Management and Recovery and Accident Management and Recovery)

Accident management provisions shall ensure effective defences against radiological hazards resulting from DBAs and Beyond Design Basis Accidents (BDBAs). The fundamental premise underlying accident management is that the licensee must establish and maintain overlapping measures for accident prevention and, should an accident occur, is able to:

- Prevent the escalation of the accident;
- Mitigate the consequences of the accident; and
- Achieve a long-term safe stable state after the accident.

OPG has in place Abnormal Incident Manuals (AIMs) and Emergency Operating Procedures (EOPs) to ensure that the operation of the facility can be returned to a safe and controlled state should operation deviate from normal operation.

The licensee shall ensure all abnormal operational scenarios analyzed in the design basis are accounted for in the AIMs and EOPs. In addition, the licensee shall ensure clear instruction is provided directing operations in abnormal conditions to the appropriate set of procedures or guides.

In addition to the operational guidance for abnormal and DBA conditions, the licensee shall implement and maintain an accident management program to address residual risks posed by BDBA. The licensee shall also ensure clear instruction is provided directing operations to use an appropriate set of severe accident management guidelines (SAMGs), if a severe accident is detected.

In addition to SAMGs, OPG has a series of emergency operating procedures i.e. Emergency Mitigating Equipment Guidelines (EMEGs), which have been developed through the incorporation of lessons learned from world events. The SAMGs and EMEGs are licensing basis documents, which are not included in the table of “Licensee Documents that Require Notification of Change”. Any changes to the strategic direction or major revisions/updates to the SAMGs or EMEGs shall be subject to notification of change and shall be reviewed by CNSC staff to confirm they remain within the licensing basis.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
Procedures			
CNSC	G-278	Human Factors Verification and Validation Plans	2003

Guidance Publications			
Org	**Document #**	**Title**	**Version**
Procedures			
CNSC	G-278	Human Factors Verification and Validation Plans	2003
Outage Management Performance			
CSA	N290.11	Requirements for reactor heat removal capability during outage of nuclear power plants	2013
Integrated Accident Management and Recovery			
CNSC	REGDOC-2.3.2	Accident Management, Version 2	2015
CSA	N290.16	Requirements for Beyond Design Basis Accidents	2016

Procedures

G-278, *Human Factors Verification and Validation Plans*, describes the elements of effective human factors verification and validation planning, including a suggested format for documenting these elements. A verification and validation plan documents the set of activities within a specific project that will be carried out to demonstrate that the human factors considerations of the project conform to accepted human factors principles. This will ensure that the licensee enables personnel to perform their tasks safely and to meet operational goals.

Outage Management Performance

The outage program should have designated criteria that the licensee will follow to confirm that planned and discovery work has been satisfactorily completed during the planned outage, and that all safety-significant structures, systems and components (SSCs) are available to ensure the continued safe operation of the facility.

CNSC staff located at the site offices should be invited to the restart meetings in order to verify that all appropriate reviews for restart of the reactor have occurred.

Outage completion assurance statement should describe the status of all planned work, including activities that were identified in the notification of regulatory undertakings but not completed.

Integrated Accident Management and Recovery (Severe Accident Management and Recovery and Accident Management and Recovery)

Lessons learned from drills, exercises and OPEX, including insights from deterministic and probabilistic analyses, should be incorporated into severe accident analysis and SAMGs updates.

Licensees should take in consideration the 2015 version 2 of CNSC regulatory document REGDOC-2.3.2 on accident management with attention to the requirement to train personnel, test and verify SAMG strategies implementation on a periodic basis. This expectation could be aligned and integrated with the Emergency Preparedness and Fire Protection SCA for drills and exercises in accordance with the requirements of REGDOC-2.10.1, *Nuclear Emergency Preparedness and Response*. See LC 10.1 for more information.

In addition, the severe accident management and recovery should include the requirements from CSA N290-16, *Requirements for beyond design basis accidents*.

3.2 Approval to restart after a serious process failure

Licence Condition 3.2:

The licensee shall not restart a reactor after a serious process failure without the prior written approval of the Commission, or the prior written consent of a person authorized by the Commission.

Preamble:

A serious process failure is defined in REGDOC-3.1.1 as "*A failure of a process structure, system or component that leads to a systematic fuel failure or a significant release from the nuclear power plant, or that could lead to a systematic fuel failure or a significant release in the absence of action by any special safety system.*" Serious process failures are reportable in accordance with REGDOC-3.1.1, See LC 3.3.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-PROG-MP-0014	Reactor Safety Program	No
N-STD-OP-0017	Response to Transients	No

When an event is found to be a serious process failure or where the determination as to the cause and/or extent of condition has proved inconclusive (i.e. a serious process failure cannot be ruled out), a request for restart of the reactor shall be submitted in writing and approval to restart the reactor must be obtained from the CNSC.

If there is sufficient assurance that the cause of the serious process failure has been resolved and it is now safe to return the facility to service, a CNSC authorized person has the authority to give the consent to the licensee to proceed with the restart of the reactor. See the Introduction of the LCH for details on delegation of authority.

The written request for restart of the reactor shall include the following information:

- description of the event;
- causes of the event;
- consequences and safety significance of the event;
- recovery plan including corrective actions, and fitness for service assessment on the systems/components impacted from the failure if applicable, which shall be completed prior to reactor restart;

- a statement regarding plant readiness to resume safe operation, which shall include any conditions that the licensee proposes to impose upon reactor restart and/or subsequent reactor operation to ensure safe operation of the nuclear facility; and
- extent of completion of the conditions mentioned in the statement regarding plant readiness to resume safe operation.

Guidance:

In addition to the requirements listed above, the written request to restart a reactor after a serious process failure should also include the following information:

- a statement specifying that an assessment of the extent of condition which led or contributed to a serious process failure has been completed;
- documentation and communication to licensee staff addressing the root cause analysis, corrective actions and plant readiness to resume operation (including additional training, if necessary); and,
- applicable historical Operating Experience (OPEX) for review for comparable events (OPEX is further described in LC 1.1).

3.3 Reporting Requirements

Licence Condition 3.3:

The licensee shall notify and report in accordance with CNSC regulatory document REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants*.

Preamble:

CNSC regulatory document REGDOC-3.1.1 has comprehensive reporting requirements (scheduled and unscheduled) for operation of NPPs. It describes information that the CNSC needs to evaluate the performance of the facilities it regulates. This document is complementary to the reporting requirements in the *Nuclear Safety and Control Act* and the associated regulations, as well as to the additional reporting that may be required by specific projects and activities.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-PROC-RA-0005	Written Reporting to Regulatory Agencies	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	REGDOC-3.1.1	Reporting Requirements for Nuclear Power Plants, Version 2	2016	2016-01-01

Reporting and Trending

CNSC staff will evaluate whether the reporting requirements as specified by REGDOC-3.1.1 are met as part of the reporting and trending SpA; however, the most applicable SCA and SpA will be used to evaluate the information reported. In addition, information provided in accordance with REGDOC-3.1.1 will be evaluated under the Management System SCA (LC 1.1) and the SpA for performance assessment, improvement and management review, which includes assessment, self-assessment, independent assessment and problem identification and resolution. The following reports relate to the following sections of the LCH:

Quarterly Reports

- Safety Performance Indicators (applies to multiple SCAs/LCs);
- Nuclear Power Plant Pressure Boundaries (LC 5.2);
- Nuclear Power Plant Personnel (LC 2.4);

- Operational Security (LC 12.1);

Annual Reports

- Environmental Protection (LC 9.1);
- Research and Development (LC 4.1);
- Risk and Reliability (LC 7.1); and
- Fuel Monitoring and Inspection (LC 5.1).

Scheduled Specific Periodic Reports

- Updates to Facility Descriptions (LC G.3 and 5.1) and Final Safety Analysis Report (LC 4.1);
- Probabilistic Safety Assessment (LC 4.1);
- Site Environmental Risk Assessment (LC 9.1);
- Station Security Report (LC 12.1); and
- Proposed Decommissioning Plan (LC 11.2).

Event Reports and Notifications

- Preliminary Event Reports and Immediate Notifications (applies to multiple SCAs/LCs); and
- Detailed Event Reports (applies to multiple SCAs/LCs).

Events shall be assessed and reported per Event Notifications criteria as specified in Appendix A of REGDOC-3.1.1, and as clarified in CNSC document "*Interpretation of REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plant*" Rev. 0, provided in CNSC letter e-Doc 4860156.

Specific reporting provisions for outages under Situation No. 16 (a. to c.) in Table A.1 in REGDOC-3.1.1 refer to notifications for regulatory undertakings (NoRU) regarding:

- regulatory undertakings that will be completed during outages;
- changes to regulatory undertakings; and
- outage completion assurance statements (OCAS) confirming all regulatory undertakings were completed during the outage.

Regulatory undertakings for outages are included in the SpA for outage management performance under LC 3.1.

When reporting per the requirements under Situation/Event No. 18 in Table A.1 in REGDOC-3.1.1, the licensee shall include any non-compliance of applicable law at the federal, provincial or municipal level that pertains to the activities licensed under this licence and that has consequences for the environment, health and safety of persons, national security and/or compliance with international obligations to which Canada has agreed. It is unnecessary to report trivial non-compliances.

Sealed source tracking reports shall be filed under Situation/Event No. 25 in Table A.1 in REGDOC-3.1.1 within 48 hours of receipt or import. See LC 15.5 for more information on activities dealing with Cobalt-60 sealed sources.

Guidance:

To ensure consistency of reporting across the fleet of Canadian NPPs, CNSC staff have prepared a document, which provides additional clarification, "*Interpretation of REGDOC-3.1.1 Reporting Requirements for Nuclear Power Plants"* Rev. 0 (e-Doc 4525925).

4 SCA – SAFETY ANALYSIS

4.1 Safety Analysis Program

Licence Condition 4.1:

The licensee shall implement and maintain a safety analysis program.

Preamble:

A deterministic safety analysis evaluates the NPP's responses to events by using appropriate rules, models and assumptions. Deterministic safety analysis allows predicting extent of potential loads, such as temperatures and pressures, on reactor system and structures in assumed accident scenarios. REGDOC-2.4.1 sets out the objectives and requirements for deterministic safety analysis.

Probabilistic safety assessment (PSA) is a comprehensive and integrated assessment of the safety of the nuclear power plant that, by considering the initial plant state and the probability, progression, and consequences of equipment failures and operator response, derives numerical estimates of a consistent measure of the safety of the plant. Such assessments are most useful in assessing the relative level of safety. The objectives of the probabilistic safety analysis are stated in REGDOC-2.4.2.

The safety analysis SCA includes the following SpAs:

- Deterministic safety analysis;
- Hazard analysis;
- Probabilistic safety analysis (PSA);
- Criticality safety;
- Severe accident analysis; and
- Management of safety issues (including R&D).

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Deterministic Safety Analysis		
N-PROG-MP-0014	Reactor Safety Program	No
N-PROC-MP-0086	Safety Analysis Basis and Safety Report	No
N-PROG-MP-0006	Software	No

N-PROC-MP-0096	Use of Scientific, Engineering and Safety Analysis Software	No
Probabilistic Safety Analysis		
N-PROG-RA-0016	Risk and Reliability Program	No
N-STD-RA-0034	Preparation, Maintenance and Application of Probabilistic Risk Assessment	No
Severe Accident Analysis		
N-STD-MP-0019	Beyond Design Basis Accident Management	Yes
N-REP-03491-0650826	Updated Emergency Planning Technical Basis for Provincial Nuclear Emergency Response Plan	Yes
Management of Safety Issues (including R&D programs)		
N-STD-MP-0023	Technology and Research	No
N-PROC-MP-0092	Technology and Research Program Management	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	REGDOC-2.4.1	Deterministic Safety Analysis	2014	2015-12-18
CNSC	S-294	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	2005	2013-09-01
CNSC	REGDOC-2.4.2	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	2014	2020-12-31
CSA	N286.7	Quality assurance of analytical, scientific and design computer programs for nuclear power plants	2016	2018-09-01
AECB	1059	Reactor Licensing and Safety Requirements, Hurst and Boyd	1972	N/A

Deterministic Safety Analysis

The licensee shall conduct and maintain a deterministic safety analysis in accordance with applicable requirements and reflecting the actual plant design and conditions. The deterministic safety analysis must demonstrate that the radiological consequences of the postulated initiating events involving a single process failure and events involving a single process failure in conjunction with failure of one of the special safety systems do not exceed the accident-dependent reference public dose limits specified in Appendix A to AECB 1059 *Reactor Licensing and Safety Requirements*, Hurst and Boyd, 1972, otherwise known as the siting guide, and reproduced in the table, below.

	Individual Dose Limit		Population Dose Limit	
	Thyroid Dose (mSv)	Whole Body Dose (mSv)	Thyroid Dose (Person mSv)	Whole Body Dose (Person mSv)
Single Failure	30	5	10^5	10^5
Dual Failure	2500	250	10^7	10^7

Implementation Strategy for REGDOC-2.4.1

OPG has developed a REGDOC-2.4.1 implementation plan (e-Doc 5408759), which defines the REGDOC-2.4.1 compliant analyses to be undertaken in the 2018-2021 timeframe. For Pickering, the analysis scope includes revision of the Pickering Safety Report analyses for the large break LOCA (LBLOCA) events and loss of reactor power regulation (LORPR) events.

For Pickering, analysis for common mode events (CME) was completed; lacking CME analysis represented the single largest gap against REGDOC-2.4.1. A new section documenting the CME analysis is expected to be added into the Pickering NGS-A and Pickering NGS-B Safety reports in 2018 to demonstrate the plant design robustness to cope with CME.

The existing OPG Safety Report Update process *N-PROC-MP-0086* shall be followed to comply with the regulatory requirement of updating Safety Reports. If significant design or operational changes are to be made to the plant, the licensee shall update the deterministic safety analysis, while following requirements of REGDOC-2.4.1.

Hazard Analysis

A hazards analysis is used to demonstrate the ability of the design to effectively respond to common-cause events by confirming that the NPP design incorporates sufficient diversity and physical separation to cope with these events. It also confirms that credited SSCs are qualified to survive and can function as required during the event.

For Pickering NGS, 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.

Probabilistic Safety Analysis (PSA)

The licensee is in compliance with S-294 and expected to transition to REGDOC-2.4.2 by December 31, 2020. The planned PSA updates and the implementation strategy for REGDOC-2.4.2 are described in the table, below.

Scope	Requirements	Scheduled PSA Update
Pickering NGS-B PSA Update including detailed risk re-quantification	S-294	End of 2017 - Completed
Pickering NGS-A PSA Update including detailed risk re-quantification	S-294	End of 2018
Pickering NGS-A and -B Update (solely focusing on additional updated requirements of REGDOC-2.4.2 going beyond S-294	REGDOC-2.4.2	End of 2020

requirements, including for example, irradiated fuel bay risk assessment and other risk contributors of less significance)		
Pickering NGS-B PSA Update	REGDOC-2.4.2	End of 2022
Pickering NGS-A PSA Update	REGDOC-2.4.2	End of 2023

The licensee shall update the PSA if there are significant design or operational changes to the plant.

Criticality Safety

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

The Pickering NGS reactors use natural uranium fuel which cannot achieve a criticality in air or in light water. New fuel is stored in such a manner that it 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 of Pickering NGS.

Severe Accident Analysis

Severe accidents represent the set of accidents under beyond design basis accidents that involve significant fuel degradation, either in-core or in fuel storage. Severe accident analysis is performed to identify and characterize these types of accidents to ensure the design is balanced such that no particular design feature or event makes a dominant contribution to the frequency of severe accidents. The analysis can identify challenges to the plant presented by such events and identify equipment that can be included in the severe accident management guidelines.

REGDOC-2.4.1 requires performance of deterministic analysis of beyond design basis accidents (BDBA) to support the evaluation of safety goals (Level 1 and Level 2 PSA) and to demonstrate that the procedures/guidelines and equipment put in place to mitigate consequences of severe accidents can handle the severe accident management needs.

This type of analysis also demonstrates that the existing design, including the post-Fukushima enhancements, is effective to cope with BDBA, including severe accidents with core degradation and melt.

The following can be considered as analysis of BDBA:

- Analysis of low-probability (<10-5) duel-failure events included in the current Safety Reports;
- Recent assessments that consider the conditions beyond the plant original design basis (e.g., sensitivity cases recently performed for low-probability CME);
- MAAP-CANDU severe accident analyses as part of Level 1 and Level 2 PSA;
- MAAP-CANDU severe accident analyses to support the severe accident management technical basis; and
- BDBA/severe accident assessments (e.g., for in-vessel retention, hydrogen control and mitigation, containment performance, etc.) to address post-Fukushima questions and demonstrate the effectiveness of the design complementary features, including post-Fukushima enhancements for severe accident prevention, mitigation, and management.

Management of Safety Issues (including R&D Programs)

The management of safety issues SpA includes the following review topics:

- Research and Development (Clause 7.11.3 of CSA N286); and
- CANDU Safety Issues.

A Research and Development report is submitted annually in accordance with REGDOC-3.1.1 (see LC 3.3).

OPG is expected to continue R&D activities related to the performance of Passive Autocatalytic Recombiners (PARs) in H_2 and D_2 environments, steel oxidation and hydrogen/deuterium production, MAAP-CANDU modeling improvements, in-vessel retention, hydrogen source term estimation, and long-term monitoring capability for SAM. Completion of these R&D activities will strengthen capability of the nuclear power plant to withstand severe accident conditions.

CNSC staff will track progress on the ongoing R&D topics through either site specific action items or annual reporting under REGDOC-3.1.1.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
Deterministic Safety Analysis			
COG	09-9030	Principles & Guidelines For Deterministic Safety Analysis	R03
COG	11-9023	Guidelines for Application of the LOE/ROE Methodology to Deterministic Safety Analysis	R01
COG	06-9012	Guidelines for Application of the Best Estimate Analysis and Uncertainty (BEAU) Methodology to Licensing Analysis	R01
COG	08-2078	Principles and Guidelines for NOP/ROP Trip Setpoint Analysis for CANDU Reactors	R00
Probabilistic Safety Analysis			
CSA	N290.17	Probabilistic Safety Assessment for Nuclear Power Plants	2017
ASME	ASME/ANS RA-Sa-2013	Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, Addenda ASME/ANS RA-Sb-2013	2013
IAEA	SSG-3	Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants	2010

Guidance Publications			
Org	**Document #**	**Title**	**Version**
IAEA	SSG-4	Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants	2010
Criticality Safety			
CNSC	RD-327	Nuclear Criticality Safety	2010
CNSC	GD-327	Guidance for Nuclear Criticality Safety	2010

Deterministic Safety Analysis

The licensee should use the detailed methodologies and derived acceptance criteria for the conduct of deterministic safety analysis described in the COG documents included as guidance publications.

Updates to deterministic safety analysis should contain a revision summary sheet highlighting the key differences between the existing analyses and updated analysis. The revision summary should include:

- Summary of changes (key differences):
    - In acceptance criteria;
    - In event characterization;
    - In safety analysis assumptions;
    - In methodology, or in elements of a methodology;
    - In plant models;
    - In use of computer codes and embedded models;
    - In trip coverage.
- Reasons for updating the analysis and for updating models, assumptions, initial conditions or boundary conditions;
- Significance of changes, and their justification;
- Significant changes in results that may affect the conclusions of the analysis for the design; operational or emergency safety requirements for a particular situation or event; and
- Impact on operating and safety margins.

The licensee should maintain a Safety Report Basis consisting of Analysis of Record Items and supporting documents. The licensee should continue to provide CNSC staff with regular updates of the Analysis of Record indicating the submissions to be included in the next Safety Report update (Part 3).

When the deterministic safety analysis methodology is modified as a result of improved knowledge, or to address emerging issues, the licensee should assess the impact of such a modification on the operating limits, as well as procedural and administrative rules.

The licensee should not credit results obtained with a modified safety analysis methodology to relax operating conditions and/or change safety margins until the modification of the methodology has been reviewed by CNSC staff. If CNSC staff indicates that the modified methodology is appropriate, the licensee must still fulfill any other requirements or criteria associated with the changes to the operating conditions or safety margins. General criteria that CNSC will consider when reviewing such methodologies are provided in LC G.2.

In addition to industry standards, CNSC staff will refer to the applicable industry verification and validation process practices related to computer codes and software used to support the safe plant operation.

Probabilistic Safety Assessment

Periodic updates of the PSA should follow the guidance given in CSA N290.17, *Probabilistic Safety Assessment for Nuclear Power Plants*.

Severe Accident Analysis

Documentation of severe accident (also referred to as beyond design basis accident) analyses and assessments is currently not consolidated and centralized. REGDOC-2.4.1 section 4.5 provides the requirements for safety analysis documentation; however, the licensee should consider consolidating the existing and new analyses to improve the integration, maintenance, control and further updates to facilitate the regulatory review and verification.

5 SCA – PHYSICAL DESIGN

The physical design SCA includes the following SpAs:

- Design governance (LC 5.1);
- Site characterization (LC G.3, 4.1, 5.1);
- Facility design (LC G.3 and 5.1);
- Structure design (LC 5.1);
- System design (LC 5.1, 5.2, 5.3 10.2); and
- Component design (addressed under System design).

5.1 Design Program

Licence Condition 5.1:

The licensee shall implement and maintain a design program.

Preamble:

A design program ensures that the plant design is managed using a well-defined systematic approach. Implementing and maintaining a design program confirms that safety-related SSCs and any modifications to them continue to meet their design bases given new information arising over time and taking changes in the external environment into account. It also confirms that SSCs continue to be able to perform their safety functions under all plant states. An important cross-cutting element of a design program is design basis management.

A design program should be composed of elements that consider topics including but not limited to: pressure boundary design, civil structure design, seismic design, mechanical design, fuel design, core nuclear design, core thermal-hydraulic design, safety system design, fire protection design, electrical power system design, instrumentation and control system design, as well as equipment and structure qualification .

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
	Design Governance	
N-PROG-MP-0007	Conduct of Engineering	No
N-PROG-MP-0009	Design Management	No

N-PROG-MP-0006	Software	No
N-LIST-00590-00001	List of Significant Technical Changes from Code-Over-Code Review	Yes
See list of Written Notification Documents in the LCH, e-Doc 4027172	Code-Over-Code Reviews	Yes
Site Characterization		
P-REP-07701-00002	Predictive Effects Assessment For Pickering Nuclear Safe Storage	No
W-PROC-WM-0093	Planning for Decommissioning	No
System Design		
N-PROG-MA-0016	Fuel	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
Design Governance				
CSA	N286.7	Quality assurance of analytical, scientific and design computer programs for nuclear power plants	2016	2018-09-01
CSA	N290.12	Human factors in design for nuclear power plants	2014	2018-09-01
Structure Design				
CSA	N291	Requirements for safety-related structures for CANDU nuclear power plants	2008	2016-01-01

Design Governance

The design governance SpA includes the following review topics and requirements from CSA N286:

- Design Program:
  - Design process (Clauses 7.3, 7.3.1);
  - Design inputs (Clauses 7.3.2, 7.3.2 (a) to (t));
  - Design requirements (Clause 7.3.3);
  - Tools (Clause 7.3.4 as well as CSA N286.7);
  - Design (Clause 7.3.5);
  - Documents (Clause 7.3.6, 7.3.6 (a) to (g)); and

- Human factors in design (Clause 7.3.2 (k), as well as CSA N290.12).

The design of the existing nuclear facility including safety-related SSCs and any modification shall comply with applicable codes, standards and regulations including adequate consideration of human factors principles and practices in order to minimize the potential for human error and promote safe and reliable system performance through the consideration of human factors in the design of facilities, systems, and equipment.

The design basis for reliability targets shall meet the requirements in RD/GD-98 (LC 6.1).

OPG shall continue providing the CNSC with the code-over-code reviews conducted for any subsequent editions, addendums and/or updates of the codes and standards that were agreed upon, with OPG's assessment of the changes and their significance upon completion of the review and assessment of significance. OPG is required to submit such assessments on an annual basis. N-LIST-00590-00001, *List of Significant Technical Changes from Code-Over-Code Review*, identifies which requirements shall apply to design modifications.

The licensee shall ensure that plant design and changes to plant design are accurately reflected in the safety analysis. Furthermore, the licensee shall ensure that plant status changes (design modifications) are controlled such that the plant is maintained and modified within the limits prescribed by the design and licensing basis.

Aspects of design are considered safety and control measures if changes to them would:

- Invalidate the limits documented in the operating policies and principles or safe operating envelope referred to in LC 3.1,
- Introduce hazards different in nature or greater in probability or consequence than those considered by the safety analyses and probabilistic safety assessment and/or,
- Adversely impact other important safety and control measures, such as those related to operations, radiation protection, emergency preparedness, etc.

The licensee shall ensure that any changes to those aspects remain within the limits established by the licensing basis. Changes affecting the licensing basis (including those that would invalidate limits or introduce different hazards) require prior written approval by the Commission.The design program should minimize the potential for human error and promote safe and reliable system performance through the consideration of human factors in the design of facilities, systems, and equipment.

For proposed modifications, modern requirements that are consistent with the current licensing basis of the plant shall be applied to the extent practicable.

Site Characterization

The site characterization SpA includes the following review topics and requirements from CSA N286:

- Site selection (Clauses 7.2, 7.2 (a) to (f)) also see SpA for Hazard Analysis (LC 4.1);
- Relevant:
  - environmental assessments, environmental impact statements, geological, geotechnical, seismological, hydrological, hydrogeological and meteorological data;
  - site plan and description, and site reference data (LC G.3);

- exclusion zone authority and control (LC G.3); and
- proximity of industrial, transport and military facilities (LC G.3).

Facility Design

The facility design SpA includes the following review topics:

- Facility design includes, but is not limited to the following:
- Layout of the facility (LC G.3); and
- Site plan and description (LC G.3).

The licensee document that contains the facility description and the final safety analysis report is cited under LCs G.3 and 4.1, respectively.

Structure Design

The structure design SpA includes the following review topics:

- Structure design and modification (including repairs), which includes but is not limited to the following:
    - Concrete containment structures; and
    - Safety-related structures (CSA N291).

System Design

The system design SpA includes the following review topics:

- System design, which includes but is not limited to the following systems or specialized areas:
    - Pressure boundary program CSA N285.0 (LC 5.2);
    - Safety systems
    - Shutdown systems
    - Emergency core cooling systems
    - Containment system
    - Reactor control systems Electrical power and instrument air systems
    - Monitoring and display of nuclear power plant safety functions in the event of an accident
    - Fuel bundles and fuel assemblies;
    - Seismic design and qualification (CSA N289.1 – N289.5) (LC 5.3);
    - Environmental qualification of equipment (CSA N286 Clause 7.3.2 (e), CSA N290.13) (LC 5.3); and
    - Fire protection systems (CSA N293) (LC 10.2).

Special Safety Systems (SSS)

Modification of the special safety systems (Shutdown System 1, Shutdown System 2, Emergency Core Cooling System and Containment System) or significant changes to systems connected to the special safety systems would require prior notification and engagement of CNSC. When reviewing such changes, CNSC staff will use the criteria in Appendix A of e-Doc 4055483 and any other applicable criteria. Changes of the licensing basis in a potentially unsafe direction would require prior written notification. Prior notification is not required for changes to items that serve the same functional characteristics of the originally designed item and does not result in a change to operating procedures or safety system testing.

All changes or modifications, temporary or permanent, to the special safety systems (SSS) and systems related to safety (SRS) shall be identified in the annual reliability report. See LC 3.3 for details on reporting in accordance with REGDOC-3.1.1.

Electrical Power Systems and Instrumentation and Control (I&C) Systems

The plant electrical power system design shall include the safety classifications of the systems. Its design shall be adequate for all modes of operation under steady-state, voltage and frequency excursion, and transient conditions, as confirmed by electrical analysis. The electrical power systems shall be monitored and tested to demonstrate they comply with the design requirements and to verify the operability for AC systems and DC systems.

The licensee shall ensure that the plant overall instrumentation and control (I&C) system and electrical power systems is designed to satisfy the following:

- Plant level system classification;
- Separation requirements between the groups and channels;
- Safety features for enhancing system reliability and integrity are identified and implemented in the design, for example, fail safe design, redundancy, independence and testing capability;
- System is not vulnerable to common cause failures; and
- I&C and electrical power systems of safety systems meet the requirements of single failure criteria.

The licensee shall demonstrate survivability of the I&C systems and components that are critical to the management of BDBAs, and the availability of power supply to equipment and associated I&C necessary for management of BDBAs.

Fuel Bundles
Fuel bundles are important examples of designs that are considered safety and control measures. When considering possible design changes to fuel bundles the licensee shall engage CNSC staff reasonably in advance to confirm that the changes are within the licensing basis before implementing the change. Prior to making use of a new fuel bundle design in the reactor, design verification activities, analyses and testing are to be performed to demonstrate that design requirements are met. The length and complexities of those activities depend on the novelty of the design.

The annual report on fuel monitoring and inspection is submitted in accordance with REGDOC-3.1.1 (See LC 3.3). The details of this report are relevant to this SpA whereas the compliance with REGDOC-3.1.1 is considered to be part of the reporting and trending SpA (LC 3.3).

Reactor Core Design

The licensee shall update and maintain the reactor core nuclear design information found in the SOE documentation (LC 3.1), safety report (LC 4.1) and supporting design manuals. Core surveillance activities shall be implemented to ensure compliance with reactor core nuclear design and operation within the design envelope. Significant changes to core nuclear design would require prior notification and engagement of the CNSC. When reviewing such changes, CNSC staff will use the criteria in Appendix A of e-Doc 4055483 and any other applicable criteria.

Component design

Compliance verification criteria set out for system design also apply to component design.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
Design Governance			
CNSC	REGDOC-1.1.3	Licence Application Guide: Licence to Operate a Nuclear Power Plant	2017
CNSC	REGDOC-2.5.2	Design of Reactor Facilities: Nuclear Power Plants	2014
CSA	N291	Requirements for safety-related structures for CANDU nuclear power plants	2015
CNSC	G-276	Human Factors Engineering Program Plans	2003
CNSC	G-278	Human Factors Verification and Validation Plans	2003
System Design			
CSA	N290.0	General Requirements for Safety Systems of Nuclear Power Plants	2011
CSA	N290.1	Requirements for the shutdown systems of nuclear power plants	2013
CSA	N290.2	Requirements for emergency core cooling systems for nuclear plants	2011
CSA	N290.3	Requirements for the containment system of nuclear power plants	2016

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CSA	N290.4	Requirements for reactor control systems of nuclear power plants	2011
CSA	N290.5	Requirements for electrical power and instrument air systems of CANDU nuclear power plants	2006
CSA	N290.6	Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident	2009
CSA	N290.14	Qualification of Digital Hardware and Software for Use in Instrumentation and Control Applications for Nuclear Power Plants	2015

Design Governance

The design program should include, but is not limited to the following:

- Safety objectives, which include general nuclear safety objectives, radiation protection objectives, technical safety objectives and environmental protection objectives;
- Safety goals, which include qualitative and quantitative safety goals, core damage frequency, and small and large release frequencies;
- The identification of the design authority for the overall design (see also SpA for Organization under LC 1.1.). The design authority should have the authority to review, verify, approve (or reject), document the design changes and maintain design configuration control;
- The design approach for defence-in-depth including the approach adopted to include multiple and (to the extent practicable) independent levels and barriers for defence for all operational states including accidents;
- A systematic process throughout the design phase to show that the design meets all relevant safety requirements, and that the plant design process has followed proven engineering practices;
- Fundamental safety functions incorporated into the design including SSCs used to perform necessary safety functions; and
- Considerations for robustness against malevolent acts.

5.2 Pressure Boundary Program

Licence Condition 5.2:

The licensee shall implement and maintain a pressure boundary program and have in place a formal agreement with an Authorized Inspection Agency.

Preamble:

Pressure boundary is defined as a boundary of any pressure-retaining vessel, system or component of a nuclear or non-nuclear system, where the vessel, system or component is registered or eligible for registration.

A pressure boundary program is comprised of the many programs, processes and procedures and associated controls that are required to ensure compliance with all the requirements of CSA N285.0.

This LC also ensures that the Authorized Inspection Agency (AIA) will be subcontracted directly by the licensee. An AIA is an organization recognized by the CNSC as authorized to register designs and procedures, perform inspections, and other functions and activities as defined by the CSA N285.0 and its applicable referenced publications (e.g. CSA B51, ASME Boiler & Pressure Vessel Code, National Board Inspection Code). The AIA is accredited by the American Society of Mechanical Engineers (ASME) as stipulated by NCA-5121 of the ASME Boiler & Pressure Vessel Code. In order for the licensee to fulfill its obligations under this licence condition, it must obtain the services of an AIA to perform activities as defined by the relevant standards.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
System Design		
N-PROG-MP-0004	Pressure Boundary	Yes
N-PROC-MP-0040	System and Item Classification	Yes
N-PROC-MP-0082	Design Registration	Yes
N-MAN-01913.11-10000	Pressure Boundary Program Manual	No
N/A	Authorized Inspection Agency Service Agreement	Yes
N-LIST-00531-10003	Index to OPG Pressure Boundary Program Elements	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
System Design				
CSA	N285.0/N285.6	General requirements for pressure-retaining systems and components in CANDU nuclear power plants/Materials Standards for reactor components for CANDU nuclear power plants, issued June 2008 - Annex K and Annex M are accepted to be used as "Normative" Annexes.	2008 and Update No. 2* (August 2010)	2013-10-30
CSA	N285.0/N285.6	General requirements for pressure-retaining systems and components in CANDU nuclear power plants/ Materials Standards for reactor components for CANDU nuclear power plants, issued August 2012 – Annex N (only)	2012 and Update No. 1 (Sept. 2013)	2018-09-01
CSA	B51	Boiler, pressure vessel, and pressure piping code	2009 and Update No. 1 (March 2009)	2013-10-30
ASME	BPVC	ASME Boiler and Pressure Vessel Code with Addenda	2010 Edition with 2011 Addendum	2013-10-30
ASME	B31.1	Power Piping	2010	2013-10-30
ASME	B31.3	Process Piping	2010	2013-10-30
ASME	B31.5	Refrigeration Piping and Heat Transfer Components	2010	2013-10-30

CSA N285.0 includes references to other applicable codes and standards. Any additional CSA or ASME code references are included in the list only if they are not the version referred to in CSA N285.0-08.

Compliance Verification Criteria:

The pressure boundary program is a one of several review topics for the system design SpA, as discussed under LC 5.1. The licensee is responsible for all aspects of pressure boundary registration and inspections.

The following transitional provisions apply to CSA N285.0-08 with Update No. 2:

a) Work packages compliant with CSA N285.0-08 and Update No.1, being produced or underway prior to October 30, 2013 will remain valid for implementation until June 30, 2019.

b) Design modifications classified (approved by CNSC or using the OPG Classification procedure) after January 1, 2011 and before October 30, 2013, but no later than June 30, 2019, will be designed and installed to the CSA N285.0 and ASME edition or version specified in the System Classification List.

c) Purchase Orders compliant with CSA N285.0-08 and Update No. 1 issued prior to October 30, 2013 will remain valid for installation.

d) The code effective dates do not apply to “non design-related” requirements under the codes and standards listed above. CNSC may require OPG’s programs or processes to be updated for “non design-related” requirements to meet the new version of the standards once it is published.

The licensee shall maintain a pressure boundary program document roadmap in compliance with Annex N of CSA N285.0-12 and Update No. 1.

OPG is to provide the CNSC with the code-over-code reviews (See LC 5.1 for more information and WN of code-over-code reviews).

The licensee shall operate vessels, boilers, systems, piping, fittings, parts, components, and supports safely and maintain them in a safe condition. OPG shall:

- Follow work plans and procedures, accepted by the AIA, to test, maintain, or alter over-pressure protection devices;
- Comply with operating limits specified in certificates, orders, designs, overpressure protection reports, and applicable codes and standards; and
- Have any certified boiler or vessel that is in operation or use inspected and certified by an authorized inspector according to an accepted schedule.

Personnel conducting non-destructive examinations shall be certified in accordance with the edition of CAN/CGSB 48.9712/ISO 9712 currently adopted for use by the National Certification Body (NCB) of Natural Resources Canada for the appropriate examination method. If the NCB does not offer certification for a specific inspection method, the relevant alternate requirements of Clause 11.3 of CSA N285.0 shall apply to ensure that personnel are appropriately trained and qualified.

Classification, Registration and Reconciliation Procedures

Licensee procedures describing the classification, registration and reconciliation processes and the associated controls shall form part of the pressure boundary program. The licensee shall provide prior notification of any changes to the procedures describing the classification, registration and reconciliation processes.

Overpressure Protection Reports

The licensee shall provide WN to CNSC staff, of new or revised overpressure protection reports, after the final registration of the system.

Quality Assurance Program

The licensee’s pressure boundary quality assurance program shall comply with clause 10 of CSA N285.0 with the exception of sub-clause 10.2.6. Repair and replacement activities shall comply with sub clause 10.3 of CSA N285.0.

Classification and Registration of Fire Protection Systems

Fire protection systems and associated fittings and components are to be classified at least as Code Class 6, designed to the ASME B31.1 and registered, unless the exemption criteria noted below are met.

The following fittings and components may be exempt from requiring a Canadian Registration Number (CRN) provided they meet the following exemption criteria:

a) deluge, fire hose control, pressure control, drain, pre-action, alarm and dry pipe valves and devices, provided they are cUL or ULC (Underwriters Laboratory of Canada) listed and suitable for the expected environmental conditions and maximum pressure; or
b) fire and jockey pumps and their controllers that meet the requirements of the National Fire Protection Association (NFPA)-20, are cUL or ULC listed and are suitable for the expected environmental conditions and maximum pressure; or
c) sprinkler, nozzles, inductors, proportioners, hoses, strainers and other spray and distribution devices, that are cUL or ULC listed and suitable for the expected environmental conditions and maximum pressure; or
d) pressurized cylinders and tubes, such as extinguishers, inert gas and foam tanks, that bear Transport Canada approvals and suitable for the expected environmental conditions and maximum pressures; or
e) buried fire protection piping that is in compliance with NFPA-24.

Buried fire protection piping designed to the ASME piping code may be exempt from the ASME pressure testing requirements if testing is the pressure testing performed to NFPA-24.

The requirements of CSA N285.0 apply for components higher than Code Class 6.

Formal Agreement with an Authorized Inspection Agency (AIA)

The licensee shall always have in place a formal agreement with an AIA to provide services for the pressure boundaries of the nuclear facility as defined by CSA N285.0 and its applicable referenced publications. The AIA must be accredited by the ASME as stipulated by NCA-5121 of the ASME Boiler and Pressure Vessel Code.

Design registration services for pressure boundaries shall be provided by an AIA legally entitled under the Provincial Boilers and Pressure Vessels Acts and Regulations to register designs. Registration of piping systems shall be done by the Technical Standards and Safety Authority (TSSA), who is legally entitled to register designs in Ontario.

A copy of the signed agreement shall be provided to the CNSC. During the licence period, the licensee shall notify the CNSC in writing of any change to the terms and conditions of the agreement, including termination of the agreement.

The licensee shall arrange for the AIA inspectors to have access to all areas of the facility and records, and to the facilities and records of the licensee's pressure boundary contractors and material organizations, as necessary for the purposes of performing inspections and other activities required by the standards. Inspectors of the AIA shall be provided with information, reasonably in advance with notice and time necessary to plan and perform inspections and other activities required by the standards.

For a variance or deviation from the requirements of the CSA N285.0 standard, except as noted below, the licensee must first submit the proposed resolution to the AIA for evaluation, and then to the CNSC for consent. The licensee must demonstrate that meeting the code requirement is impracticable and the proposed resolution will provide adequate safety. Per the agreement with the AIA, the evaluated resolution shall not be implemented without the prior written consent of CNSC staff. A variance or deviation related to Code Edition, Code Classification, and Legacy Registration issues may be submitted directly to the CNSC without prior AIA evaluation. General criteria for obtaining prior written consent/approval for a proposed resolution from the CNSC can be found in LC G.2.

Guidance:

There is none provided.

5.3 Equipment and Structure Qualification Program

Licence Condition 5.3:

The licensee shall implement and maintain an equipment and structure qualification program.

Preamble:

Environmental qualification (EQ) ensures that all required equipment in a nuclear facility are qualified to perform their safety functions if exposed to harsh environmental conditions resulting from Design Basis Accidents (DBA) and that this capability is preserved for the life of the plant.

Seismic qualification (SQ) ensures that all seismically credited safety-related SSCs in a NPP are designed, installed and maintained to perform their safety function during and/or after (as needed and pre-defined) earthquakes.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-PROG-RA-0006	Environmental Qualification	No
N-STD-MP-0016	General Requirements for Seismic Qualification of OPG Nuclear Facilities	No
N-PROC-RA-0051	Environmental Qualification Lists	No
N-PROC-RA-0044	Environmental Qualification Assessment	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
Component Design				
CSA	N289.1	General requirements for seismic design and qualification of CANDU nuclear power plants	2008	TBD
CSA	N290.13	Environmental qualification of equipment for CANDU nuclear power plants	2005 & Update 1 (2009), Re-affirmed in 2015	2013-09-01

Environmental Qualification:

In addition to the criteria set out in N290.13, the EQ program shall include monitoring consisting of condition monitoring and environmental monitoring, to measure degradation and failures of qualified equipment, including cables. Condition monitoring assesses variables that indicate the physical state of the equipment, and assesses its ability to perform its intended function following the period of observation. Environmental monitoring measures environmental stressors, such as temperature, radiation and operational cycling during normal operating conditions.

Seismic Qualification:

Seismically credited safety-related SSCs in a nuclear facility shall be designed, installed and maintained to perform their safety function against earthquakes. Any changes to seismic qualification that impact the licensing basis would require prior notification of the CNSC.

The processes and procedures related to the SQ program shall:

- Identify the methods for establishing SQ, including code effective dates;
- Identify the SSCs for which evaluation of their capacity beyond the Design Basis Earthquake has been done;
- Identify the methods used for Beyond Design Basis Earthquake evaluation;
- Include procedural controls for periodic inspection and maintenance of conditions to ensure SQ of existing SSCs for the life of the plant;
- Identify the seismic monitoring system and its design and maintenance requirements; and
- Include procedural controls for establishing SQ for new and replacement items.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CSA	N289.2	Ground motion determination for seismic qualification of nuclear power plants	2010
CSA	N289.3	Design procedures for seismic qualification of nuclear power plants	2010
CSA	N289.4	Testing procedures for seismic qualification of nuclear power plant structures, systems, and components	2012
CSA	N289.5	Seismic instrumentation requirements for nuclear power plants and nuclear facilities	2012

6 SCA – FITNESS FOR SERVICE

6.1 Fitness for Service Program

Licence Condition 6.1:

The licensee shall implement and maintain a fitness for service program.

Preamble:

The fitness for service SCA includes the following SpAs:

- Equipment fitness for service/equipment performance (Reliability);
- Maintenance;
- Structural integrity (Addressed in other SpAs);
- Aging management;
- Chemistry control; and
- Periodic inspection and testing.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Equipment Fitness for Service/Equipment Performance (Reliability)		
N-PROG-MA-0026	Equipment Reliability	No
N-PROG-RA-0016	Risk and Reliability Program	No
N-STD-RA-0033	Reliability and Monitoring of Systems Important to Safety	No
P-REP-03611-00012	PNGS Systems and Components Important to Safety	Yes
P-LIST-06937-00001	Pickering A and B List of Safety Related Systems	Yes
Maintenance		
I-PROG-AS-0001	Conduct of Inspection and Maintenance Services	No
N-PROG-MA-0004	Conduct of Maintenance	No

N-PROG-MA-0017	Component and Equipment Surveillance	Yes
N-PROG-MA-0025	Major Components	No
N-PROC-MA-0024	System Performance Monitoring	No
Aging Management		
N-PROG-MP-0008	Integrated Aging Management	No
N-PROC-MP-0060	Aging Management Process	No
N-STD-MA-0024	Obsolescence Management	No
N-PLAN-01060-10003	Reactor Components and Structures Life Cycle Management Plan	Yes
N-PLAN-01060-10008	Reactor Components and Structures Life Cycle Management Plan: Technical Basis Document	No
N-PROC-MA-0044	Fuel Channel Life Cycle Management	No
N-PLAN-01060-10002	Fuel Channels Life Cycle Management Plan	Yes
N-PLAN-01060-10001	Feeders Life Cycle Management Plan	Yes
N-PLAN-01060-10007	Feeders Life Cycle Management Plan: Technical Basis Document	No
N-PLAN-33110-10009	Steam Generators Life Cycle Management Plan	Yes
NA44-PLAN-33110-10003	Pickering Units 1 and 4 Steam Generator Life Cycle Management Plan (Except Appendix B)	No
NK30-PLAN-33110-10008	Pickering Units 5-8 Steam Generator Life Cycle Management Plan (excluding Sheet Sections 001 to 007)	No
N-PLAN-01060-10004	Aging Management Plan for Containment Structures	Yes
NA44-PLAN-34220-00002	Life Cycle and Aging Management Program Plan for Fiberglass-Reinforced Plastic Components in the Pickering NGS Vacuum Building	Yes
Chemistry Control		
N-PROG-OP-0004	Chemistry	No
Periodic Inspection and Testing		
I-STD-AS-0003	Non-Destructive Examination	No
I-PROG-AS-0001	Conduct of Inspection and Maintenance Services	No
N-PROC-MA-0052	Flaw Dispositioning	No

General Pressure Boundaries		
NA44-PIP-03641.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Plan For Unit 1	Yes
NA44-PIP-03641.2-00007	Pickering Nuclear Generating Station A Periodic Inspection Plan For Unit 4	Yes
NK30-PIP-03641.2-00001	Pickering B Periodic Inspection Program Unit 5	Yes
NK30-PIP-03641.2-00002	Pickering B Periodic Inspection Program Unit 6	Yes
NK30-PIP-03641.2-00003	Pickering B Periodic Inspection Program Unit 7	Yes
NK30-PIP-03641.2-00004	Pickering B Periodic Inspection Program Unit 8	Yes
Fuel Channels		
N-REP-31100-10041	Acceptance Criteria and Evaluation Procedures for Material Surveillance Pressure Tube	Yes
NA44-PIP-31100-00001	Pickering Nuclear 1-4, Unit 1 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	Yes
NA44-PIP-31100-00004	Pickering Nuclear 1-4, Unit 4 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	Yes
NK30-PIP-31100-00001	Pickering Nuclear 5-8, Unit 5 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	Yes
NK30-PIP-31100-00002	Pickering Nuclear 5-8, Unit 6 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	Yes
NK30-PIP-31100-00003	Pickering Nuclear 5-8, Unit 7 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	Yes
NK30-PIP-31100-00004	Pickering Nuclear 5-8, Unit 8 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	Yes
N-REP-31100-10061	Compliance Plan for Long-Term Use of CSA N285.8 For In-Service Evaluation of Zirconium Alloy Pressure Tubes	Yes
Feeders		
NA44-PIP-33126-00002	Pickering Nuclear Unit 1 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	Yes
NA44-PIP-33126-00001	Pickering Nuclear Unit 4 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	Yes
NK30-PIP-33126-00001	Pickering Nuclear Unit 5 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	Yes

NK30-PIP-33126-00002	Pickering Nuclear Unit 6 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	Yes
NK30-PIP-33126-00003	Pickering Nuclear Unit 7 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	Yes
NK30-PIP-33126-00004	Pickering Nuclear Unit 8 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	Yes
COG-JP-4107-V06	Fitness-for-Service Guidelines for Feeders in CANDU Reactors	Yes
Steam Generators		
Appendix B in NA44-PLAN-33110-10003	Pickering Units 1 and 4 Steam Generator Life Cycle Management Plan - Appendix B: Pickering Units 1 and 4 Steam Generators In-Service Inspection Plan	Yes
NK30-PLAN-33110-10008 Sheet Section 006	Pickering Units 5-8 In-Service Inspection Plan	Yes
COG Report 07-4089	Fitness-For-Service Guidelines for Steam Generator and Preheater Tubes	Yes
Containment Components		
NA44-PIP-03642.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Program For Containment Components	Yes
NK30-PIP-03642.2-00001	Pickering Nuclear Generating Station “B” Periodic Inspection Program For Containment Components	Yes
P-PIP-03642.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Program For Unit 0 Containment Components	Yes
Concrete Containment Structures		
N-PROC-MA-0066	Administrative Requirements for In-Service Examination and Testing for Concrete Containment Structures	Yes
NA44-PIP-03643.2-00001	Pickering Nuclear GSA – Reactor Building Periodic Inspection Program	Yes
NK30-PIP-03643.2-00001	Pickering Nuclear GSB – Reactor Building Periodic Inspection Program	Yes
NA44-PIP-03643.2-00002	Pickering Nuclear GS – PRD & VB Periodic Inspection Program	Yes
NA44-PIP-03643.2-00003	Pickering Nuclear GS – Vacuum Building Post	Yes

	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	Yes
NA44-REP-25100-00009	Pickering NGS Vacuum Building In-service Leakage Rate Test Requirements in Accordance with CSA N287.7-08	Yes
Balance of Plant		
N-PROC-MP-0060	Aging Management Process	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
Equipment Fitness for Service/Equipment Performance (Reliability)				
CNSC	RD/GD-98	Reliability Programs for Nuclear Power Plants	2012	2013-09-01
Maintenance				
CNSC	RD/GD-210	Maintenance Programs for Nuclear Power Plants	2012	2018-09-01
Aging Management				
CNSC	REGDOC 2.6.3	Aging Management	2014	2017-07-15
Periodic Inspection and Testing				
CSA	N285.4	Periodic Inspection of CANDU Nuclear Power Plant Components	2005	2013-09-01
CSA	N285.4	Periodic Inspection of CANDU Nuclear Power Plant Components	2014 and Update No. 1 May 2016	TBD
CSA	N285.8	Technical Requirements for In-Service Inspection Evaluation of Zirconium Alloy in Pressure Tubes in CANDU Reactors	2015	2016-12-05
CSA	N285.5	Periodic Inspection of CANDU Nuclear Power Plant Containment Components	2008	2013-09-01
CSA	N285.5	Periodic Inspection of CANDU Nuclear Power Plant Containment Components	2013	TBD
CSA	N287.1*	General requirements for concrete containment structures for nuclear power plants	2014	2013-09-01

CSA	N287.2*	Material requirements for concrete containment structures for CANDU nuclear power plants	2008	2013-09-01
CSA	N287.7	In-service Examination and Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants	2008	2013-09-01
CSA	N291	Requirements for safety-related structures for CANDU nuclear power plants	2008	TBD

** The CSA N287.1 and N287.2 are required by CSA N287.7 Clauses 5.3.1 (qualified personnel) and 6.5.1(repair materials).*

Equipment Fitness for Service/Equipment Performance (Reliability)

The equipment fitness for service/equipment performance relates to the reliability of the facility's SSCs. These requirements help to assure that the systems important to safety (SIS) can meet their defined design, and performance criteria throughout the lifetime of the facility.

The equipment fitness for service/equipment performance SpA includes the following review topics and requirements from CSA N286 (clauses identified below) and RD/GD-98:

- Reliability Program (N286 Clauses 7.9.5, 7.9.5 (a) – (d)):
    - Systems Important to Safety (SIS);
    - Reliability of SIS;
    - Reliability Targets; and
    - Reliability Assessments.

<u>Reliability Program</u>

The licensee shall establish a reliability program in accordance with RD/GD-98 that includes setting reliability targets, performing reliability assessments, testing and monitoring, and reporting for plant systems whose failure affect the risk of a release of radioactive or hazardous material.

<u>Systems Important to Safety and Reliability Targets</u>

OPG has developed the lists of systems important to safety for both Pickering NGS-A and Pickering NGS-B as required by RD/GD-98. The systems important to safety, along with their unavailability target, are documented in P-REP-03611-00012 "*PNGS Systems and Components Important to Safety*".

CNSC staff will review the annual report on risk and reliability required by REGDOC-3.1.1 to ensure the performance of systems important to safety meets their reliability requirements and if not, that the licensee has taken appropriate corrective actions. See LC 3.3 for more information on this report.

Maintenance Program

A nuclear power plant maintenance program consists of policies, processes and procedures that provide direction for maintaining SSCs of the plant. The intent of a maintenance program is to ensure that the

SSCs remain capable of maintaining their function as described in the safety analysis. A maintenance program uses organized activities, both administrative and technical, to keep SSCs in good operating condition, and to ensure that they function as per design.

The maintenance SpA includes the following review topics and requirements from CSA N286 (clauses identified below) and RD/GD-210:

- Maintenance Program (Clauses 7.9.9, 7.9.9 (a) – (d)):
  - Work management (Clauses 4.8, 4.8.1, 4.8.2, 4.8.3);
  - Preventive Maintenance;
  - Corrective Maintenance;
  - System Health Monitoring (7.9.10, 7.9.10 (a) – (c), 7.9.4, 7.9.4 (a) – (c)); and
  - Maintenance records (Clause 4.7.4).

Aging Management

The aging management SpA includes the following review topics and requirements:

- Integrated Aging Management (REGDOC-2.6.3):
  - Lifecycle Management:
    - Major pressure boundary components (fuel channels, feeders and steam generators) and reactor components and structures;
    - Concrete Containment Structures; and
  - Periodic Inspection (See SpA for Periodic Inspection).

Aging management is comprised of activities (engineering, operational, inspection, and maintenance actions) implemented proactively to ensure the reliability and availability of required safety functions of SSCs throughout the life of a nuclear power plant. Consistent with the intent of the *Class I Nuclear Facilities Regulations*, licensees are expected to establish, implement, and improve programs for managing aging, including obsolescence, of SSCs to ensure that required safety functions are maintained.

Managing the aging effects of a reactor facility is necessary to ensure the availability of required safety functions throughout the facility's service life, with consideration given to changes that occur over time and with use. This requires addressing both physical aging and obsolescence of SSCs that can, directly or indirectly, have an adverse effect on the safe operation of the reactor facility.

OPG shall submit to the CNSC proposed programmatic changes to aging management plans with a notification period increased to 60 days prior to their planned implementation. Administrative changes to these plans are subject to normal notification requirements as indicated in the written notification table for this section. The aging management plans are also subject to the integrated implementation plan actions, which are detail under LC 15.1.

<u>Fuel Channel Aging Management</u>

The current operating limit for the Pickering NGS-A Units 1 and 4 pressure tubes is 182,000 and 159,000 Effective Full Power Hours (EFPH), respectively. The current operating limit for Pickering NGS-B Units

5 to 8 pressure tubes is 295,000 EFPH for the lead Unit, which was approved by the Commission on Month Date Year. For further details see the Record of Decision, e-Doc xxxxxxx.

Continued use of Fracture Toughness Model(s)

Licensee shall submit an impact assessment for CSA N285.8-15 Clause 7 evaluations whenever a fracture toughness test result challenges the model's lower prediction bound, and where the model is applied in the Clause 7 evaluation(s).

Validation of the Cohesive Zone-based Fracture Toughness Model (Clause D13.2.3 of CSA N285.8-15)

To support the use of the Cohesive Zone-based fracture toughness model specified in Annex D of CSA N285.8-15 the licensee shall, by December 15, 2018:

- submit (for CNSC staff acceptance) a quantitative assessment of uncertainties in the Model; and
- submit a Research and Development (R&D) test plan, including the test schedule to improve understanding of the fracture toughness at the front end of pressure tubes, and to provide the necessary support for the Cohesive Zone-based model validation for the front end region of pressure tubes.

The licensee shall, on a semi-annual basis submit the following until all the activities under the R&D test plan have been completed:

- the latest fracture toughness test results from the executed R&D test plan pertaining to the Cohesive Zone-based fracture toughness Model;
- an assessment of the fracture toughness test results against the applicable model predictions; and
- any updates to the test plan and schedule.

Specific CVC for Pickering pressure tubes predicted to exceed an Heq concentration of 120 parts per million is included under LC 15.3.

Chemistry Control

The licensee's chemistry control SpA includes the following review topics and requirements from CSA N286:

- Chemistry Control Program (Clauses 7.9.11, 7.9.11 (a) – (c)):
  - Preserve integrity of SSCs important to safety;
  - Manage the harmful effects of chemical impurities and corrosion on plant SSCs; and
  - Implement the ALARA principle to manage the buildup of radioactive material and occupational radiation exposure.
  - Limit the release of chemicals and radioactive materials to the environment.
- Chemical Surveillance (effectiveness of chemistry control in plant systems):

- Chemical parameters;
- Operational specifications;
- Parameter monitoring, measurement and sampling including post-accident sampling; and
- Trending.

- Chemistry Specifications for systems, and
- Storage and Handling.

Chemistry Control and Monitoring Program

Chemistry control and monitoring program establishes processes and overall requirements to ensure effective control and monitoring of plant chemistry during operational and lay-up conditions, to ensure critical plant equipment performs safely and reliably over the life of the stations.

The chemistry control program shall specify processes, specifications, overall requirements, parameter monitoring, data trending and evaluation to ensure effective control of plant chemistry during operational and lay-up conditions.

The licensee shall also maintain a set of technical basis documents for chemistry control and monitoring.

Periodic Inspection and Testing

The purpose of a periodic inspection program (PIP) or an in-service inspection (ISI) program is to provide assurance that the likelihood of a failure that could endanger the environment and/or radiological health and safety of persons has not increased significantly since the plant was put into service.

The periodic inspection and testing SpA includes the following review topics and requirements:

- Periodic Inspection/In-Service Inspection:
    - General Pressure Boundaries (CSA N285.4);
    - Fuel Channels (CSA N285.4);
    - Feeders (CSA N285.4);
    - Steam Generators (CSA N285.4);
    - Containment Components (CSA N285.5);
    - Concrete Containment Structures (CSA N287 Series);
    - Safety-related Structures (CSA N291); and
    - Balance of Plant Systems and Components.

Periodic and in-service inspection programs are established to confirm that pressure-boundary components; containment structures and components, continue to meet their design requirements. The condition of safety significant balance of plant pressure retaining systems and components, as well as, safety-related structures are monitored for degradation through in-service inspection programs.

Personnel conducting non-destructive examinations shall be certified in accordance with the edition of CAN/CGSB 48.9712/ISO 9712 currently adopted for use by the National Certification Body (NCB) of

Natural Resources Canada for the appropriate examination method. If the NCB does not offer certification for a specific inspection method, the relevant alternate requirements of Clause 5 of CSA N285.4 or Clause 6 of N285.5 shall apply to ensure that personnel are appropriately trained and qualified.

OPG shall prepare, update and revise, as necessary, PIP documents in accordance with the requirements of the applicable CSA Standards listed in the licence condition. The currently accepted PIP documents are listed in the written notification table for this section. Revisions to OPG's PIP documents require CNSC acceptance prior to implementation.

OPG shall carry out periodic inspections in accordance with CNSC accepted PIP documents. If a deviation from the accepted PIP program is anticipated during inspection planning activities, OPG shall obtain CNSC acceptance prior to conducting the affected inspection. However, for any findings, discoveries or deviations from the accepted PIP that are identified during an inspection, OPG shall inform the CNSC and provide justification in the corresponding inspection report submission.

CVC Related to CSA N285.4-05 and N285.4-14

Permanent exemptions to the requirements of the standard that receive regulatory acceptance shall be incorporated, including supporting technical basis, into the PIP documents, listed in the "Written Notification" table for this section.

OPG shall disposition all gaps as committed in December 15, 2017 letter (e-Doc 5419126) concerning compliance with the requirements of CSA N285.4-14 Update No. 1. OPG shall submit the disposition for CNSC staff review and acceptance by June 29, 2018. A transition plan to adopt any required safety improvements deemed necessary should be included in the submission.

If it is determined that deterioration related to erosion-corrosion or environmentally assisted cracking is credible on systems covered by the current PIPs at the Pickering units, OPG shall evaluate the need to adopt the requirements of Clauses 7.4.7 or 7.4.8 of CSA N285.4-14 Update No. 1 into their existing PIP and submit the evaluation for CNSC staff review and acceptance.

General Pressure Boundaries (N285.4 Clauses 3 to 11):

CNSC staff have accepted the Pickering-A NGS PIP documents (e-Doc 3345880) and the Pickering-B NGS PIP documents (e-Doc 1379036).

Fuel Channel (FC) Pressure Tubes (PT) (CSA N285.4 Clause 12):

CNSC staff have accepted the Pickering NGS-A and the Pickering-B NGS PIP documents (e-Doc 4190308).

Evaluation of results and dispositions for Pickering NGS pressure tubes

With respect to N285.4-05 clause 12.2.5.1.3, CNSC staff have accepted (e-Doc 5126091) with conditions, the OPG's revised compliance plan N-REP-31100-10061 R002 (N-CORR-00531-17932, e-Doc 4895642) for the use of CSA N285.8-15 "In-Service Evaluation of Zirconium Alloy Pressure Tubes", as the evaluation method used for the fitness-for-service assessment of the Fuel Channels in Pickering 1 & 4 and 5 to 8 units.

Pressure Tube-Calandria Tube (PT-CT) contact assessment for Pickering NGS-B inspected channels

With respect to N285.4-05 clause 12.2.5.2.3 (d), when PT-CT contact cannot be precluded, a disposition following a CNSC accepted methodology is required. The licensee shall use "Heq concentration less than Blister Formation Threshold" as the evaluation failure criteria. Further, the maximum allowable evaluation period shall not exceed two hot years, from the last Body-of-Tube Heq concentration measurement in the affected Unit (or otherwise justified).

Licensee may operate a unit beyond the maximum evaluation period of two hot years, provided that a "time at risk" assessment is performed for the requested extension of the evaluation period, and submitted to the CNSC for acceptance. The "time at risk" assessment shall demonstrate that the predicted hydride blister depth will be less than 0.10 mm when the tube-specific Heq is unknown at the start of the evaluation period, and 0.15 mm when the tube-specific Heq is known at the start of the evaluation period.

PT Flaw Assessments (hydrided region overload)

With respect to CSA N285.8-15 Clause 5.4.3.1 (g), regarding the evaluation of the initiation of delayed hydride cracking of detected flaws during Service Level B transients , due to fracture of hydrided region, OPG has submitted a short term and long term plan (e-Doc 5223024).

PT Material Testing

With respect to N285.4-05 clause 12.4.4.2, CNSC staff have accepted (e-Doc 3895468) OPG's procedural updates and technical justifications for pressure tube material testing submitted in e-Doc 3848127, N-CORR-00531-05488.

Probabilistic Leak-Before-Break (PLBB) Assessments (CSA N285.8)

With respect to Clause 7.4.3.2 of CSA N285.8-15, the maximum allowable conditional probability over the evaluation period of pressure tube failure caused by a growing axial crack exceeding the critical crack length during the sequence of events from pressure tube through-wall penetration to reactor shutdown shall be less than or equal to 0.10 ruptures per through-wall crack, This applies to the assessed most limiting pressure tube in the reactor core. CNSC staff reserve the right to revisit the acceptance criterion periodically, and to make adjustments as needed.

Disposition of pressure tubes with high Heq concentrations

Licensee shall disposition any pressure tube with observed or predicted Heq concentration that exceeds the limits specified in Clause 8.2(a) of CSA N285.8-15 for an evaluation period.

Fuel Channel Feeder Pipes (N285.4 Clause 13):

CNSC staff have accepted the Pickering NGS-A PIP and the Pickering NGS-B PIP documents (e-Doc 5331943 and 4780461).

With respect to N285.4-05 clause 13.2.5.1.3, CNSC staff have accepted OPG's request to use the updated feeder fitness-for-service guidelines: COG-JP-4107-V06 Revision 3, "Fitness-for-Service Guidelines (FFSG) for Feeders in CANDU Reactors" (e-Doc 3922168 and e-Doc 4001054).

Steam Generator Tubes (N285.4 Clause 14):

CNSC staff have accepted the Pickering NGS-A PIP documents (e-Doc 3570040) and the Pickering NGS-B PIP documents (e-Doc 3567593) subject to the following exemptions:

CNSC staff have accepted the *"performance based disposition process*" (e-Doc 3615950) for steam generator inspections and dispositions, which allows the restart of the NGS without a formal CNSC approval of the disposition before restart, subject to an agreed upon set of conditions. Under this process, OPG will analyze and assess the inspection results and disposition the findings using the applicable FFSG. Prior to returning the steam generators to service, OPG is required to confirm, in writing, that the current CNSC accepted disposition for the unit has not been invalidated by the latest inspection findings.

With respect to N285.4-05 clause 14.2.5.1.3, CNSC staff have accepted OPG's request to use COG Report 07-4089 R1"Fitness-for-Service Guidelines for Steam Generator and Preheater Tubes, with one exception pertaining to the use of the Level D safety factors stipulated in ID 2.3.2.2 Paragraph (a), *Deterministic Leak-Before-Break,* to other load levels (levels A, B, C) and any other portions of the FFSG that invoke the use of ID-2.3.2.2 (See CNSC letter e-Doc 4298097). Instead, OPG is required to continue using the safety factors defined in ID 2.3.2.2 Paragraph (a) of Revision 0 of the fitness-for-service guidelines for the appropriate load levels.

CVC Related to CSA N285.5-08

CNSC staff have accepted the Pickering NGS A, B and Unit 0 PIP Programs meeting the requirements of N285.5-08 (e-Doc 4038995).

CVC Related to CSA N287.7-08

CNSC staff have accepted the Pickering NGS-A and B PIP documents (e-Doc 4452432).

OPG shall carry out the inspections and tests of the vacuum building, the dousing system and the pressure relief duct at least once every ten years. The next inspections and tests for these structures shall be carried out before December 31, 2020 and shall be in accordance with the requirements of CSA N287.7-08.

OPG shall perform a test to measure the leakage rate, at full design pressure, of the operating reactor buildings and inspect the reactor building concrete structures and components of all units once every six years.

The leakage rate test schedule for Pickering NGS-A units is as follows:

- Unit 1 before the end of 2023
- Unit 4 before the end of 2022

The leakage rate test schedule for Pickering NGS-B units is as follows:

- Unit 5, before the end of 2023
- Unit 6, before the end of June 2018 (see CNSC letter, e-Doc 5308799)
- Unit 7, before the end of December 2018
- Unit 8, before the end of 2022

In-Service Inspection of Safety-Related Structures (CSA N291)

For safety-significant safety-related structure(s) OPG shall implement and maintain an in-service inspection program(s) in accordance with industry best practices.

The licensee shall have adequate knowledge of the current state of safety-related structures to ensure that they are capable of operating within their design intent and perform required safety functions if called upon.

The licensee shall develop, implement and maintain in-service inspection program(s) and LCMPs for BOP safety-related structures, excluding concrete containment structures in accordance with CSA N291 *Requirements for safety-related structures for CANDU nuclear power plants*, keeping with industry best practices.

The in-service inspection program(s) developed to satisfy this licence requirement will ensure safety-related structures are monitored for credible degradation.

In-Service Inspection of Balance of Plant Systems and Components

For safety-significant BOP pressure retaining systems and components OPG shall implement and maintain an in-service inspection program(s) in accordance with industry best practices.

The licensee shall have adequate knowledge of the current state of BOP pressure retaining systems, components to ensure that they are capable of operating within their design intent and perform the required safety functions if called upon.

The licensee shall develop, implement and maintain in-service inspection program(s) and LCMPs for safety-significant BOP pressure retaining systems and components, keeping with industry best practices.

The in-service inspection program(s) developed to satisfy this licence requirement will ensure balance-of-plant (BOP) safety-significant pressure retaining systems and components are monitored for credible degradation.

Under normal operation and upset conditions, the plant safety analyses may take direct and/or indirect credit for the operation of some of the BOP SSCs, which are outside the scope of CSA N285.4, CSA N285.5 and CSA N287.7 standards and not inspected in accordance with these standards. The condition of these SSCs may have an indirect, but significant, impact on nuclear safety if they are permitted to degrade over time.

These programs shall incorporate the inspection requirements for SSCs important to safety based upon industry best practices appropriate to the design and operation of the SSCs.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	REGDOC-2.6.1	Reliability Programs for Nuclear Power Plants	2017
CNSC	REGDOC-2.6.2	Maintenance Programs for Nuclear Power Plants	2017
CSA	N287.1	General requirements for concrete containment structures for nuclear power plants	2014
CSA	N287.2	Material requirements for concrete containment structures for CANDU nuclear power plants	2008
CSA	N287.3	Design requirements for concrete containment structures for nuclear power plants	2014
CSA	N287.4	Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants	2008
CSA	N287.5	Examination and testing requirements for concrete containment structures for nuclear power plants	2011

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CSA	N287.8	Aging Management for Concrete Containment Structures for Nuclear Power Plants	2015
CSA	N285.7	Periodic Inspection of CANDU Nuclear Power Plants Balance of Plant Systems and Components	2015
CSA	N291	Requirements for safety-related structures for CANDU nuclear power plants	2015
CNSC	REGDOC-1.1.3	Licence Application Guide: Licence to Operate a Nuclear Power Plant	2017

Maintenance

The scope of the maintenance program covers all SSCs within the bounds of the nuclear power plant, which includes activities for monitoring, inspecting, testing, assessing, calibrating, servicing, overhauling, repairing, and parts replacing. The type of maintenance activity and frequency applied to each SSC should be commensurate with importance to safety, design function and required performance.

Aging Management

For balance of plant pressure boundary component inspection programs non-destructive examination (NDE) procedures used in the Components and Equipment Surveillance sub-program should be developed and implemented using a level of rigour consistent with the safety significance of systems and components and the nature of the degradation. For NDE procedures necessary to carry out inspections in the BOP programs, guidance may be obtained from NDE requirements for the PIP program addressed in CSA N285.4.

Disposition of pressure tubes with high Heq concentrations

To disposition any pressure tube(s) predicted to exceed the limits specified in Clause 8.2(a) of CSA N285.8-15, OPG may perform an in-service inspection (volumetric, Heq measurement) of the subject pressure tube(s). The inclusion of volumetric inspections for high Heq concentration tubes in the periodic inspection plan will not preclude the requirement to disposition the results of Heq concentration measurements in accordance with the requirements of Clause 12.3.5 and 12.4.5 of CSA N285.4.

Further, OPG is expected to provide technical justification for the substitution (if any) of pressure tubes identified for inspection during the periodic inspection interval.

Periodic Inspection and Testing

Balance of Plant Pressure Retaining Components

Given the limited planned operating time remaining for the Pickering NGS it would be impractical for OPG to develop and implement a CSA N285.7-15 compliant periodic inspection program for balance of plant pressure boundary components. However, the licensee should be capable of demonstrating that existing inspection programs meet the objectives of the CSA standard.

7 SCA – RADIATION PROTECTION

7.1 Radiation Protection Program and Action Levels

Licence Condition 7.1:

The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

Preamble:

The *Radiation Protection Regulations* require that the licensee implement a radiation protection program and also ascertain and record doses for each person who perform any duties in connection with any activity that is authorized by the *NSCA* or is present at a place where that activity is carried on. This program must ensure that doses to persons (including workers) do not exceed prescribed dose limits and are kept As Low As Reasonably Achievable (the ALARA principle), social and economic factors being taken into account.

The regulatory dose limits to workers and the general public are explicitly provided in sections 13, 14 and 15 of the *Radiation Protection Regulations*.

Specific regulatory requirements related to the implementation of all aspects of a radiation protection program, including action levels, are found in the *Radiation Protection Regulations*, *Class I Nuclear Facilities Regulations*, *General Nuclear Safety and Control Regulations*, *Nuclear Substances Radiation Devices Regulations*, REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* (LC 3.3), and CSA N286, *Management Systems Requirements for Nuclear Power Plants* (LC 1.1.). For this licence, the compliance verification criteria are identified in these requirements as well as in the compliance verification criteria below.

In accordance with the CNSC regulatory framework, the Safety and Control Area "*Radiation Protection*" covers the implementation of a radiation protection program as required by the Radiation Protection Regulations.

The radiation protection SCA includes the following SpAs:

- Application of ALARA;
- Worker dose control;
- Radiation protection program performance;
- Radiological hazard control; and
- Estimated dose to public.

The development of the action levels referred to in the LC is captured in the radiation protection program performance SpA.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-PROG-RA-0013	Radiation Protection	Yes
N-STD-RA-0018	Controlling Exposure As Low As Reasonably Achievable	No
N-REP-03420-10001	Occupational Radiation Protection Action Levels for Power Reactor Operating Licences	Yes
N-PROC-RA-0019	Dose Limits and Exposure Control	Yes
N-MAN-03416-10000	Radiation Dosimetry Program – General Requirements	No
OPG-PROC-0132	Respiratory Protection	No

Application of ALARA

The purpose of this specific area is to verify efforts towards maintaining radiation doses ALARA, social and economic factors taken into account. Review topics captured in this specific area include:

- ALARA in design of facilities, processes, structures, systems and components;
- ALARA optimization process; and
- ALARA program.

Worker Dose Control

The purpose of this specific area is to verify the control of occupational exposures to radiation and to report on radiation doses received by workers. Review topics captured in this specific area include:

- Bioassays (in vivo and in vitro) and radiation dose devices;
- Nuclear Energy Worker policy and procedures;
- Planning for unusual situations;
- Radiation dose targets and tracking/trending;
- Radiation exposures and radiation dose assessments;
- Radiation work planning;
- Reporting and performance trending of worker doses; and
- Selection, use (donning and doffing), and maintenance of radiation personal protective equipment (PPE).

Radiation Protection Program Performance

The purpose of this specific area is to verify the effectiveness of the radiation protection program in protecting the health and safety of persons, including performance against objectives, goals and targets, and continuous improvement initiatives. Review topics captured in specific area include:

- Content for radiation protection (RP) training and qualification of management, workers, and all other persons (i.e. visitors, contractors);
- Effectiveness reviews of the RP program;
- Management oversight of the RP program;
- Quality management of RP procedures and practices;
- Organization and administration of the RP program;
- The establishment and implementation of RP Action and Administrative Levels (described in more detail, below); and
- Self-assessment process/audits and corrective action feedback of the RP program.

Radiation Protection Action Levels

Action Levels (ALs) are designed to alert licensees before regulatory dose limits are reached. By definition, if an action level referred to in a licence is reached, a loss of control of some part of the associated radiation protection program may have occurred, and specific action is required, as defined in the *Radiation Protection Regulations* and the licence. Dose performance history should be considered when establishing ALs. ALs should be reviewed on a routine basis to ensure that they remain appropriate.

At OPG, Administrative Dose Limits (ADLs) are the licensee's internal dose limits designed to ensure individuals do not exceed regulatory dose limits.

Section 6 of the *Radiation Protection Regulations* specifies the requirements related to action levels and indicates that the licence will be used to identify action levels and their notification timeframes. For this licence, the action levels and notification time frames are provided in the following tables.

The current ALs and ADLs for this facility are extracted from N-REP-03420-10001 and N-PROC-RA-0019 and are summarized in the following tables. OPG's ALs and ADLs are considered part of the licensing basis. Changes to these limits are subject to notification of change. In the event of a discrepancy between the tables below and the licensee documentation upon which they are based, the licensee documentation shall be considered the authoritative source (assuming that the licensee has followed its own change control process).

Action Levels for Dose to Workers		
Field of application	**Value**	**Action Level**
DOSE TO WORKERS: Individual worker external radiation dose received on a job greater than planned	2mSv (200 mrem)	A person receives an external whole body dose that equals or exceeds 2 mSv (200 mrem) above the Electronic Personal Dosimeter (EPD) dose alarm set point.

Action Levels for Dose to Workers		
Field of application	**Value**	**Action Level**
DOSE TO WORKERS: Individual worker internal exposures to tritium oxide greater than planned	2400 kBq/L (65 µCi/L) [2 mSv or (200 mrem)]	A person receives a single intake of tritium oxide (tritiated water) in which the unplanned component of the initial concentration immediately after intake is estimated to equal or exceed 2400 kBq/L (65 µCi/L) (representing a nominal unplanned exposure of 2 mSv (200 mrem)).
DOSE TO WORKERS: Individual worker internal exposure to radionuclides (other than tritium as tritium oxide) greater than planned	0.1 ALI for a radionuclide other than tritium (tritium oxide). [2 mSv or (200 mrem)]	A person receives an intake of a radionuclide other than tritium (in the form of tritium oxide) attributable to a single event that equals or exceed 0.1 of an Annual Limit of Intake (ALI) as defined in ICRP Publication 68, *Dose Coefficients for Intakes of Radionuclides by Workers*, (representing a nominal unplanned exposure of 2 mSv [200 mrem].
DOSE TO WORKERS: Cumulative annual individual radiation dose exceeds annual administrative dose limits without approval.	The Administrative Dose Limits (ADLs) are shown in the table below.	An individual's total whole body radiation dose accumulated over a calendar year exceeds his annual Administrative Dose Limit (ADL) without approval.

Administrative Dose Limits			
Whole Body Dose (Effective) limits (one calendar year)			
Category of Worker	**Nuclear Part D&G Employees**	**Other Ontario Power Generation Employees**	**Contract and Building Trades Union Employees**
Nuclear Energy Workers (NEW)	20 mSv (2 rem)	20 mSv (2 rem)	40 mSv (4 rem)
NEW with a lifetime whole body dose greater than 500 mSv (50 rem)	10 mSv (1 rem)	10 mSv (1 rem)	Not applicable
Non-NEW	0.5 mSv (0.05 rem)	0.5 mSv (0.05 rem)	0.5 mSv (0.05 rem)
Whole Body Dose (Effective) limits (rolling 5 calendar years)			
NEW	50 mSv (5 rem)	90 mSv (9 rem)	90 mSv (9 rem)

Action Level for Surface Contamination Levels		
Field of application	**Action Level**	**Observations**
CONTAMINATION CONTROL: Alpha or Beta-gamma surface contamination levels beyond limits in Zone 1.	37 kBq/m^2 (1 µCi/m^2) (beta-gamma); 3.7 kBq/m^2 (0.1 µCi/m^2) (alpha)	Total (fixed and loose) surface contamination levels greater than 37 kBq/m^2 (1 µCi/m^2) (beta-gamma) or 3.7 kBq/m^2 (0.1 µCi/m^2) (alpha) are found in Zone 1.

Radiological Hazard Control

The purpose of this specific area is to verify efforts to control radiological hazards, preventing unnecessary radioactive releases and radiation exposures. Review topics to verify compliance in this specific area include:

- Classification of areas and zoning, including area posting, policies and procedures;
- Radiation monitoring equipment and instrumentation;
- Radiological hazard characterization and assessment;
- Radiological hazard non-conformances with RP program requirements;
- Radiological hazard surveys and control programs; and
- Labeling of containers and devices.

Estimated Dose to Public

The *Radiation Protection Regulations* prescribe the radiation dose limits for the general public of 1 mSv per calendar year. The licensee reports the estimated dose to the public from the Pickering site annually, in accordance with REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* (See LC 3.3), in the Environmental Protection report.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	G-129	Keeping Radiation Exposures and Doses “As Low As Reasonably Achievable (ALARA)”	2004
CNSC	G-228	Developing and Using Action Levels	2001

The licensee should conduct a documented review and, if necessary, revise the ALs specified above at least once every five years in order to validate their effectiveness. The results of such reviews should be provided to CNSC staff.

8 SCA – CONVENTIONAL HEALTH AND SAFETY

8.1 Conventional Health and Safety Program

Licence Condition 8.1:

The licensee shall implement and maintain a conventional health and safety program.

Preamble:

As of March 19, 1998, nuclear facilities owned and operated by Ontario Hydro were exempted from application of Part I, Part II and Part III of the *Canada Labour Code*. This was established as per the following Consolidated Regulations: *SOR/98-179, SOR/98-180* and *SOR/98-181*. Pickering NGS is now regulated by the *Occupational Health and Safety Act of Ontario* and the *Labour Relations Act*. Related legislation includes the *Ontario Workplace Safety and Insurance Act (WSIA)* and the *Ontario Human Rights Code*.

The conventional health and safety SCA includes the following SpAs:

- Performance;
- Practices; and
- Awareness.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
OPG-POL-0001	Employee Health and Safety Policy	No
OPG-PROG-0010	Health and Safety Management System Program	No
N-PROG-MA-0015	Work Protection	No
OPG-PROC-0132	Respiratory Protection	No

Conventional Health and Safety Program (Performance, Practices and Awareness)

The licensee's approach to worker safety is governed by OPG-PROG-0010, *Safety Management System Program*, which defines the overall process for managing safety and the responsibilities of the parties, specifically at the corporate level. The licensee shall ensure that contractors and other organizations present on site are informed of and uphold their roles and responsibilities related to conventional health and safety.

The licensee reports on safety performance indications related to conventional health and safety on a quarterly basis in accordance with REGDOC-3.1.1 (See LC 3.3). The following indicators are relevant to Conventional Health and Safety:

- Spills, and
- Conventional Health and Safety.

Guidance:

There is none provided.

9 SCA – ENVIRONMENTAL PROTECTION

9.1 Environmental Protection Program

Licence Condition 9.1:

The licensee shall implement and maintain an environmental protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

Preamble:

Licensees set Environmental Action Levels (EAL) and related parameters, so as to provide early warnings of any actual or potential losses of control of the Environmental Protection Program. EALs are precautionary levels and are set far below the actual Derived Release Limits (DRLs). EALs are designed to alert licensees before DRLs are reached. They are specific doses of radiation or other parameter that, if reached, may indicate a loss of control of the licensee's Environmental Protection Program.

CNSC Regulatory Policy P-223, *Protection of the Environment*, describes the principles and factors that guide the CNSC in regulating the development, production and use of nuclear energy and the production, procession and use of nuclear substances, prescribed equipment and prescribed information in order to prevent unreasonable risk to the environment in a manner that is consistent with Canadian environmental policies, acts and regulations and with Canada's international obligations.

The environmental protection SCA includes the following SpAs:

- Effluent and emissions control (releases);
- Environmental management system (EMS);
- Assessment and monitoring;
- Protection of the public; and
- Environmental Risk Assessment.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
Effluent and Emissions Control (Releases)		
N-STD-OP-0031	Monitoring of Nuclear and Hazardous Substances in Effluents	No
NA44-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Generating Station A	Yes

NK30-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Generating Station B	Yes
P-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Sewage Effluent	Yes
Environmental Management System (EMS)		
OPG-POL-0021	Environmental Policy	No
N-PROG-OP-0006	Environmental Management	No
N-PROC-OP-0044	Contaminated Lands and Groundwater Management	No
N-INS-07080-10000	Hazardous Material Control	No
N-PROC-OP-0038	Abnormal Waterborne Tritium Emission Response	No
Assessment and Monitoring		
N-PROC-OP-0025	Management of the Environmental Monitoring Programs	No
P-MAN-03443-00002	Pickering Environmental Monitoring Program	No
N-PROC-OP-0037	Environmental Approvals	No
Environmental Risk Assessment (ERA)		
P-REP-07701-0001	Environmental Risk Assessment Report for Pickering Nuclear	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
Effluent and Emissions Control (Releases)				
CSA	N288.5	Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills	2011	2015-12-31
CSA	N288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2008	2013-09-01
CSA	N288.3.4	Performance Testing of Nuclear Air-Cleaning Systems at Nuclear Facilities	2013	2018-09-01
Environmental Management System (EMS)				
CNSC	REGDOC-2.9.1	Environmental Protection Policies, Programs and Procedures	2013	2018-09-01

CSA	N288.7	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2015	2020-12-31
Assessment and Monitoring				
CSA	N288.4	Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills	2010	2013-09-01
Environmental Risk Assessment (ERA)				
CSA	N288.6	Environmental risk assessments at Class I nuclear facilities and uranium mines and mills	2012	2018-09-01

Effluent and Emissions Control (Releases)

The licensee shall ensure effluent monitoring for nuclear and hazardous substances is designed, implemented and managed to respect applicable laws and to incorporate best practices. The effluent monitoring program shall provide for control of airborne and waterborne effluents. Effluent monitoring is a risk-informed activity which assures quantifying of the important releases of the nuclear and hazardous substances into the environment.

<u>Nuclear Substances – Derived Release Limits (DRL)</u>

The licensee shall control radiological releases to ALARA, within the DRLs, and take action to investigate and correct the cause(s) of increased releases should they occur. The licensee shall report the releases in accordance with REGDOC-3.1.1 (LC 3.3).

The licensee shall establish the DRLs in accordance with CSA N288.1. If any of the individual radionuclide DRLs are exceeded, or if the sum of individual releases (expressed as a fraction of the relevant DRL) exceeds unity, it indicates that the public dose limit of 1mSv/year set in the CNSC *Radiation Protection Regulations* may be exceeded.

The DRLs are considered part of the licensing basis. The DRLs for this facility are summarized in the table below.

Release Category	Radionuclide	DRL(Becquerel/year) Pickering A	DRL(Becquerel/year) Pickering B
Air	Tritium (HTO)	1.2×10^{17}	1.9×10^{17}
	Iodine (mixed fission products)	9.8×10^{12}	8.9×10^{12}
	Carbon-14(CO2)	2.2×10^{15}	2.0×10^{15}
	Noble Gases*	3.2×10^{16}	4.7×10^{16}
	Particulate – Gross Beta-Gamma (Co-60)	4.9×10^{11}	7.2×10^{11}
	Particulate – Gross Alpha (Pu-239, Pu-240)	8.7×10^{10}	1.2×10^{11}
Water	Tritium	3.7×10^{17}	7.0×10^{17}
	Carbon-14 (as carbonate)	3.2×10^{13}	6.0×10^{13}
	Gross Alpha (Pu-239/Pu-240)	1.4×10^{13}	2.6×10^{13}
	Gross Beta-Gamma (P-32)	1.7×10^{12}	3.2×10^{12}

Sewage**	Tritium	5.4×10^{16}	
	C-14	9.9×10^{13}	
	Gross beta-gamma (limited by Co-60)	1.2×10^{11}	

*Units for noble gases DRLs are Bq-MeV
** All sewage from the Pickering Nuclear site is reported as a release from Pickering Nuclear Generating Station A

These DRLs for radionuclides and radionuclide groups account for the most significant nuclear substances which can be released and are the focus of monitoring and reporting requirements.

Based on the information provided in OPG letter P-CORR-00531-04657, e-Doc 4955185, OPG is no longer expected to monitor and report on C-14 in sewage.

Nuclear Substances – Environmental Action Levels (EAL)

For OPG, the established EALs are ~10% of the DRLs for respective radionuclides released via airborne, waterborne or sewage discharge pathways.

OPG's EALs are documented in the reports 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", and P-REP-03482-00001 "Derived Release Limits and Environmental Action Levels for Pickering Nuclear Sewage Effluent".

Further to the requirements of LC 3.3 that cites CNSC REGDOC-3.1.1, OPG shall notify the Commission within seven days of becoming aware that an action level has been reached.

The EALs are considered part of the licensing basis. The EALs for this facility are summarized in the table below.

The current EALs for Pickering NGS are given in the following table:

Release Category	Radionuclide	Action Levels: Gaseous releases (Pickering A) (Becquerel/week)	Action Levels: Gaseous releases (Pickering B) (Becquerel/week)
Air	Tritium (HTO)	2.5×10^{14}	3.7×10^{14}
	Iodine	2.0×10^{10}	1.8×10^{10}
	Carbon-14	4.4×10^{12}	4.0×10^{12}
	Noble Gases*	6.3×10^{13}	9.4×10^{13}
	Particulates	9.8×10^{8}	1.4×10^{9}
Release Category	Radionuclide	Action Levels: Liquid releases (Becquerel/month)	Action Levels: Liquid releases (Becquerel/month)
Water	Tritium (HTO)	3.0×10^{15}	5.6×10^{15}
	Carbon-14	2.6×10^{11}	4.8×10^{11}
	Gross Beta-Gamma	1.4×10^{10}	2.5×10^{10}
Sewage**	Tritium (HTO)	4.3×10^{14}	
	Carbon-14	7.9×10^{11}	
	Gross beta-gamma	9.7×10^{8}	

* Units for noble gas action level are Bq-MeV/week
** All sewage from the Pickering Nuclear site is reported as a release from Pickering Nuclear Generating Station A

Hazardous Substances

The licensee shall control hazardous substance releases according to the limits defined in accordance with the applicable environmental compliance approvals and take action to investigate and correct the cause(s) of increased releases.

Environmental Management System (EMS)

The objective of the environmental protection policies, programs and procedures is to establish adequate provisions for protection of the environment. This shall be accomplished through an integrated set of documented activities that are typical of an environmental management system (EMS).

OPG has established and implemented an environmental management program to assess environmental risks associated with its nuclear activities, and to ensure these activities are conducted in such a way that adverse environmental effects are prevented or mitigated. OPG environmental management program is compliant with REGDOC-2.9.1, *Environmental Protection Policies, Programs and Procedures*, version 2013.

OPG shall ensure that all aspects of its environmental management program are effectively implemented in order to assure compliance with environmental regulatory requirements and expectations, including those set in the International Organization for Standardization 14001, *Environmental Management Systems*. OPG's EMS is registered to the ISO-14001. Having the ISO-14001certification is not part of the CNSC requirement; however it shows that a third party recognized OPG Environmental Management System as being in accordance with the standard.

<u>Groundwater</u>

OPG shall implement CSA N288.7, *Groundwater Protection Programs at Class I Nuclear Facilities and Uranium Mines and Mills* by December 31, 2020.

Assessment and Monitoring

An environmental monitoring program consists of a risk-informed set of integrated and documented activities to sample, measure, analyze, interpret, and report the following:

- the concentration of hazardous and/or nuclear substances in environmental media to assess one or both of
    - exposure of receptors to those substances; and
    - the potential effects on human health, safety, and the environment;
- the intensity of physical stressors and/or their potential effect on human health and the environment; and
- the physical, chemical, and biological parameters of the environment normally considered in design of the EMP.

<u>Management of adverse effects on fish population</u>

OPG is to submit an annual report on fish impingement and entrainment monitoring at Pickering NGS by May 31 each year. Details on the report content are contained in Attachment 1 of CNSC letter e-Doc 4742751 (P-CORR-00531-04457). OPG shall provide preliminary results by February 28 each year.

Protection of the public

See the SpA for the Estimated Dose to the Public under the SCA for Radiation Protection under LC 7.1.

Environmental Risk Assessment (ERA)

In accordance with CSA N288.4 and N288.5, the ERA establishes the basis for both the environmental monitoring program and the effluent monitoring program. The ERA shall be updated periodically with the results from the environmental and effluent monitoring programs in order to confirm the effectiveness of any additional mitigation measures needed.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	REGDOC-2.9.1	Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.1	2017
CSA	N288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2014
CSA	N288.2	Guidelines for Calculating the Radiological Consequences to the Public of a Release of Airborne Radioactive Material for Nuclear Reactor Accidents	2014
CSA	N288.7	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2015
CNSC	G-228	Developing and Using Action Levels	2001
CNSC	G-129	Keeping Radiation Exposures and Doses "As Low As Reasonably Achievable (ALARA)"	2004

It is recommended that the licensee provide to the CNSC a copy of the reports sent to the Ontario's Ministry of the Environment and Climate Change Canada on hazardous releases.

The licensee should review and, if necessary, revise and reissue the DRLs at least once every five years. Similarly, the licensee should review and, if necessary revise the EALs specified above at least once every five years.

CNSC staff use the criteria set out in the CNSC guidance document G-228 *Developing and Using Action Levels* as guidance to help assess the adequacy of EALs established by the licensee.

10 SCA – EMERGENCY MANAGEMENT AND FIRE PROTECTION

The emergency management and fire protection SCA includes the following SpAs:

- Conventional emergency preparedness and response (includes the emergency preparedness program) (LC 10.1);
- Nuclear emergency preparedness and response (LC 10.1); and
- Fire emergency preparedness and response (LC 10.2).

10.1 Emergency Preparedness Program

Licence Condition 10.1:

The licensee shall implement and maintain an emergency preparedness program.

Preamble:

Emergency preparedness allows preparation and management of resources for responding to emergencies, with the aim to reduce the harmful effects of emergency. Specific provisions for dealing with emergencies are required because normal processes are disrupted and a different set of resources is needed to respond to and recover from the disruption.

The licensee also has processes in place to ensure business continuity including a nuclear pandemic plan in the event of an emergency (see LC 1.1).

In addition to the nuclear emergency program, the licensee maintains a set of emergency operating procedures and abnormal plant operating procedures (see LC 3.1).

A security response to malevolent acts is governed by a separate plan under OPG's nuclear security program (see LC 12.1) but provisions of the licensee's site security report apply to any associated potential threat of release of radioactive material - for example, the need for off-site notification, situation updates and confirmation of any radioactive releases.

Liquid release response plan, radioactive materials transportation emergency response plan and security (or hostile action) response plan are also governed by separate plans (see LC 9.1, 12.1and 14.1, respectively).

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-PROG-RA-0001	Consolidated Nuclear Emergency Plan	Yes

N-REP-03491-0650826	Updated Emergency Planning Technical Basis for Provincial Nuclear Emergency Response Plan	Yes
N-STD-AS-0010	Nuclear Crisis Communications Standard	No
N-PROC-RA-0045	Emergency Preparedness Drill and Exercises	No
N-PROC-RA-0133	Management of Equipment Important to Emergency Response	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	REGDOC-2.10.1	Nuclear Emergency Preparedness and Response	2014	2018-09-01

Conventional and Nuclear Emergency Preparedness and Response

Emergency Preparedness Program

The emergency preparedness program encompasses emergency preparedness, emergency response and emergency response measures. It ensures that appropriate emergency response capabilities are developed and maintained available for use.

The emergency preparedness program consists of:

- Basis for emergency planning;
- Personnel selection and qualification;
- Emergency preparedness and response organizations;
- Staffing levels;
- Emergency training, drills and exercises;
- Emergency facilities and equipment;
- Emergency procedures;
- Assessment of emergency response capability;
- Assessment of accidents;
- Activation and termination of emergency responses;
- Protection of facility personnel and equipment;
- Interface with off-site organizations;
- Recovery program;
- Public information program (see LC G.6); and
- Public education program (see LC G.6).

The licensee's Consolidated Nuclear Emergency Plan (CNEP) deals with emergency situations that could endanger the safety of on-site staff, the environment and the public. It is predominantly conceived to deal with releases of radioactive materials from fixed facilities and to outline interfaces with the Provincial Nuclear Emergency Response Plan (PNERP). The licensee shall maintain equipment, procedures and staff to support off- site response activities for an accidental release. Infrastructures defined within the PNERP may be used in planning and response to virtually all emergencies. The licensee's CNEP also represents a basis for controlling changes and modifications to the licensee's nuclear emergency preparedness program.

In accordance to REGDOC-2.10.1, the licensee is required to provide regional and provincial offsite authorities with the necessary information to allow for effective emergency planning policies and procedures to be established and updated, if needed or on a periodic basis. This information includes an estimate of the associated radiological consequences, with isotopic release quantities (source term), possible release start time and duration and the geographical area potentially affected.

The licensee shall test all requirements listed in REGDOC-2.10.1 over a five-year period, with a full-scale integrated emergency testing exercise at least once every three years involving, at a minimum, regional and provincial offsite authorities. OPG is required to develop and submit to the CNSC emergency drill and exercise schedules annually. Drills and/or exercises are required at least annually in most areas. The drill and exercise program details the requirements for corporate exercises, testing of drill and exercise objectives, and coordination with non-OPG facilities. Participation by municipal and provincial emergency response groups is scheduled by mutual agreement.

The licensee shall implement and maintain an automated (collected and posted without human intervention) data sharing system for the CNSC EOC, with near real-time (at 15 minute interval or less). Such data-sharing system shall allow posting of a set of pre-determined plant data, with web-based access for viewing and trending, including the ability to download to support CNSC emergency response mandate.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	REGDOC 2.3.2	Accident Management, Version 2	2015
CNSC	REGDOC-2.10.1	Nuclear Emergency Preparedness and Response, Version 2	2016
CSA	N1600	General requirements for nuclear emergency management programs	2016

10.2 Fire Protection Program

Licence Condition 10.2:

The licensee shall implement and maintain a fire protection program.

Preamble:

Licensees require a comprehensive Fire Protection Program (FPP) to ensure the licensed activities do not result in unreasonable risk to the health and safety of persons and to the environment due to fire and to ensure that the licensee is able to efficiently and effectively respond to emergency fire situations.

Fire protection provisions, including response, are required for the design, construction, commissioning, operation, maintenance, and decommissioning of nuclear facilities. Fire provisions cover structures, systems, and components that support the plant operation and extend within the exclusion area. External events, such as an aircraft crash or threats, are addressed by LC 12.1.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-PROG-RA-0012	Fire Protection	Yes
NA44-REP-71400-10001	Fire Protection Code Compliance Review – Pickering Nuclear Generating Station "A"	Yes
NA44-REP-71400-00023	Fire Safe Shutdown Analysis – Pickering A Nuclear Generating Station	Yes
NA44-REP-71400-10003	Fire Hazard Assessment - Pickering A Nuclear Generating Station	Yes
NK30-REP-71400-10001	Fire Protection Code Compliance Review – Pickering Nuclear Generating Station "B"	Yes
NK30-REP-71400-00001	Fire Safe Shutdown Analysis – Pickering B Nuclear Generating Station	Yes
NK30-REP-71400-10002	Fire Hazard Assessment – Pickering B Nuclear Generating Station	Yes

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CSA	N293	Fire protection for CANDU nuclear power plants	2007	2013-09-01
CSA	N293	Fire protection for CANDU nuclear power plants	2012	TBD

Fire Emergency Preparedness and Response

Fire Protection

As required by CSA N293, the licensee shall ensure that a qualified third party performs a plant condition inspection annually and a fire protection program audit every three years. The resulting inspection and audit reports shall be submitted to CNSC staff for review (see OPG letter P-CORR-00531-03922, e-Doc 4164728).

It is expected that OPG will apply the Ontario building and fire codes to SSCs within the exclusion zone but external to the protected area. For fire protection, OPG's documents N-PROG-RA-0012, Fire Protection, and P-LIST-71400-00001, Application of CSA N293 to Structures, Systems and Components for Pickering Nuclear, may identify specific SSCs in the exclusion zone to which the requirements of CSA N293 are applied. See LC G.3 for more information.

Fire Response

In accordance with CSA N293, the licensee shall arrange for third party audits of one industrial fire brigade fire drill once every two years. The purpose of a Third Party Audit is to provide an in-depth analysis of the Industrial Fire Brigade's (IFB) fire response performance against applicable regulatory criteria. A fire response is a planned, coordinated and controlled activity to provide emergency response to a fire. The audit is to analyze and ensure competencies of the IFB against CSA N293 standard and the referred NFPA 600 and 1081 standards. The resulting audit report shall be submitted to CNSC staff for review.

An independent third party auditor is required to be an expert in their discipline, normally firefighting and qualified through specific education and relevant experience. The third party auditor is required to be independent from the facility to ensure total impartiality. The review shall be of sufficient depth and detail that the reviewer can attest with reasonable confidence on the competencies of the IFB at the facility.

Fire Design

The licensee shall design, build, modify and otherwise carry out work related to the nuclear facility with potential to impact protection from fire in accordance with the CSA N293. Any changes that have the potential to impact fire protection are assessed for compliance with CSA N293 and, if required, an external third party review shall be performed and the results submitted to the CNSC. See also LC 5.1 for additional requirements related to the Physical Design SCA and the design program and LC 5.2 for fire protection system classification and registration.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
NEI	NEI 00-01	Guidance for Post Fire Safe Shutdown Circuit Analysis	Revision 2

Where CSA N293 does not address a fire protection topic or issue in whole, or where additional guidance is beneficial, the standards and recommended practices set out by the National Fire Protection Association are used as guidance by CNSC staff in determining the adequacy of a fire protection measure. The Nuclear Energy Institute guidance in NEI 00-01, *Guidance for Post Fire Safe Shutdown Circuit Analysis*, is used by CNSC staff to help determine the adequacy of safe shutdown electrical circuit analysis.

The results of the Third Party Audit report will typically consist of a report which compares the requirements of the applicable codes and standards against the implementation of the FPP or the Fire Response exercised (based on the scope of the audit). The report should identify any non-compliance and formulate a conclusion if the licensee's FPP or IFB meets the requirements of CSA N293.

As a guideline the report should provide sufficient detail to support the conclusion and to convey that the requirements of CSA N293 are met. As a minimum, the documentation for a Third Party Audit should include:

- Cover page with the name of the facility, date and signature of the authors;
- Name, address and phone number of the preparing agency or organization;
- Names of review team members, including brief descriptions of experience and education;
- Name, address, and phone number of licensee;
- Title of report, name of project, project number(s), date, and document number;
- Introduction briefly describing the project;
- Statement of review scope specifically listing any exclusions;
- Objectives of the review;
- A list of applicable codes and standards;
- Summary of the review methodology, including areas and documents reviewed;
- Detailed observations with relation to standard requirements against the observed response;
- Conclusions, including a statement that the response meets the requirements of the applicable standards, achieves the fire response objectives, and a summary of any non-compliances;
- Recommendations (if any); and
- An issues tracking table.

11 SCA – WASTE MANAGEMENT

The waste management SCA includes the following SpAs:

- Waste characterization (LC 11.1);
- Waste minimization (LC 11.1);
- Waste management practices (LC 11.1); and
- Decommissioning plans (LC 11.2).

11.1 Waste Management Program

Licence Condition 11.1:

The licensee shall implement and maintain a waste management program.

Preamble:

CNSC Regulatory Policy P-290, *Managing Radioactive Waste*, defines radioactive waste as any material (liquid, gaseous or solid) that contains a radioactive "nuclear substance," as defined in section 2 of the *NSCA* and which the owner has declared to be waste. In addition to containing nuclear substances, radioactive waste may also contain non-radioactive "hazardous substances," as defined in section 1 of the *General Nuclear Safety and Control Regulations*.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
W-PROG-WM-0001	Nuclear Waste Management	Yes
N-PROC-OP-0043	Waste Management	No
N-PROC-RA-0017	Segregation and Handling of Radioactive Wastes	No
N-PROC-WM-0001	Disposal of Oil and Chemical Waste	No
N-PROG-OP-0006	Environmental Management	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CSA	N292.2	Interim Dry Storage of Irradiated Fuel	2013	2018-09-01
CSA	N292.3	Management of Low and Intermediate-Level Radioactive Waste	2008	2013-09-01

Waste Characterization/Waste Minimization/Waste Management Practices

Waste Management Program

The licensee shall implement and maintain a program for waste management that includes strategies for waste minimization. Low- and intermediate-level waste shall be managed in accordance with CSA N292.3, *Management of Low and Intermediate-Level Radioactive Waste*.

The licensee shall:

- characterize its waste streams and minimize the production of all wastes taking into consideration the health and safety of workers and the environment;
- integrate waste management programs as a key element of the facility's safety culture; and
- audit, on a regular basis, its program to maximize its efficiency.

Waste management programs shall be developed to control the management of operational wastes (waste associated with normal operation of a facility) at the facility where it is generated or stored.

See LC 15.4 for plans for end of commercial operation that pertain to OPG's long-term plan for waste management.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	G-320	Assessing the Long term Safety of Radioactive Waste Management	2006
CSA	N292.0	General principles for the management of radioactive waste and irradiated fuel	2014
CSA	N292.1	Wet storage of irradiated fuel and other radioactive materials	2016
CSA	N292.3	Management of low- and intermediate-level radioactive waste	2014

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CSA	N292.5	Guideline for the exemption of clearance from regulatory control of materials that contain, or potentially contain, nuclear substances	2011

With respect to the storage and management of spent nuclear fuel, the waste management program should reflect the fundamental safety principles as applied to nuclear waste. Namely, the systems that are designed and operated should assure subcriticality, control radiation exposure, assure heat removal, assure containment and allow retrievability.

11.2 Decommissioning Plan

Licence Condition 11.2:

The licensee shall maintain a decommissioning plan.

Preamble:

Paragraph 3(k) of the *Class I Nuclear Facilities Regulations* requires that a licence application contain the proposed plan for decommissioning of the nuclear facility.

This licence condition requires that the licensee maintain a preliminary decommissioning plan (PDP). A PDP provides an overview of the proposed decommissioning approach that is sufficiently detailed to assure that the proposed approach is, in the light of existing knowledge, technically and financially feasible, and appropriate in the interests of health, safety, security and the protection of the environment. The PDP defines areas to be decommissioned and the general structure and sequence of the principle work packages. The PDP forms the basis for establishing and maintaining a financial arrangement (financial guarantee – see LC G.5) that will assure adequate funding of the decommissioning plan.

It is expected that the PDP will be revised as the conditions at the facility change.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
W-PROG-WM-0003	Decommissioning Program	Yes
W-PROC-WM-0093	Planning for Decommissioning	No
W-STD-WM-0005	Conduct of Decommissioning	No
P-PLAN-00960-00001	Preliminary Decommissioning Plan – Pickering Nuclear Generating Stations A and B	Yes

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CSA	N294	Decommissioning of facilities containing nuclear substances	2009	2013-09-01

Decommissioning Plans

The decommissioning plan shall be kept current to reflect any changes in the site or nuclear facility. The decommissioning plan shall be revised at a minimum every five years, unless specified otherwise by the Commission. See REGDOC-3.1.1, *Reporting Requirements for Nuclear Power Plants* (LC 3.3). The latest revision of OPG's N-PLAN-00960-00001, *Preliminary Decommissioning Plan – Pickering Nuclear Generating Stations A and B* was submitted to the CNSC on January 31, 2017. When the PDP is revised the cost of decommissioning must be reviewed. OPG's next submission of the PDP for the Western Waste Management Facility (WWMF) is due to be submitted to CNSC staff in 2022.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	G-206	Financial Guarantees for the Decommissioning of Licensed Activities	2000
CNSC	G-219	Decommissioning Planning for Licensed Activities	2000

CNSC regulatory document G-219 *Decommissioning Planning for Licensed Activities* provides guidance regarding the preparation of decommissioning plans for activities licensed by the CNSC. It also provides the basis for calculating the financial guarantees discussed in the regulatory document G-206 *Financial Guarantees for the Decommissioning of Licensed Activities* (further discussed under licence condition G.5)

12 SCA – SECURITY

12.1 Nuclear Security Program

Licence Condition 12.1:

The licensee shall implement and maintain a security program.

Preamble:

The nuclear security puts in place provisions to prevent, detect and stop malevolent acts, such as theft, sabotage, unauthorized access, illegal transfer or other acts involving nuclear material, other radioactive substances or their associated facilities.

The *Nuclear Security Regulations* require every licensee to: conduct, at least once every 12 months, a threat and risk assessment specific to a facility where it carries on licensed activities in order to determine the adequacy of its physical protection system; make modifications to its physical protection system, as necessary, to counter any credible threat identified as a result of the threat and risk assessment; keep a written record of each threat and risk assessment that it conducts and provide a copy of the written record, together with a statement of actions taken as a result of the threat and risk assessment, to the Commission within (within 60 days) after completion of the assessment.

The security SCA includes the following SpAs:

- Facilities and Equipment;
- Response arrangements;
- Security practices; and
- Drills and exercises.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-PROG-RA-0011	Nuclear Security	Yes
TRAN-PLAN-03450-10000	Transport Security Plan	Yes
N-PROC-MP-0103	Security for Real-Time Process Computing System	No
OPG-POL-0035	Cyber Security Policy	No
P-LIST-69000-00001	Significant Cyber Assets	No

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	REGDOC-2.12.1	High-Security Sites: Nuclear Response Force	2013	2016-09-23
CNSC	REGDOC-2.12.2	Site Access Security Clearance	2013	2016-09-23
CNSC	REGDOC-2.12.3	Security of Nuclear Substances: Sealed Sources	2013	2017-06-19
CNSC	RD-321	Criteria for Physical Protection Systems and Devices at High-Security Sites	2010	2013-09-01
CNSC	RD-361	Criteria for Explosive Substance Detection, X-ray Imaging, and Metal Detection Devices at High-Security Sites	2010	2013-09-01
CSA	N290.7	Cyber security for nuclear power plants and small reactor facilities	2014	2019-11-30

Facilities and Equipment/Response Arrangements/Security Practices/Drills and Exercises

Nuclear Security Program

The licensee shall ensure the identified vital areas within the nuclear facility are protected against design basis threats and any other credible threat identified in their Threat and Risk Assessment documentation. The prime functions that must be maintained to prevent unacceptable radiological consequences are those of control, cool, and contain.

The licensee shall maintain the operation, design and analysis provisions credited in the above assessments to ensure adequate engineered safety barriers for the protection against malevolent acts. The provisions for the protection against malevolent acts shall be documented as part of a managed sub-program or process within the management system. The licensee shall summarize changes in design, analysis or operational procedures that are credited for the protection against malevolent acts in the annual threat and risk assessment, and submit a copy to the Commission in accordance with the *Nuclear Security Regulations*.

All detection devices shall be installed, operated and maintained in accordance with manufacturers' specifications and meet the criteria in RD-321 and RD-361.

The licensee shall implement measures for the purpose of preventing and detecting unauthorized entry into a protected area or inner area at a high-security site, including:

- vehicle barriers and vehicle access control points
- perimeter intrusion detection systems and devices
- closed-circuit video systems/ devices for applications in a protected area or inner area
- security monitoring rooms
- security monitoring room systems and devices

Cyber Security

The licensee's cyber-security program shall be implemented and maintained to protect the cyber-essential assets (CEA) for nuclear safety, physical protection and emergency preparedness functions from cyber-attacks.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	G-274	Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities	2003
CNSC	G-208	Transportation Security Plans for Category I, II or III Nuclear Material	2003
IAEA	IAEA Nuclear Security Series No. 4 Technical Guidance	Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage	2007
IAEA	IAEA Nuclear Security Series No. 13 Recommendations	Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities	Revision 5
IAEA	IAEA Nuclear Security Series No. 17 Technical Guidance	Computer Security at Nuclear Facilities	2011

13 SCA – SAFEGUARDS AND NON-PROLIFERATION

13.1 Safeguards Program

Licence Condition 13.1:

The licensee shall implement and maintain a safeguards program.

Preamble:

Safeguards is a system of inspection and other verification activities undertaken by the IAEA in order to evaluate a Member State's compliance with its obligations pursuant to its safeguards agreements with the IAEA.

Canada has entered into a Safeguards Agreement and an Additional Protocol (hereafter referred to as "safeguards agreements") with the IAEA pursuant to its obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons* (INFCIRC/140). The objective of the Canada-IAEA safeguards agreements is for the IAEA to provide assurance on an annual basis to Canada and to the international community that all declared nuclear materials are in peaceful, non-explosive uses and that there is no indication of undeclared nuclear materials or activities. This conclusion confirms that Canada is in compliance with its obligations under the following Canada-IAEA safeguards agreements:

- *Agreement Between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*
- *Protocol Additional to the Agreement Between Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*

These are reproduced in information circulars INFCIRC/164, and INFCIRC/164/Add. 1.

The scope of non-proliferation activities carried out under this licence is limited to tracking and reporting of foreign obligations and origins of nuclear material, which includes the enriched uranium for Shutdown System Enhancement fission chambers. Additionally, the import and export of controlled nuclear substances, equipment and information identified in the *Nuclear Non-proliferation Import and Export Control Regulations* require separate authorization from the CNSC, consistent with section 3.(2) of the *General Nuclear Safety and Control Regulations*. The guidance to seek such an authorization is provided in REGDOC-2.13.2 – *Import and Export*.

The safeguards and non-proliferation SCA includes the following SpAs:

- Nuclear material accountancy and control;
- Access and assistance to the IAEA;
- Operational and design information;
- Safeguards equipment, containment and surveillance; and

- Import and Export (see above regarding separate authorization).

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
N-PROG-RA-0015	Nuclear Safeguards	Yes
N-STD-RA-0024	Nuclear Safeguards Implementation	Yes

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	RD-336	Accounting and Reporting of Nuclear Material	2010	2013-09-01

<u>Safeguards Program</u>

To ensure the safeguards program enables Canada to meet its international safeguards obligations, the licensee shall:

- Make and submit reports to the Commission on the inventory and transfer of fissionable and fertile substances in accordance with the regulatory document RD-336, *Accounting and Reporting of Nuclear Material*, or as otherwise stipulated in any regulatory document that replaces RD-336.
- Disclose to the Commission, to the IAEA, or to an IAEA inspector, any records that are required to be kept or any reports that are required to be made under a safeguards agreement.
- Make such reports and provide such information to the Commission as are required to facilitate Canada's compliance with any applicable safeguards agreement.
- Provide the IAEA, an IAEA inspector, or a person acting on behalf of the IAEA, with such reasonable services and assistance as are required to enable the IAEA to carry out its duties and functions pursuant to a safeguards agreement.
- Grant prompt access at all reasonable times to all locations at the nuclear facility to an IAEA inspector, or to a person acting on behalf of the IAEA, where such access is required for the purposes of carrying on an activity pursuant to a safeguards agreement. In granting access, the licensee will provide health and safety services and escorts as required in order to facilitate activities pursuant to a safeguards agreement.
- Provide such reasonable assistance to an IAEA inspector, or to a person acting on behalf of the IAEA, as is required to enable sampling and removal or shipment of samples required pursuant to a safeguards agreement.
- Provide such reasonable assistance to an IAEA inspector, or to a person acting on behalf of the IAEA, as is required to enable measurements, tests and removal or shipment of equipment required pursuant to a safeguards agreement.

- At the request of the Commission, or of a person authorized by the Commission, install safeguards equipment at the nuclear facility.
- Permit an IAEA inspector, or a person acting on behalf of the IAEA, to service safeguards equipment at the nuclear facility.
- Operate safeguards equipment at the nuclear facility in accordance with the methods and procedures specified by the IAEA.
- Provide the services required for the operation of the safeguards equipment at the nuclear facility, in accordance with the specifications of the IAEA.
- Not interfere with or interrupt the operation of safeguards equipment at the nuclear facility, or alter, deface or break a safeguards seal, except pursuant to a safeguards agreement.
- Implement measures to prevent damage to, or the theft, loss or sabotage of safeguards equipment or samples collected pursuant to a safeguards agreement or the illegal use, possession, operation or removal of such equipment or samples.

Some additional reporting requirements in RD-336 are relaxed effective February 17, 2016 (see CNSC letter e-Doc 4918737):

- Pickering NGS is no longer required to submit monthly General Ledgers for months in which no inventory changes occur. Note that this does not remove the requirement to create and retain General Ledgers, and to provide them at CNSC or IAEA request.
- Pickering NGS is no longer required to create or submit Summary of Inventory Change reports.
- Pickering NGS is no longer required to create or submit Obligated Materials Information Summary (OMIS) reports for years in which there was no inventory of foreign-obligated materials in their possession. An OMIS must still be submitted for any year in which the foreign obligated material inventory is not zero for the entirety of the year.

Safeguards measures are included in operation, equipment or procedures are considered to be part of the licensing basis. With respect to the implementation of safeguards measures, changes made by the licensee to operation, equipment or procedures as of the result of agreement between the licensee, the CNSC and the IAEA are considered routine.

If a requested change would adversely impact Canada’s compliance with its safeguards agreements, CNSC staff do not have the authority to give approval, as this would violate the obligations arising from the Canada-IAEA safeguards agreement.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	GD-336	Guidance for Accounting and Reporting of Nuclear Material	2010
CNSC	REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	2018

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	REGDOC-2.13.2	Import and Export	2016

14 SCA – PACKAGING AND TRANSPORT

14.1 Packaging and Transport Program

Licence Condition 14.1:

The licensee shall implement and maintain a packaging and transport program.

Preamble:

Every person who transports radioactive material, or requires it to be transported, shall act in accordance with the requirements of the *Transportation of Dangerous Goods Regulations* (*TDGR*) and the *Packaging and Transport of Nuclear Substances Regulations, 2015* (*PTNSR* 2015).

The *PTNSR* 2015 and the *TDGR* provide specific requirements for the design of transport packages, the packaging, marking and labeling of packages and the handling and transport of nuclear substances.

The packaging and transport SCA includes the following SpAs:

- Package design and maintenance;
- Packaging and transport; and
- Registration for use.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
W-PROG-WM-0002	Radioactive Material Transportation	No
N-STD-RA-0036	Radioactive Materials Transportation Emergency Response Plan	No

Package Design and Maintenance

PTNSR 2015 apply to the packaging and transport of nuclear substances, including the design, production, use, inspection, maintenance and repair of packages, and the preparation, consigning, handling, loading, carriage and unloading of packages.

Where necessary, OPG package designs are certified by the CNSC.

Packaging and Transport (Program)

The licensee shall implement and maintain a packaging and transport program that will ensure compliance with the requirements of the TDGR and the PTNSR 2015 for all shipments of nuclear substances to and from the Pickering NGS site. Shipments of nuclear substances within the nuclear facility where access to the property is controlled are exempted from the application of TDGR and PTNSR 2015.

Registration and Use

OPG's packaging and transport program also covers the registration for use of certified packages as required by the regulations.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	REGDOC 2.14.1	Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substance Regulations, 2015	2016

15 NUCLEAR FACILITY-SPECIFIC

15.1 Periodic Safety Review Integrated Implementation Plan

Licence Condition 15.1:

The licensee shall implement the Integrated Implementation Plan.

Preamble:

In support of the application (see LC G.1 for more information) for renewal of Pickering NGS Power Reactor Operating Licence (PROL), Ontario Power Generation (OPG) conducted a Periodic Safety Review (PSR) in accordance with the requirements of REGDOC-2.3.3, Periodic Safety Reviews. In conducting the PSR, OPG built on the results of several earlier safety reviews such as the work performed in support of Units 1 and 4 return to service, the 2009 Integrated Safety Review (ISR) conducted for Pickering NGS B, and the Darlington ISR completed in 2015 (because of these previous reviews, the current PSR is sometimes referred to as PSR2). LC 15.1 requires the licensee to implement the results of the PSR to ensure the continued safe and reliable commercial operation of Pickering NGS to the end of 2024. The results of Pickering NGS PSR are documented in an Integrated Implementation Plan (IIP), developed in accordance with REGDOC-2.3.3. Should OPG request to extend the operation of any Pickering reactor unit beyond December 31, 2024, OPG shall be required to reassess the impact of such extended operation on the licensing basis and continued plant safety, and submit the results of such reassessment for CNSC staff acceptance in accordance with REGDOC-2.3.3.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
P-REP-03680-0031	Pickering NGS Periodic Safety Review 2 (PSR2) Integrated Implementation Plan	Yes
P-INS-03680-00001	Pickering IIP Administration	Yes

Licensing Basis Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
CNSC	REGDOC-2.3.3	Periodic Safety Reviews	2008	2018-09-01

The PSR IIP contains commitments with target completion dates for safety enhancement actions; the last of which is to be completed by December 31, 2020. OPG instruction P-INS-03680-00001, *Pickering IIP Administration* was developed by OPG and reviewed by CNSC staff for matters such as IIP management, change control, completion and closure of actions, reporting, roles and responsibilities, and communication with CNSC

Among the high-ranked IIP committed actions are the following:

- Upgrading, as well as annually updating and submitting to CNSC the Life Cycle Management Plans (LCMP) for fuel channels demonstrating their fitness for service for operation to the end of commercial operation.
- Assessing the impact of aging on safety analyses.
- Upgrading Pickering NGS Units 1 and 4 water makeup provisions to the steam generators, heat transport system and calandria.
- Providing additional means for restoring emergency cooling water and electric power to the Air Conditioning Units (ACUs) in reactor units and the Pressure Relief Duct (PRD), as well as emergency electric powers to Hydrogen Igniters, Filtered Air Discharge System (FADS) and Main Volume Vacuum Pumps.
- Interconnecting the Fire Protection System water supplies of Pickering Units 1, 4 and Units 5-8.
- Updating the LCMP for the steam generators, feeders, and calandria internal components.
- Completing the Pickering Units 5-8 Irradiated Fuel Bay Leak Mitigation Project.
- Developing and implementing Condition Assessment action tracking and reporting process including a database.

Detailed criteria for implementing the results of the PSR are as follows:

- The licensee shall progress to completion the actions identified during the PSR and documented in the P-REP-03680-0031, *Pickering NGS Periodic Safety Review 2 (PSR2) Integrated Implementation Plan*.
- In each calendar year, and as per P-INS-03680-00001, *Pickering IIP Administration*, the licensee shall submit a quarterly progress report on the IIP implementation, no later than fifteen calendar days from the end of the quarter.
- The licensee quarterly progress reports on the IIP implementation should contain, as a minimum, the following:
    - Summary of changes in the IIP Administration, IIP Change Control, Action completion and closure targets;
    - A list of actions completed since the last quarter, emphasizing physical improvements;
    - A list of actions to be completed in the subsequent four quarters, emphasizing physical improvements;
    - Intent and non-intent changes effected; and
    - Requests for closure of completed actions.

- For each calendar year, and as per P-INS-03680-00001, *Pickering IIP Administration*, the licensee shall submit an annual report on the state of the IIP execution, no later than February 28 of the following year.
- The licensee annual status report on the IIP implementation shall contain, as a minimum, the following:
    - Summary of changes in the IIP Administration, IIP Change Control, Action completion and closure targets;
    - Update of the information included in Appendix B of REP-03680-00031, *Pickering NGS Periodic Safety Review 2 (PSR2) Integrated Implementation Plan*, reflecting most current information;
    - Actions completed since the last annual report, emphasizing physical improvements;
    - Actions to be completed in the subsequent year, emphasizing physical improvements;
    - Intent and non-intent changes effected during the reporting year;
    - Requests for closure of completed IIP actions during the year;
    - Request for closure of completed Resolution Statements during the year; and
    - Changes to the IIP pending CNSC acceptance/concurrence.
- For any of the Pickering units to operate beyond December 31, 2024, the licensee shall perform and complete by or before December 31, 2022 a reassessment of the continued validity of the PSR results and, as a minimum, shall:
    - Reassess the results of the global assessment included in the PSR *Global Assessment Report* (GAR);
    - Include new or revised requirements, expectations and practices that became available since the freeze-date of the PSR stated in P-REP-03680-0001, *Pickering NGS Periodic Safety Review 2 (PSR2) Basis Document*;
    - For any newly identified findings, utilize the consolidation, prioritization and ranking methods employed in performing the PSR global assessment to formulate new global issues and resolutions plans;
    - Evaluate the continued validity of conclusions reached in PSR; and
    - Revise the IIP by incorporation the results of the reassessment as new or modified IIP actions, and submit the revised IIP for CNSC acceptance.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CSA	N290.18	Periodic safety review for nuclear power plants	2017
IAEA	Specific Safety Guide No. SSG-25	Periodic Safety Review for Nuclear Power Plants	2013

15.2 Safe Storage of Units 2 and 3

Licence Condition 15.2:

The licensee shall maintain Units 2 and 3 in the safe storage phase.

Preamble:

Units 2 and 3 were shutdown at the end of December 1997. Units 2 and 3 were not returned to service and placed in safe storage. Both Units 2 and 3 have been de-fuelled and D_2O in both the moderator and the Heat Transport System (HTS) drained completely.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
NA44-SR-01320-00001	Pickering A Safety Report (Part 1)	No

The licensing basis for all units of the Pickering Nuclear Generating Station including units 2 and 3 is described throughout the LCH.

Guidance:

The graded approach may be applied commensurate with risk, in accordance with Section 4.1.3 of CSA N286, *Management System Requirements for Nuclear Facilities*, when considering implementation of safety provisions specific to units 2 and 3

15.3 Pressure Tube Assessment for Safe Operation

Licence Condition 15.3:

The licensee shall maintain pressure tube fracture toughness sufficient for safe operation.

Preamble:

OPG submits assessments for fuel channel components to support safe operation and satisfy compliance verification criteria in CSA N285.4 and CSA N285.8 as outlined in LC 6.1. These assessments rely on models that represent the current and predicted conditions of fuel channel components. Fracture toughness models are used to assess likelihood of pressure tube failure from postulated flaws in the reactor core, through CSA N285.8-15 Clause 7 evaluations. The current model(s) for fracture toughness have been incorporated into CSA N285.8-15 for use up to a maximum hydrogen equivalent (Heq) concentration of 120 ppm in pressure tubes.

If OPG predicts that Pickering NGS will operate any pressure tube with Heq concentration in excess of 120 ppm, before the end of an evaluation period, OPG must demonstrate that this has no impact on safe operation.

Compliance Verification Criteria:

The following compliance verification criteria apply to Pickering NGS Unit with a pressure tube predicted to exceed 120 ppm in Heq concentration.

OPG shall provide prior written notification and seek CNSC concurrence before operating any pressure tube with a predicted Heq concentration greater than 120 ppm between the inlet and outlet burnish marks.

OPG shall submit a technical basis document for the Fracture Toughness Model that is intended to support operation of pressure tubes with Heq predictions in excess of 120 ppm. OPG shall concurrently submit a schedule for the activities to support model development and validation.

Until the Fracture Toughness Model is accepted for use, OPG shall report, on a semi-annual basis, the following:

- Status updates on the validation of the Fracture Toughness Model;
- Quantitative assessment of uncertainties for the revised Model as new test data are added;
- Updates to the test plan, which includes:
  - status of findings and outcomes from previous fracture toughness tests;
  - additions and changes to the test plan;
  - changes to the test strategy; and
  - results of fracture toughness tests including, as a minimum, material tested, test conditions, the results, whether the test objective has been met, and
  - the tests planned for the next six months.

Guidance:

Guidance Publications				
Org	**Document #**	**Title**	**Version**	**Effective Date**
COG	JP-4491-V197	Fuel Channel Life Management – Third Party Review of Probabilistic Fracture Protection Evaluation Methodology Acceptance Criteria	March 2017	2018-09-01

Attributes for an Acceptable Fracture Toughness Model

To support the licensing application of the updated Model(s), OPG should demonstrate that the model can:

- Explicitly account for actual hydride orientation;
- Account for the variation in hydride morphology from pressure tube inlet to outlet;
- Predict hydride fracture, as a function of hydride length and temperature;
- Predict the transition-to-upper shelf temperature;
- Account for hydride length and orientation (using improved fracture path and ligament rupture models);
- Explicitly model the fissures initiating at zirconium-chlorine-carbon precipitates; and
- Make use of the conventional traction-separation rule applied to finite-element cohesive-zone analyses.

Uncertainty Analysis

To support the licensing application of the revised Model(s), a quantitative assessment of uncertainties should be conducted. The assessment should utilize the approach in sections A.1, A.2 and A.5 of Appendix A to COG-JP-4491-V197, "*Fuel Channel Life Management: Third Party Review of Probabilistic Fracture Protection Evaluation Methodology and Acceptance Criteria*", e-Doc 5230291.

Predicted Maximum Heq Concentration

The predicted Heq concentration at the inlet and outlet burnish marks at the end of the evaluation period should be determined through a station or unit-specific model. The initial Hydrogen concentration should be from off-cut measurements and be channel-specific, the unit-specific bounding value, or the station-specific bounding value. Operating conditions such as temperature and fast flux, where applicable to the model or its components, should be channel-specific, the unit-specific bounding combination, or the station-specific bounding combination. If any inputs are sampled from a distribution, the inputs as well as their percentiles should be justified. For a parametric or probabilistic approach, the input for and choice of the upper-bound percentile for the Heq prediction at the end of the evaluation period should be justified. In accordance with Clauses 12.3.4.6 and 12.4.4.6 of CSA N285.4, OPG should report all of the parametric data and inputs used in the determination and prediction of the Heq concentration values.

The maximum limit of 120 ppm for Heq concentration identified in this LC is the validity limit for the currently used fracture toughness model (see also LC 6.1) in accordance with CSA N285.8-15 Clause D.13.2. This limit should be distinguished from the maximum Heq concentration limit(s) identified in CSA N285.8-15 Clause 8.2(a), which provides the material surveillance measurement requirements for the inspected pressure tubes. LC 6.1 provides additional CVC for Pickering pressure tubes predicted to exceed the maximum Heq concentration limit identified in CSA Standard N285.8-15 Clause 8.2(a).

15.4 End of Commercial Operations

Licence Condition 15.4:

The licensee shall implement and maintain plans for end of commercial operations of all Pickering units.

Preamble:

On June 28, 2017, OPG informed the CNSC that all Pickering units would cease commercial operation on December 31, 2024 (P-CORR-00531-04930, e-doc 5290277).

As a result of this announcement, CNSC staff revised regulatory expectations specific to the end of commercial operation to reflect evolving elements of the regulatory framework. Previous regulatory expectations had been developed in 2011, in the anticipation that Pickering NGS would cease commercial operation in 2020. The revised regulatory expectations are detailed in CNSC letter, e-doc 5307950, dated August 2, 2017.

This licence condition states the regulatory requirement for the licensee to implement and maintain plans for the end of commercial operation for Pickering NGS. According to the CNSC letter of August 2, 2017, these plans are to include:

- A sustainable operations plan (SOP) for the safe operation until the final permanent shutdown of each reactor, and
- A stabilization activity plan (SAP) for transitioning every shutdown reactor unit to the safe storage state.

This licence condition also ensures that operation beyond December 31, 2024 would constitute a change in the licensing basis requiring approval by the Commission or a person delegated by the Commission.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
P-PLAN-09314-00003	Pickering Site Strategic Plan	No

CNSC regulatory requirements and expectations for the systematic preparation for the end of commercial operation of Pickering NGS are detailed in CNSC letter, e-doc 5307950, dated August 2, 2017.

End of Commercial Operation - General Requirements

- The licensee shall notify the CNSC, in writing and no later than December 31, 2022, of its intent to operate any reactor unit of Pickering NGS beyond December 31, 2024 and provide as a minimum the following:

- Changes to OPG P-PLAN-09314-00003, *Pickering Site Strategic Plan*;
- Revised dates for end of commercial operation of each Pickering operating reactor units;
- Timeline for the reassessment of the impact of operations beyond 2024, based on the global assessment included in P-REP-03680-00032, *Pickering NGS PSR2 Global Assessment Report*, and the consequential impact on identifying new findings that could result in new IIP actions (See also LC 15.1 and 15.3 and LC 15.1 for WN of the GAR); and
- Request for CNSC acceptance, by a specific date, of potential new or revised actions in P-REP-03680-0031, *Pickering NGS Periodic Safety Review 2 (PSR2) Integrated Implementation Plan* (See LC 15.1 for WN of the IIP).

- The licensee shall establish and implement an end of commercial operation (ECO) strategy that includes:
  - A sustainable operations plan (SOP) to manage anticipated challenges while approaching the ECO of any reactor unit to be shut down; and
  - A stabilization activity plan (SAP) to manage the transition period until all the units of Pickering NGS are placed in a Safe Storage Stage (SSS).

SOP – Specific Requirements

- The sustainable operations plan (SOP) shall be developed and implemented at least five years preceding the permanent shutdown of the first unit of Pickering NGS.
- For any subsequent Pickering NGS unit to be shut down, the SOP shall be updated using lessons learned from previous application.

SAP – Specific Requirements

- The stabilization activity plan (SAP) shall be developed at least 3 years prior to, and be implemented immediately after the permanent shutdown of the first unit of Pickering NGS.
- For any subsequent Pickering unit to be shut down, the SAP shall to be updated using lessons learned from previous application.

Annual updates to the SOP and SAP shall be submitted by December 15 of each year, and include a report on the progress and effectiveness of measures committed to in these two plans.

Guidance:

Additional guidance is provided in the CNSC letter, e-doc 5307950, dated August 2, 2017.

15.5 Cobalt-60 Program

Licence Condition 15.5:

The licensee shall implement and maintain a Cobalt-60 program for activities described under Part IV) of this licence.

Preamble:

This LC provides basis for regulatory oversight related to the licensed activity associated with Cobalt-60. Pickering NGS Units 1 and 4 currently do not produce Cobalt-60, but OPG is authorized to produce Cobalt-60 as a commercial by-product at Pickering NGS Units 5 to 8. Cobalt-60 rods are packaged and shipped off-site. OPG is under contractual obligation to take back the spent Cobalt-60 that has reached the end of its service life (the spent Cobalt-60 arrives to the site in form of sealed sources).

The CNSC has strengthened its regulatory controls on sealed sources, principally through establishment of a sealed source tracking system within an upgraded national sealed source registry and enhanced export and import controls for high-risk sealed sources. These measures provide for safe and secure management and protection of such sources in Canada and are consistent with strengthened international norms in these areas, particularly with respect to the IAEA *Code of Conduct on the Safety and Security of Radioactive Sources*.

OPG is exempted from the requirement for leak testing in accordance with Section 18(2)(d) of the *Nuclear Substances and Radiation Devices Regulations*, based on the Summary Record of Proceedings and Decision (e-Doc 3609970), which detailed that the sealed sources are stored underwater and that OPG's equipment is capable of detecting waterborne contamination of 200 Bq or less of a nuclear substance.

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
P-OM-018-31985-01	Cobalt Processing - Table of Contents/Revision History	No
P-OP-31985-0001	Cobalt Processing Procedure	No
P-OM-018-31985-04.04.12	Cobalt Processing – Cobalt Handling	No

When managing Cobalt-60 produced at Pickering NGS Units 5 to 8 OPG shall follow the Operating Manual "Cobalt Processing" and the relevant associated procedures.

Applicable requirements set out in the Transport Canada *Transportation of Dangerous Goods Regulations* and in the CNSC *Packaging and Transport of Nuclear Substances Regulations* shall be met before transferring Cobalt-60 and shipping it off-site.

When managing and storing Cobalt-60 sealed sources, OPG shall follow the Operating Manual section 4.4.12 “Cobalt Handling” and the relevant associated procedures.

Cobalt-60 sealed sources are recorded in the CNSC database (the Sealed Source Tracking System) that tracks the location of each significantly hazardous radioactive source (IAEA Category 1 and 2 sources) in Canada.

The licensee shall submit a report in writing within 48 hours of any receipt of a Cobalt-60 sealed source with an activity equal to, or greater than, 0.3 TBq in accordance with the requirements of REGDOC-3.1.1 (LC 3.3). The report shall be submitted to the CNSC in accordance with standard communication protocols. The report shall include:

(i) The date of receipt of a transfer,

(ii) The name of the shipper and licence number,

(iii) The address of the shipper's authorized location,

(iv) The nuclear substance,

(v) Activity (radioactivity) (Bq) per source on the reference date,

(vi) The reference date,

(vii) The number of sealed source(s), and

(viii) The aggregate activity (Bq).

<u>Guidance:</u>

This section has no contents.

15.6 Import and Export of Nuclear Substances

Licence Condition 15.6:

The licensee shall limit the import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment.

Preamble:

OPG is authorized to import and export nuclear substances occurring as contaminants in laundry originating from the Pickering NGS site and the Western Waste Management Facility (WWMF). Under this licence condition, Pickering NGS is allowed to accept contaminated laundry from WWMF to combine with the Pickering laundry prior to export to the United States for laundering. In addition to contaminated laundry, the licence condition allows for import and export of packaging, shielding or equipment with low levels of contamination similar to laundry. This licence condition does not authorize OPG to import and export controlled nuclear substances as defined under the Nuclear Non-Proliferation Import and Export Control Regulations.

This licensed activity was previously authorized under NSRD licence 12861-15-19.1. The original licensing basis for this activity is described in OPG's November 25, 2011, licence application for the renewal of the NSRD licence 12861-15-12.0 (N-CORR-00531-05496, e doc 3846889).

Compliance Verification Criteria:

Licensee Documents that Require Notification of Change		
Document #	**Title**	**Prior Notification**
W-PROG-WM-0002	Radioactive Material Transportation	No

The licensee shall limit the import and export of nuclear substances to the nuclear substances and quantities listed in Table 1 as follows:

Table 1: Nuclear Substances and Quantity Limits for Import and Export

Nuclear Substance	Maximum Total Quantity
Americium 241	10 MBq
Antimony 122	10 GBq
Antimony 124	50 GBq
Antimony 125	20 GBq
Carbon 14	10 GBq
Cerium 141	1 GBq

Nuclear Substance	Maximum Total Quantity
Cerium 144	1 GBq
Cesium 134	1 GBq
Cesium 137	5 GBq
Chromium 51	50 GBq
Cobalt 57	10 MBq
Cobalt 58	100 MBq
Cobalt 60	50 GBq
Curium 242	1 MBq
Curium 244	100 kBq
Deuterium	350 mg
Europium 154	50 MBq
Europium 155	50 MBq
Gadolinium 153	100 MBq
Gadolinium 159	500 MBq
Hafnium 181	10 MBq
Hydrogen 3 (Tritium)	10 GBq
Iodine 129	200 kBq
Iodine 131	2 MBq
Iodine 133	2 MBq
Iron 55	10 GBq
Iron 59	50 GBq
Lanthanum 140	1 MBq
Manganese 54	5 GBq
Manganese 56	5 GBq
Molybdenum 99	1 MBq
Neptunium 237	1 kBq
Neptunium 239	500 kBq
Nickel 59	200 MBq
Nickel 63	500 MBq
Niobium 94	10 MBq
Niobium 95	5 GBq

Nuclear Substance	Maximum Total Quantity
Plutonium 238	1 MBq
Plutonium 239	50 MBq
Plutonium 240	1 MBq
Plutonium 241	58 MBq
Promethium 147	50 MBq
Ruthenium 103	1 GBq
Ruthenium 106	1 GBq
Scandium 46	50 MBq
Silver 108m	100 kBq
Silver 110m	10 MBq
Strontium 89	5 MBq
Strontium 90	10 MBq
Tantalum 182	50 kBq
Tin 113	50 MBq
Tungsten 187	1 MBq
Uranium 234	1 kBq
Uranium 235	1 kBq
Uranium 238	10 kBq
Zinc 65	5 MBq
Zirconium 93	100 GBq
Zirconium 95	100 GBq

The licensee is not authorized, subject to any restrictions or exemptions under the regulation, to import or export the items described in Parts A and B of the Schedule to the *Nuclear Non-Proliferation Import and Export Control Regulations*, such as:

(1) Special fissionable material, as described in paragraph A.1.1:

(i) Plutonium;

(ii) Uranium 233;

(iii) Uranium enriched in Uranium 233 or Uranium 235.

(2) Source material, as described in paragraph A.1.2:

(i) Uranium, containing the mixture of isotopes that occurs in nature;

(ii) Uranium, depleted in the isotope Uranium 235; and

(iii) Thorium.

(3) Deuterium and heavy water, as described in paragraph A.1.3.

(4) Tritium, as described in paragraph A.1.5.

(5) Alpha-emitting nuclear substances, as described in paragraph B.1.1.1, including but not limited to:

(i) Actinium 225, 227;

(ii) Californium 248, 250, 252, 253, 254;

(iii) Curium 240, 241, 242, 243, 244;

(iv) Einsteinium 252, 253, 254, 255;

(v) Fermium 257;

(vi) Gadolinium 148;

(vii) Mendelevium 258, 260;

(viii) Neptunium 235;

(ix) Polonium 208, 209, 210;

(x) Radium 223; and

(6) Radium-226, as described in paragraph B.1.1.16.

Guidance:

Guidance Publications			
Org	**Document #**	**Title**	**Version**
CNSC	REGDOC-2.13.2	Import and Export	2016

APPENDIX A – ACRONYMS

The following is the list of acronyms used in the LCH:

ACU	Air Conditioning Units
Act (the)	*Nuclear Safety and Control Act*
ADL	Administrative Dose limits
AECB	Atomic Energy Control Board
AIA	Authorized Inspection Agency
AIM	Abnormal Incident Manual
AL	Action Levels
ALARA	As Low As Reasonably Achievable
ASME	American Society of Mechanical Engineers
BDBA	Beyond Design Based Accident
CANDU	CANadian Deuterium Uranium
CEA	Cyber Essential Assets
CMD	Commission Member Document
CME	Common Mode Events
CNEP	Consolidated Nuclear Emergency Plan
CNSC	Canadian Nuclear Safety Commission
COG	CANDU Owners Group
CRSS	Control Room Shift Supervisor
CSA	Canadian Standards Association
CT	Calandria Tube
cUL/ULC	Underwriters Laboratory of Canada
CVC	Compliance Verification Criteria
DBA	Design Basis Accident
DRL	Derived Release Limits
EAL	Environmental Action Levels
ECO	End of Commercial Operations
EFPH	Effective Full Power Hour
EMEG	Emergency Mitigating Equipment Guidelines
EMS	Environmental Management System
E-NOP	Enhanced Neutron Overpower Protection
EOP	Emergency Operating Procedures
EQ	Environmental Qualification
FADS	Filtered Air Discharge System
FC	Fuel Channel
FPP	Fire Protection Program
GAR	Global Assessment Report
Gd	Gadolinium
GSS	Guaranteed Shutdown State
Heq	Hydrogen Equivalent Concentration
HTS	Heat Transport System
IAEA	International Atomic Energy Agency
IFB	Industrial Fire Brigade
IIP	Integrated Implementation Plan
INFO	CNSC INFOrmation documents
ISI	In-service Inspection
IUC	Instrument Uncertainty Calculations

LBB	Leak Before Break
LBLOCA	Large Break LOCA
LC	Licence Condition
LCH	Licence Conditions Handbook
LCMP	Life Cycle Management Plans
LOCA	Loss of Coolant Accident
LORPR	Loss of Reactor Power Regulation
MCCP	Minimum Complement Coordination Program
MSC	Minimum Shift Complement
NDE	Non-destructive Examination
NEW	Nuclear Energy Worker
NFPA	National Fire Protection Association
NGS	Nuclear Generating Station
NOP	Neutron Overpower Protection
NoRU	Notification of Regulatory Undertakings
NPP	Nuclear Power Plant
NSCA	*Nuclear Safety and Control Act*
OMIS	Obligated Materials Information Summary
OPG	Ontario Power Generation Inc.
OP&P	Operating Policies and Principles
OPEX	Operating Experience
OSR	Operational Safety Requirements
OCAS	Outage Completion Assurance Statement
PARs	Passive Autocatalytic Combiners
PDP	Preliminary Decommissioning Plan
PIDP	Public Information Disclosure Program
PIP	Periodic Inspection Program
PLBB	Probabilistic Leak Before Break
PNERP	Provincial Nuclear Emergency Response Plan
PPE	Personal Protective Equipment
ppm	Parts Per Million
PR	Power Reactor
PRA	Probabilistic Risk Assessment
PRD	Pressurized Relief Duct
PROL	Power Reactor Operating Licence
PRPD	Pickering Regulatory Program Division
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PT	Pressure Tube
PT-CT	Pressure Tube-Calandria Tube
R	Revision
RD	Regulatory Document
R&D	Research and Development
RBGSS	Rod Based Guaranteed Shutdown State
RBGSS-DM	Rod Based Guaranteed Shutdown State with a Drained Moderator
REGDOC	Regulatory Document
RP	Radiation Protection
SAMG	Severe Accident Management Guidelines
SAP	Stabilization Activity Plan
SCA	Safety and Control Area

SM	Shift Manager
SOE	Safe Operating Envelope
SOP	Sustainable Operations Plan
SpA	Specific Area
SRS	Systems Related Safety
SSCs	Structures, systems and components
SSS	Special Safety Systems
SQ	Seismic Qualification
TDGR	*Transportation of Dangerous Goods Regulations*
ULC/cUL	Underwriters Laboratory of Canada
VB	Vacuum Building
wk	Week
WN	Written Notification
WSLA	*Workplace Safety and Insurance Act*
WWMF	Western Waste Management Facility

APPENDIX B – GLOSSARY OF TERMS - DEFINITIONS

For definitions of terms used in this document, see REGDOC-3.6, *Glossary of CNSC Terminology*, which includes terms and definitions used in the *NSCA* and the regulations made under it, and in CNSC regulatory documents and other publications.

The following definitions, which have not been formally defined in REGDOC-3.6, are also applicable to this document.

Accept/ed/able/ance
Meet regulatory requirements, which mean it is in compliance with regulatory documents or technical standards referenced in the licence.

Approval
Commission's permission to proceed, for situations or changes where the licensee would be:

- Not compliant with a regulatory requirements set out in applicable laws and regulations, or
- Not compliant with a licence condition, or
- Not in the **safe direction** but the objective of the licensing basis is met.

Consent
Written permission to proceed, given by CNSC delegated authority, for situations or changes where the licensee would:

- Comply with a regulatory requirements set out in applicable laws and regulations;
- Comply with a licence condition; and
- Not adversely impact the licensing basis.

Effective Date
The date that a given document becomes effective within the licensing period. The effective date is either set to the licence issue date or to a future date when the given document becomes effective.

Extent of condition
Means an evaluation to determine if an issue has potential or actual applicability to other activities, processes, equipment, programs, facilities, operations or organizations.

Important to safety
Items important to safety include, but are not limited to:

- Structures, Systems or Components (SSC) whose malfunction or failure could lead to undue radiation exposure of the facility/site personnel, or members of the public.
- SSCs that prevent anticipated operational occurrences from leading to accident conditions.
- Those features that are provided to mitigate the consequences of malfunctions or failures of SSCs.
- Tasks, duties, activities, aging mechanisms, findings, or any work that improperly performed could lead to radiation exposure of the facility/site personnel, or members of the public.

Program(s)

A documented group of planned activities, procedures, processes, standards and instructions coordinated to meet a specific purpose.

Published Document(s)

A document issued or published for public knowledge, which are typically CNSC regulatory documents and CSA standards.

Qualified Staff

Trained licensee staff, deemed competent and qualified to carry out tasks associated to their respective positions.

Recommendations and Guidance

Non-mandatory suggestions on how to comply with the licence condition. Recommendations and guidance may include regulatory advice and/or recommended industry best practices to guide the licensee towards a higher level of safety and/or fully satisfactory performance/implementation of its programs.

Regulatory undertakings

Refers to high level commitments that ensure safety, not component work orders or regulatory predefined maintenance tasks. The licensee's deferral and Station Condition Record process focus on these lower level commitments.

Restart of the reactor

Means removal of the Guaranteed Shutdown State (GSS).

Safe direction

Means changes in plant safety levels which would not result in:

- A reduction in safety margins,
- A breakdown of barrier,
- An increase (in certain parameters) above accepted limits,
- An increase in risk,
- Impairment(s) of special safety systems,
- An increase in the risk of radioactive releases or spills of hazardous substances,
- Injuries to workers or members of the public,
- Introduction of a new hazard,
- Reduction of the defense-in-depth provisions,
- Reducing the capability to control, cool and contain the reactor while retaining the adequacy thereof, and
- Causing hazards or risks different in nature or greater in probability or magnitude than those stated in the safety analysis of the nuclear facility.

Safety and control measures

Measures or provisions that demonstrate that the applicant:

(i) is qualified to carry on the licensed activities, and

(ii) has made adequate provision for the protection of the environment, the health and safety of persons, the maintenance of national security and any measures required to implement international obligations to which Canada has agreed.

Written notification

A physical or electronic communication between a CNSC delegated authority and a person authorized to act on behalf of the licensee.

Written notification prior to implementation

CNSC must receive the written notification for the proposed changes within a reasonable time (based on the extent of the proposed changes and the potential impact on safe operation of the facility) prior to the implementation. This will allow sufficient time for CNSC staff to review the submission and determine the acceptability.

APPENDIX C – LIST OF LICENSEE DOCUMENTS THAT REQUIRE NOTIFICATION OF CHANGE

Document #	Document Title	Notification Requirements	L.C.
GENERAL			
NK30-D0A-10200-0001	Building Development Site Plan	When implemented	G.3
NA44-SR-01320-00001	Pickering A Safety Report (Part 1)	When implemented	G.3 15.2
NK30-SR-01320-00001	Pickering B Safety Report (Part 1)	When implemented	G.3
N/A	CNSC Financial Security and ONFA Access Agreement between OPG, the Province of Ontario and the CNSC effective January 1, 2018 (Commission Decision e-Doc 5400969 and CMD 17-H11 e-Doc 5306917.	PRIOR to implementation	G.5
W-STD-WM-0003	Nuclear Liability Management – Update of Cost Estimates for the Ontario Nuclear Funds Agreement and Financial Guarantee Processes	When implemented	G.5
N-STD-AS-0013	Nuclear Public Information Disclosure	When implemented	G.6
MANAGEMENT SYSTEM			
N-POL-0001	Nuclear Safety Policy	When implemented	1.1
N-CHAR-AS-0002	Nuclear Management System	PRIOR to implementation	1.1
N-PROG-AS-0001	Managed Systems	When implemented	1.1
N-STD-AS-0020	Nuclear Management Systems Organizations	When implemented	1.1
OPG-PROC-0166	Organization Design Change	When implemented	1.1
N-PROG-RA-0010	Independent Assessment	When implemented	1.1
N-PROC-RA-0097	Self-Assessment and Benchmarking	When implemented	1.1
N-PROC-RA-0023	Fleetview Program Health and Performance Rating	When implemented	1.1

Document #	Document Title	Notification Requirements	L.C.
N-PROG-RA-0003	Corrective Action	When implemented	1.1
N-PROC-RA-0035	Operating Experience Process	When implemented	1.1
N-PROC-RA-0022	Processing Station Conditions Records	When implemented	1.1
N-PROG-MP-0001	Engineering Change Control	When implemented	1.1
OPG-PROC-0178	Controlled Document Management	When implemented	1.1
N-STD-AS-0023	Nuclear Safety Oversight	When implemented	1.1
OPG-PROG-0010	Health and Safety Management System Program	When implemented	1.1 8.1
N-PROC-AS-0077	Nuclear Safety Culture Assessment	When implemented	1.1
N-STD-MP-0027	Configuration Management	When implemented	1.1
N-STD-OP-0024	Nuclear Safety Configuration Management	When implemented	1.1
OPG-PROG-0001	Information Management	When implemented	1.1
OPG-PROG-0009	Items and Services Management	When implemented	1.1
N-PROC-MM-0021	Supply Inspection	When implemented	1.1
N-PROG-AS-0005	Business Planning	When implemented	1.1
N-PROC-AS-0080	Nuclear Business Planning	When implemented	1.1
OPG-PROG-0033	Business Continuity Program	When implemented	1.1
OPG-PROG-0039	Project Management	When implemented	1.1
OPG-PROG-0010	Safety Management System Program	When implemented	1.1
HUMAN PERFORMANCE MANAGEMENT			
N-PROG-AS-0002	Human Performance	When implemented	2.1
P-PLAN-01900-00005	Pickering Human Performance Strategic Plan	When implemented	2.1

Document #	Document Title	Notification Requirements	L.C.
N-STD-OP-0002	Communications	When implemented	2.1
N-STD-OP-0012	Conservative Decision Making	When implemented	2.1
N-PROC-OP-0047	Limits of Hours of Work	PRIOR to implementation	2.1
P-INS-09100-00003	Pickering Minimum Shift Complement	PRIOR to implementation	2.2
P-INS-09260-00008	Duty Crew Minimum Complement Assurance	PRIOR to implementation	2.2
N-INS-03490-10003	Minimum Shift Complement Resources, Qualifications and Procedures Required for Responding to Resource Limiting Events	When implemented	2.2
N-PROG-TR-0005	Training	When implemented	2.3 2.4
N-PROC-TR-0008	Systematic Approach to Training	When implemented	2.3 2.4
N-MAN-08131-10000-CNSC-031	Responsible Health Physicist	PRIOR to implementation	2.4
N-MAN-08131-10000-CNSC-007	Shift Manager, Pickering Nuclear	PRIOR to implementation	2.4
N-MAN-08131-10000-CNSC-010	Authorized Nuclear Operators	PRIOR to implementation	2.4
N-MAN-08131-10000-CNSC-028	Control Room Shift Supervisor, Pickering Nuclear	PRIOR to implementation	2.4
N-INS-08920-10004	Written and Oral Initial Certification Examination for Shift Personnel	When implemented	2.4
N-INS-08920-10002	Simulator-Based Initial Certification Examinations for Shift Personnel	When implemented	2.4
N-INS-08920-10001	Requalification Testing of Certified Shift Personnel	When implemented	2.4
OPERATING PERFORMANCE			
N-PROG-OP-0001	Nuclear Operations	PRIOR to implementation	3.1
N-STD-OP-0036	Operational Decision Making	When implemented	3.1
N-PROG-AS-0008	Heavy Water Management	When implemented	3.1
N-PROG-MA-0019	Production Work Management	When implemented	3.1

Document #	Document Title	Notification Requirements	L.C.
N-STD-OP-0011	Operations Performance Monitoring	PRIOR to implementation	3.1
N-STD-AS-0002	Procedure Use and Adherence	When implemented	3.1
N-STD-AS-0014	Requirements for Technical Procedures	When implemented	3.1
N-PROC-MA-0013	Planned Outage Management	When implemented	3.1
N-PROC-MA-0049	Forced Outage Management	When implemented	3.1
N-STD-OP-0025	Heat Sink Management	When implemented	3.1
N-STD-OP-0009	Reactivity Management	When implemented	3.1
N-STD-OP-0021	Control of Fuelling Operations	When implemented	3.1
N-STD-MP-0016	Safe Operating Envelope	PRIOR to implementation	3.1
See list of Written Notification Documents in the LCH, e-Doc 4027172	Operational Safety Requirements are licensing basis documents subject to notification of change in accordance with LC G.2.	Prior to implementation	3.1
NA44-OPP-03600	Pickering NGS-A Operating Policies and Principles	PRIOR to implementation	3.1
NK30-OPP-03600	Pickering NGS-B Operating Policies and Principles	PRIOR to implementation	3.1
N-STD-MP-0020	Margin Management	When implemented	3.1
N-STD-OP-0017	Response to Transients	When implemented	3.1 3.2
N-STD-MP-0019	Beyond Design Basis Accident Management	Prior to implementation	3.1 4.1
N-PROG-MP-0014	Reactor Safety Program	When implemented	3.2 4.1
N-PROC-RA-0005	Written Reporting to Regulatory Agencies	When implemented	3.3
SAFETY ANALYSIS			
N-PROG-MP-0014	Reactor Safety Program	When implemented	3.2 4.1
N-PROC-MP-0086	Safety Analysis Basis and Safety Report	When implemented	4.1

Document #	Document Title	Notification Requirements	L.C.
N-PROG-MP-0006	Software	When implemented	4.1 5.1
N-PROC-MP-0096	Use of Scientific, Engineering and Safety Analysis Software	When implemented	4.1 5.1
N-PROG-RA-0016	Risk and Reliability Program	When implemented	4.1
N-STD-RA-0034	Preparation, Maintenance and Application of Probabilistic Risk Assessment	When implemented	4.1
N-STD-MP-0019	Beyond Design Basis Accident Management	PRIOR to implementation	3.1 4.1
N-REP-03491-0650826	Updated Emergency Planning Technical Basis for Provincial Nuclear Emergency Response Plan	PRIOR to implementation	4.1 10.1
N-STD-MP-0023	Technology and Research	When implemented	4.1
N-PROC-MP-0092	Technology and Research Program Management	When implemented	4.1
PHYSICAL DESIGN			
N-PROG-MP-0007	Conduct of Engineering	When implemented	5.1
N-PROG-MP-0009	Design Management	When implemented	5.1
N-PROG-MP-0006	Software	When implemented	4.1 5.1
N-LIST-00590-00001	List of Significant Technical Changes from Code-Over-Code Review	PRIOR to implementation	5.1
See list of Written Notification Documents in the LCH, e-Doc 4027172	Code-Over-Code Reviews	PRIOR to implementation	5.1
P-REP-07701-00002	Predictive Effects Assessment For Pickering Nuclear Safe Storage	When implemented	5.1
W-PROC-WM-0093	Planning for Decommissioning	When implemented	5.1 11.2
N-PROG-MA-0016	Fuel	When implemented	5.1
N-PROG-MP-0004	Pressure Boundary Program	PRIOR to implementation	5.2
N-PROC-MP-0040	System and Item Classification	PRIOR to implementation	5.2

Document #	Document Title	Notification Requirements	L.C.
N-PROC-MP-0082	Design Registration	PRIOR to implementation	5.2
N-MAN-01913.11-10000	Pressure Boundary Program Manual	When implemented	5.2
N/A	Authorized Inspection Agency Service Agreement	PRIOR to implementation	5.2
N-LIST-00531-10003	Index to OPG Pressure Boundary Program Elements	When implemented	5.2
N-PROG-RA-0006	Environmental Qualification	When implemented	5.3
N-STD-MP-0016	General Requirements for Seismic Qualification of OPG Nuclear Facilities	When implemented	5.3
N-PROC-RA-0051	Environmental Qualification Lists	When implemented	5.3
N-PROC-RA-0044	Environmental Qualification Assessment	When implemented	5.3
FITNESS FOR SERVICE			
N-PROG-MA-0026	Equipment Reliability	When implemented	6.1
N-PROG-RA-0016	Risk and Reliability Program	When implemented	6.1
N-STD-RA-0033	Reliability and Monitoring of Systems Important to Safety	When implemented	6.1
P-REP-03611-00012	PNGS Systems and Components Important to Safety	PRIOR to implementation	6.1
P-LIST-06937-00001	Pickering A and B List of Safety Related Systems	PRIOR to implementation	6.1
I-PROG-AS-0001	Conduct of Inspection and Maintenance Services	When implemented	6.1
N-PROG-MA-0004	Conduct of Maintenance	When implemented	6.1
N-PROG-MA-0017	Component and Equipment Surveillance	PRIOR to implementation	6.1
N-PROG-MA-0025	Major Components	When implemented	6.1
N-PROC-MA-0024	System Performance Monitoring	When implemented	6.1
N-PROG-MP-0008	Integrated Aging Management	When implemented	6.1
N-PROC-MP-0060	Aging Management Process	When implemented	6.1

Document #	Document Title	Notification Requirements	L.C.
N-STD-MA-0024	Obsolescence Management	When implemented	6.1
N-PLAN-01060-10003	Reactor Components and Structures Life Cycle Management Plan	PRIOR to implementation	6.1
N-PLAN-01060-10008	Reactor Components and Structures Life Cycle Management Plan: Technical Basis Document	When implemented	6.1
N-PROC-MA-0044	Fuel Channel Life Cycle Management	When implemented	6.1
N-PLAN-01060-10002	Fuel Channels Life Cycle Management Plan	PRIOR to implementation	6.1
N-PLAN-01060-10001	Feeders Life Cycle Management Plan	PRIOR to implementation	6.1
N-PLAN-01060-10007	Feeders Life Cycle Management Plan: Technical Basis Document	When implemented	6.1
N-PLAN-33110-10009	Steam Generators Life Cycle Management Plan	PRIOR to implementation	6.1
NA44-PLAN-33110-10003	Pickering Units 1 and 4 Steam Generator Life Cycle Management Plan (Except Appendix B)	When implemented	6.1
NK30-PLAN-33110-10008	Pickering Units 5-8 Steam Generator Life Cycle Management Plan (excluding Sheet Sections 001 to 007)	When implemented	6.1
N-PLAN-01060-10004	Aging Management Plan for Containment Structures	PRIOR to implementation	6.1
NA44-PLAN-34220-00002	Life Cycle and Aging Management Program Plan for Fiberglass-Reinforced Plastic Components in the Pickering NGS Vacuum Building	PRIOR to implementation	6.1
N-PROG-OP-0004	Chemistry	When implemented	6.1
I-STD-AS-0003	Non-Destructive Examination	When implemented	6.1
I-PROG-AS-0001	Conduct of Inspection and Maintenance Services	When implemented	6.1
N-PROC-MA-0052	Flaw Dispositioning	When implemented	6.1
NA44-PIP-03641.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Plan For Unit 1	PRIOR to implementation	6.1

Document #	Document Title	Notification Requirements	L.C.
NA44-PIP-03641.2-00007	Pickering Nuclear Generating Station A Periodic Inspection Plan For Unit 4	PRIOR to implementation	6.1
NK30-PIP-03641.2-00001	Pickering B Periodic Inspection Program Unit 5	PRIOR to implementation	6.1
NK30-PIP-03641.2-00002	Pickering B Periodic Inspection Program Unit 6	PRIOR to implementation	6.1
NK30-PIP-03641.2-00003	Pickering B Periodic Inspection Program Unit 7	PRIOR to implementation	6.1
NK30-PIP-03641.2-00004	Pickering B Periodic Inspection Program Unit 8	PRIOR to implementation	6.1
N-REP-31100-10041	Acceptance Criteria and Evaluation Procedures for Material Surveillance Pressure Tube	PRIOR to implementation	6.1
NA44-PIP-31100-00001	Pickering Nuclear 1-4, Unit 1 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NA44-PIP-31100-00004	Pickering Nuclear 1-4, Unit 4 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK30-PIP-31100-00001	Pickering Nuclear 5-8, Unit 5 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK30-PIP-31100-00002	Pickering Nuclear 5-8, Unit 6 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK30-PIP-31100-00003	Pickering Nuclear 5-8, Unit 7 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK30-PIP-31100-00004	Pickering Nuclear 5-8, Unit 8 Fuel Channel Pressure Tubes Periodic Inspection Program Plan	PRIOR to implementation	6.1
N-REP-31100-10061	Compliance Plan for Long-Term Use of CSA N285.8 For In-Service Evaluation of Zirconium Alloy Pressure Tubes	PRIOR to implementation	6.1

Document #	Document Title	Notification Requirements	L.C.
NA44-PIP-33126-00002	Pickering Nuclear Unit 1 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NA44-PIP-33126-00001	Pickering Nuclear Unit 4 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK30-PIP-33126-00001	Pickering Nuclear Unit 5 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK30-PIP-33126-00002	Pickering Nuclear Unit 6 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK30-PIP-33126-00003	Pickering Nuclear Unit 7 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
NK30-PIP-33126-00004	Pickering Nuclear Unit 8 Fuel Channel Feeder Pipes Periodic Inspection Program Plan	PRIOR to implementation	6.1
COG-JP-4107-V06	Fitness-for-Service Guidelines for Feeders in CANDU Reactors	PRIOR to implementation	6.1
Appendix B in NA44-PLAN-33110-10003	Pickering Units 1 and 4 Steam Generator Life Cycle Management Plan - Appendix B: Pickering Units 1 and 4 Steam Generators In-Service Inspection Plan	PRIOR to implementation	6.1
NK30-PLAN-33110-10008 Sheet Section 006	Pickering Units 5-8 In-Service Inspection Plan	PRIOR to implementation	6.1
COG Report 07-4089	Fitness-For-Service Guidelines for Steam Generator and Preheater Tubes	PRIOR to implementation	6.1
NA44-PIP-03642.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Program For Containment Components	PRIOR to implementation	6.1
NK30-PIP-03642.2-00001	Pickering Nuclear Generating Station "B" Periodic Inspection Program For Containment Components	PRIOR to implementation	6.1
P-PIP-03642.2-00001	Pickering Nuclear Generating Station A Periodic Inspection Program For Unit 0 Containment Components	PRIOR to implementation	6.1

Document #	Document Title	Notification Requirements	L.C.
N-PROC-MA-0066	Administrative Requirements for In-Service Examination and Testing for Concrete Containment Structures	PRIOR to implementation	6.1
NA44-PIP-03643.2-00001	Pickering Nuclear GSA – Reactor Building Periodic Inspection Program	PRIOR to implementation	6.1
NK30-PIP-03643.2-00001	Pickering Nuclear GSB – Reactor Building Periodic Inspection Program	PRIOR to implementation	6.1
NA44-PIP-03643.2-00002	Pickering Nuclear GS – PRD & VB Periodic Inspection Program	PRIOR to implementation	6.1
NA44-PIP-03643.2-00003	Pickering Nuclear GS – Vacuum Building Post Tensioning Rods Periodic Inspection Program	PRIOR to implementation	6.1
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	PRIOR to implementation	6.1
NA44-REP-25100-00009	Pickering NGS Vacuum Building In-service Leakage Rate Test Requirements in Accordance with CSA N287.7-08	PRIOR to implementation	6.1
N-PROC-MP-0060	Aging Management Process	When implemented	6.1
RADIATION PROTECTION			
N-PROG-RA-0013	Radiation Protection	PRIOR to implementation	7.1
N-STD-RA-0018	Controlling Exposure As Low As Reasonably Achievable	When implemented	7.1
N-REP-03420-10001	Occupational Radiation Protection Action Levels for Power Reactor Operating Licenses	PRIOR to implementation	7.1
N-PROC-RA-0019	Dose Limits and Exposure Control	PRIOR to implementation	7.1
N-MAN-03416-10000	Radiation Dosimetry Program – General Requirements	When implemented	7.1

Document #	Document Title	Notification Requirements	L.C.
OPG-PROC-0132	Respiratory Protection	When implemented	7.1
CONVENTIONAL HEALTH AND SAFETY			
OPG-POL-0001	Employee Health and Safety Policy	When implemented	8.1
OPG-PROG-0010	Health and Safety Management System Program	When implemented	1.1 8.1
N-PROG-MA-0015	Work Protection	When implemented	8.1
OPG-PROC-0132	Respiratory Protection	When implemented	8.1
ENVIRONMENTAL PROTECTION			
N-STD-OP-0031	Monitoring of Nuclear and Hazardous Substances in Effluents	When implemented	9.1
N-INS-03480-10002	Performance Testing of Airborne Effluent Monitoring Systems	When implemented	9.1
NA44-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Generating Station A	PRIOR to implementation	9.1
NK30-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Generating Station B	PRIOR to implementation	9.1
P-REP-03482-00001	Derived Release Limits and Environmental Action Levels for Pickering Nuclear Sewage Effluent	PRIOR to implementation	9.1
OPG-POL-0021	Environmental Policy	When implemented	9.1
N-PROG-OP-0006	Environmental Management	When implemented	9.1 11.1
N-PROC-OP-0044	Contaminated Lands and Groundwater Management	When implemented	9.1
N-INS-07080-10000	Hazardous Material Control	When implemented	9.1
N-PROC-OP-0038	Abnormal Waterborne Tritium Emission Response	When implemented	9.1

Document #	Document Title	Notification Requirements	L.C.
N-PROC-OP-0025	Management of the Environmental Monitoring Programs	When implemented	9.1
P-MAN-03443-00002	Pickering Environmental Monitoring Program	When implemented	9.1
N-PROC-OP-0037	Environmental Approvals	When implemented	9.1
P-REP-07701-0001	Environmental Risk Assessment Report for Pickering Nuclear	When implemented	9.1
EMERGENCY MANAGEMENT AND FIRE PROTECTION			
N-PROG-RA-0001	Consolidated Nuclear Emergency Plan	PRIOR to implementation	10.1
N-REP-03491-0650826	Updated Emergency Planning Technical Basis for Provincial Nuclear Emergency Response Plan	PRIOR to implementation	4.1 10.1
N-STD-AS-0010	Nuclear Crisis Communications Standard	When implemented	10.1
N-PROC-RA-0045	Emergency Preparedness Drills and Exercises	When implemented	10.1
N-PROC-RA-0133	Management of Equipment Important to Emergency Response	When implemented	10.1
N-PROG-RA-0012	Fire Protection	PRIOR to implementation	10.2
NA44-REP-71400-10001	Fire Protection Code Compliance Review – Pickering Nuclear Generating Station “A”	PRIOR to implementation	10.2
NA44-REP-71400-00023	Fire Safe Shutdown Analysis – Pickering A Nuclear Generating Station	PRIOR to implementation	10.2
NA44-REP-71400-10003	Fire Hazard Assessment - Pickering A Nuclear Generating Station	PRIOR to implementation	10.2
NK30-REP-71400-10001	Fire Protection Code Compliance Review – Pickering Nuclear Generating Station “B”	PRIOR to implementation	10.2
NK30-REP-71400-00001	Fire Safe Shutdown Analysis – Pickering B Nuclear Generating Station	PRIOR to implementation	10.2

Document #	Document Title	Notification Requirements	L.C.
NK30-REP-71400-10002	Fire Hazard Assessment – Pickering B Nuclear Generating Station	PRIOR to implementation	10.2
WASTE MANAGEMENT			
W-PROG-WM-0001	Nuclear Waste Management	PRIOR to implementation	11.1
N-PROC-OP-0043	Waste Management	When implemented	11.1
N-PROC-RA-0017	Segregation and Handling of Radioactive Wastes	When implemented	11.1
N-PROC-WM-0001	Disposal of Oil and Chemical Waste	When implemented	11.1
N-PROG-OP-0006	Environmental Management	When implemented	9.1 11.1
W-PROG-WM-0003	Decommissioning Program	PRIOR to implementation	11.2
W-PROC-WM-0093	Planning for Decommissioning	When implemented	5.1 11.2
W-STD-WM-0005	Conduct of Decommissioning	When implemented	11.2
P-PLAN-00960-00001	Preliminary Decommissioning Plan – Pickering Nuclear Generating Stations A and B	PRIOR to implementation	11.2
SECURITY			
N-PROG-RA-0011	Nuclear Security	PRIOR to implementation	12.1
TRAN-PLAN-03450-10000	Transport Security Plan	PRIOR to implementation	12.1
N-PROC-MP-0103	Security for Real-Time Process Computing System	When implemented	12.1
OPG-POL-0035	Cyber Security Policy	When implemented	12.1
P-LIST-69000-00001	Significant Cyber Assets	When implemented	12.1
SAFEGUARDS			
N-PROG-RA-0015	Nuclear Safeguards	PRIOR to implementation	13.1
N-STD-RA-0024	Nuclear Safeguards Implementation	PRIOR to implementation	13.1
PACKAGING AND TRANSPORT			
W-PROG-WM-0002	Radioactive Material Transportation	When implemented	14.1 15.6
N-STD-RA-0036	Radioactive Materials Transportation Emergency Response Plan	When implemented	14.1

Document #	Document Title	Notification Requirements	L.C.
NUCLEAR FACILITY-SPECIFIC			
P-REP-03680-0031	Pickering NGS Periodic Safety Review 2 (PSR2) Integrated Implementation Plan	PRIOR to implementation	15.1
P-INS-03680-00001	Pickering IIP Administration	PRIOR to implementation	15.1
NA44-SR-01320-00001	Pickering A Safety Report (Part 1)	When implemented	G.3 15.2
P-PLAN-09314-00003	Pickering Site Strategic Plan	When implemented	15.4
P-OM-018-31985-01	Cobalt Processing - Table of Contents/Revision History	When implemented	15.5
P-OP-31985-0001	Cobalt Processing Procedure	When implemented	15.5
P-OM-018-31985-04.04.12	Cobalt Processing – Cobalt Handling	When implemented	15.5
W-PROG-WM-0002	Radioactive Material Transportation	When implemented	14.1 15.6

APPENDIX D – LIST OF LICENSING PUBLICATIONS

Document #	Document Title	Version	L.C.
INFO-0795	Licensing Basis Objectives and Definitions	2010	G.1
AECB 1059	Reactor Licensing and Safety Requirements, Hurst and Boyd	1972	G.3 4.1
N294	Decommissioning of facilities containing nuclear substances	2009	G.5 11.2
RD/GD-99.3	Public Information and Disclosure	2012	G.6
N286	Management System Requirements for Nuclear Facilities	2012	1.1
P-119	Policy on Human Factors	2000	2.1
REGDOC-2.2.4	Fitness for Duty: Managing Worker Fatigue	2017	2.1
RD-363	Nuclear Security Officer Medical, Physical, Psychological Fitness	2008	2.1
REGDOC-2.2.2	Personnel Training	2014	2.3
RD-204	Certification of Persons Working at Nuclear Power Plants	2008	2.4
REGDOC-2.3.2	Accident Management: Severe Accident Management Programs for Nuclear Reactors	2013	3.1
N290.15	Requirements for the safe operating envelope for nuclear power plants	2010 (Reaffirmed 2015)	3.1
REGDOC-3.1.1	Reporting Requirements for Nuclear Power Plants	2016 version 2	3.3
REGDOC-2.4.1	Deterministic Safety Analysis	2014	4.1
S-294	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	2005	4.1
REGDOC-2.4.2	Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	2014	4.1
N286.7	Quality assurance of analytical, scientific and design computer programs for nuclear power plants	2016	4.1 5.1
N290.12	Human factors in design for nuclear power plants	2014	5.1
N291	Requirements for safety-related structures for CANDU nuclear power plants	2008	5.1 6.1
N285.0/N285.6	General requirements for pressure-retaining systems and components in CANDU nuclear power plants/Materials Standards for reactor components for CANDU nuclear power plants, issued June 2008 - Annex K and Annex M are accepted to be used as “Normative” Annexes.	2008 and Update No. 2 (August 2010)	5.2
N285.0/N285.6	General requirements for pressure-retaining systems and components in CANDU nuclear power plants/ Materials Standards for reactor components for CANDU nuclear power plants, issued August 2012 – Annex N (only)	2012 and Update No. 1 (September 2013)	5.2

Document #	Document Title	Version	L.C.
B51	Boiler, pressure vessel, and pressure piping code	2009 and Update No. 1 (March 2009)	5.2
BPVC	ASME Boiler and Pressure Vessel Code with Addenda	2010 Edition with 2011 Addendum	5.2
B31.1	Power Piping	2010	5.2
B31.3	Process Piping	2010	5.2
B31.5	Refrigeration Piping and Heat Transfer Components	2010	5.2
N289.1	General requirements for seismic design and qualification of CANDU nuclear power plants	2008	5.3
N290.13	Environmental qualification of equipment for CANDU nuclear power plants	2005 & Update 1 (2009) Reaffirmed in 2015	5.3
RD/GD-98	Reliability Programs for Nuclear Power Plants	2012	6.1
RD/GD-210	Maintenance Programs for Nuclear Power Plants	2012	6.1
REGDOC 2.6.3	Aging Management	2014	6.1
N285.4	Periodic Inspection of CANDU Nuclear Power Plant Components	2005	6.1
N285.4	Periodic Inspection of CANDU Nuclear Power Plant Components	2014	6.1
N285.8	Technical Requirements for In-Service Inspection Evaluation of Zirconium Alloy in Pressure Tubes in CANDU Reactors	2015	6.1
N285.5	Periodic Inspection of CANDU Nuclear Power Plant Containment Components	2008	6.1
N285.5	Periodic Inspection of CANDU Nuclear Power Plant Containment Components	2013	6.1
N287.1	General requirements for concrete containment structures for nuclear power plants	2014	6.1
N287.2	Material requirements for concrete containment structures for CANDU nuclear power plants	2008	6.1
N287.7	In-service Examination and Testing Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants	2008	6.1
P-223	Protection of the Environment	2001	9.1
N288.5	Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills	2011	9.1
N288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2008	9.1
N288.3.4	Performance Testing of Nuclear Air-Cleaning Systems at Nuclear Facilities	2013	9.1

Document #	Document Title	Version	L.C.
REGDOC-2.9.1	Environmental Protection Policies, Programs and Procedures	2013	9.1
N288.7	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2015	9.1
N288.4	Environmental monitoring programs at Class I nuclear facilities and uranium mines and mills	2010	9.1
N288.6	Environmental risk assessments at Class I nuclear facilities and uranium mines and mills	2012	9.1
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response	2014	10.1
N293	Fire protection for CANDU nuclear power plants	2007	10.2
N293	Fire protection for CANDU nuclear power plants	2012	10.2
P-290	Managing Radioactive Waste	2004	11.1
N292.2	Interim Dry Storage of Irradiated Fuel	2013	11.1
N292.3	Management of Low and Intermediate-Level Radioactive Waste	2008	11.1
REGDOC-2.12.1	High-Security Sites: Nuclear Response Force	2013	12.1
REGDOC-2.12.2	Site Access Security Clearance	2013	12.1
REGDOC-2.12.3	Security of Nuclear Substances: Sealed Sources	2013	12.1
RD-321	Criteria for Physical Protection Systems and Devices at High-Security Sites	2010	12.1
RD-361	Criteria for Explosive Substance Detection, X-ray Imaging, and Metal Detection Devices at High-Security Sites	2010	12.1
N290.7	Cyber security for nuclear power plants and small reactor facilities	2014	12.1
RD-336	Accounting and Reporting of Nuclear Material	2010	13.1
REGDOC-2.3.3	Periodic Safety Reviews	2008	15.1

APPENDIX E – LIST OF GUIDANCE PUBLICATIONS

Document #	Document Title	Version	L.C.
G-206	Financial Guarantees for the Decommissioning of Licensed Activities	2000	G.5 11.2
G-219	Decommissioning Planning for Licensed Activities	2000	G.5 11.2
REGDOC-3.2.2	Aboriginal Engagement	2016	G.6
N286.0.1	Commentary on N286-12	2014	1.1
N286.10	Configuration Management for High Energy Reactor Facilities	2016	1.1
G-323	Ensuring the Presence of Sufficiently Qualified Staff at Class I Nuclear Facilities – Minimum Staff Complement	2007	2.1 2.2
REGDOC-2.2.4	Fitness for Duty, Volume II: Managing Alcohol and Drug Use	2017	2.1
G-278	Human Factors Verification and Validation Plans	2003	2.2 3.1 5.1
REGDOC-2.2.2	Human Performance Management Personnel Training, Version 2	2016	2.3
N290.11	Requirements for reactor heat removal capability during outage of nuclear power plants	2013	3.1
REGDOC-2.3.2	Accident Management, Version 2	2015	3.1 10.1
N290.16	Requirements for Beyond Design Basis Accidents	2016	3.1
COG 09-9030	Principles & Guidelines For Deterministic Safety Analysis	R2	4.1
COG 11-9023	Guidelines for Application of the LOE/ROE Methodology to Deterministic Safety Analysis	R01	4.1
COG 06-9012	Guidelines for Application of the Best Estimate Analysis and Uncertainty (BEAU) Methodology to Licensing Analysis	R01	4.1
COG 08-2078	Principles and Guidelines for NOP/ROP Trip Setpoint Analysis for CANDU Reactors	R00	4.1
CSA N290.17	Probabilistic Safety Assessment for Nuclear Power Plants	2017	4.1
ASME/ANS RA-Sa-2009	Standard for Level 1/Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications, Addenda ASME/ANS RA-Sb-2013	2013	4.1
IAEA SSG-3	Development and Application of Level 1 Probabilistic Safety Assessment for Nuclear Power Plants	2010	4.1
IAEA SSG-4	Development and Application of Level 2 Probabilistic Safety Assessment for Nuclear Power Plants	2010	4.1
RD-327	Nuclear Criticality Safety	2010	4.1
GD-327	Guidance for Nuclear Criticality Safety	2010	4.1

Document #	Document Title	Version	L.C.
REGDOC-1.1.3	Licence Application Guide: Licence to Operate a Nuclear Power Plant	2017	5.1 6.1
REGDOC 2.5.2	Design of Reactor Facilities: Nuclear Power Plants	2014	5.1
G-276	Human Factors Engineering Program Plans	2003	5.1
N290.0	General Requirements for Safety Systems of Nuclear Power Plants	2011	5.1
N290.1	Requirements for the shutdown systems of nuclear power plants	2013	5.1
N290.2	Requirements for emergency core cooling systems for nuclear plants	2011	5.1
N290.3	Requirements for containment system of nuclear power plants	2016	5.1
N290.4	Requirements for reactor control systems of nuclear power plants	2011	5.1
N290.5	Requirements for electrical power and instrument air systems of CANDU nuclear power plants	2006	5.1
N290.6	Requirements for monitoring and display of nuclear power plant safety functions in the event of an accident	2009	5.1
N290.14	Qualification of Digital Hardware and Software for Use in Instrumentation and Control Applications for Nuclear Power Plants	2015	5.1
N291	Requirements for safety-related structures for CANDU nuclear power plants	2015	5.1 6.1
N289.2	Ground motion determination for seismic qualification of nuclear power plants	2010	5.3
N289.3	Design procedures for seismic qualification of nuclear power plants	2010	5.3
N289.4	Testing procedures for seismic qualification of nuclear power plant structures, systems, and components	2012	5.3
N289.5	Seismic instrumentation requirements for nuclear power plants and nuclear facilities	2012	5.3
REGDOC-2.6.1	Reliability Programs for Nuclear Power Plants	2017	6.1
REGDOC-2.6.2	Maintenance Programs for Nuclear Power Plants	2017	6.1
N287.1	General requirements for concrete containment structures for nuclear power plants	2014	6.1
N287.2	Material requirements for concrete containment structures for CANDU nuclear power plants	2008	6.1
N287.3	Design requirements for concrete containment structures for nuclear power plants	2014	6.1
N287.4	Construction, fabrication, and installation requirements for concrete containment structures for CANDU nuclear power plants	2008	6.1
N287.5	Examination and testing requirements for concrete containment structures for nuclear power plants	2011	6.1

Document #	Document Title	Version	L.C.
N287.8	Aging Management for Concrete Containment Structures for Nuclear Power Plants	2015	6.1
N285.7	Periodic Inspection of CANDU Nuclear Power Plants Balance of Plant Systems and Components	2015	6.1
G-129	Keeping Radiation Exposures and Doses "As Low As Reasonably Achievable (ALARA)"	2004	7.1 9.1
G-228	Developing and Using Action Levels	2001	7.1
REGDOC-2.9.1	Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.1	2017	9.1
N288.1	Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	2014	9.1
N288.2	Guidelines for Calculating the Radiological Consequences to the Public of a Release of Airborne Radioactive Material for Nuclear Reactor Accidents	2014	9.1
N288.7	Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	2015	9.1
P-223	Protection of the Environment	2001	9.1
G-228	Developing and Using Action Levels	2001	9.1
REGDOC-2.10.1	Nuclear Emergency Preparedness and Response, Version 2	2016	10.1
N1600	General requirements for nuclear emergency management programs	2016	10.1
NEI 00-01	Guidance for Post Fire Safe Shutdown Circuit Analysis	Revision 2	10.2
G-320	Assessing the Long term Safety of Radioactive Waste Management	2006	11.1
N292.0	General principles for the management of radioactive waste and irradiated fuel	2014	11.1
N292.1	Wet storage of irradiated fuel and other radioactive materials	2016	11.1
N292.3	Management of low- and intermediate-level radioactive waste	2014	11.1
N292.5	Guideline for the exemption of clearance from regulatory control of materials that contain, or potentially contain, nuclear substances	2011	11.1
G-274	Security Programs for Category I or II Nuclear Material or Certain Nuclear Facilities	2003	12.1
G-208	Transportation Security Plans for Category I, II or III Nuclear Material	2003	12.1
IAEA Nuclear Security Series No. 4 Technical Guidance	Engineering Safety Aspects of the Protection of Nuclear Power Plants Against Sabotage	2007	12.1
IAEA Nuclear Security Series No. 13 Recommendations	Recommendations on Physical Protection of Nuclear Material and Nuclear Facilities	Revision 5	12.1

Document #	Document Title	Version	L.C.
IAEA Nuclear Security Series No. 17 Technical Guidance	Computer Security at Nuclear Facilities	2011	12.1
GD-336	Guidance for Accounting and Reporting of Nuclear Material	2010	13.1
REGDOC-2.13.1	Safeguards and Nuclear Material Accountancy	2018	13.1
REGDOC-2.13.2	Import and Export	2016	13.1 15.6
REGDOC-2.14.1	Information Incorporated by Reference in Canada's Packaging and Transport of Nuclear Substance Regulations, 2015	2016	14.1
N290.18	Periodic safety review for nuclear power plants	2017	15.1
IAEA Specific Safety Guide No. SSG-25	Periodic Safety Review for Nuclear Power Plants	2013	15.1
COG JP-4491-V197	Fuel Channel Life Management – Third Party Review of Probabilistic Fracture Protection Evaluation Methodology Acceptance Criteria	2017	15.3

CURRENT LICENCE

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Word Ref.: e-Doc 5250122
PDF Ref.: e-Doc 5251091
File / Dossier: 2.01

NUCLEAR POWER REACTOR OPERATING LICENCE
PICKERING NUCLEAR GENERATING STATION

I) LICENCE NUMBER: **PROL 48.04/2018**

II) LICENSEE: Pursuant to section 24 of the *Nuclear Safety and Control Act* this licence is issued to:

Ontario Power Generation Inc.
700 University Avenue
Toronto, Ontario
M5G 1X6

III) LICENCE PERIOD: This licence is valid from September 1, 2013 to August 31, 2018, unless suspended, amended, revoked or replaced.

IV) LICENSED ACTIVITIES:

This licence authorizes the licensee to:

(i) Operate the Pickering Nuclear Generating Station (hereinafter "the nuclear facility") 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) Import and export nuclear substances, except controlled nuclear substances, that are required for, associated with, or arise from the activities described in [i]. [Added 2017.10]

(iv) Possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in [i].

(v) 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.

(vi) Possess, produce, manage, transfer and store Cobalt-60.

(vii) Possess, manage and store Cobalt-60 sealed sources.

(viii) Possess, transfer, manage and store heavy water from other nuclear facilities. [Added 2016.06]

(ix) Possess, transfer, package, manage, store and export nuclear substances, except controlled nuclear substances, from the Western Waste Management Facility. [Added 2017.10]

V) EXPLANATORY NOTES:

(i) Nothing in this licence shall be construed to authorize non-compliance with any other applicable legal obligation or restriction.

(ii) Unless otherwise provided for in this licence, words and expressions used in this licence have the same meaning as in the *Nuclear Safety and Control Act* and associated Regulations.

(iii) The PICKERING NGS LICENCE CONDITIONS HANDBOOK (LCH) provides compliance verification criteria in order to meet the conditions listed in the licence. The LCH also provides information regarding delegation of authority, applicable versions of documents and non-mandatory recommendations and guidance on how to achieve compliance.

VI) CONDITIONS:

1. General

1.1 The licensee shall conduct the activities described in Part IV of this licence in accordance with the licensing basis, as defined in Canadian Nuclear Safety Commission (CNSC) document INFO-0795 LICENSING BASIS OBJECTIVE AND DEFINITION, unless otherwise approved in writing by the CNSC (hereinafter "the Commission").

1.2 The licensee shall give written notification of changes made to the licensee documents submitted to support the licence application.

1.3 Licence condition withdrawn. [Amended 2014.12]

1.4 The licensee shall control the use and occupation of any land within the exclusion zone.

1.5 The licensee shall provide, at the nuclear facility and at no expense to the Commission, office space for employees of the Commission who customarily carry out their functions on the premises of that nuclear facility (on-site Commission staff). The licensee shall keep the office space of on-site Commission staff separate from the remainder of the building in which it is located by walls or other suitable structures.

1.6 The licensee shall maintain a financial guarantee for decommissioning that is acceptable to the Commission and shall satisfy the Commission that the financial guarantee remains valid and in effect and sufficient to meet the decommissioning needs.

1.7 The licensee shall implement and maintain a public information and disclosure program in accordance with CNSC regulatory document RD/GD-99.3 PUBLIC INFORMATION AND DISCLOSURE.

1.8 The licensee shall, in the event of any conflict or inconsistency between licence conditions, codes or standards or regulatory documents referenced in this licence, direct the conflict or inconsistency to the Commission, or a person authorized by the Commission, for resolution.

2. Management System

2.1 The licensee shall implement and maintain a management system in accordance with Canadian Standards Association (CSA) standard N286 MANAGEMENT SYSTEM REQUIREMENTS FOR NUCLEAR POWER PLANTS.

3. Human Performance Management

3.1 The licensee shall implement and maintain a human performance program.

3.2 The licensee shall implement and maintain the minimum shift complement and control room staffing for the nuclear facility.

3.3 The licensee shall implement and maintain a training program that includes certification training, examinations and tests for positions requiring certified personnel in accordance with CNSC regulatory document RD-204 CERTIFICATION OF PERSONS WORKING AT NUCLEAR POWER PLANTS.

Persons appointed to the following positions shall be certified:

(i) Responsible Health Physicist

(ii) Authorized Nuclear Operator

(iii) Control Room Shift Supervisor

(iv) Shift Manager.

4. Operating Performance

4.1 The licensee shall implement and maintain an operations program, which shall have as components:

(i) A Safe Operating Envelope in accordance with CSA standard N290.15 REQUIREMENTS FOR THE SAFE OPERATING ENVELOPE OF NUCLEAR POWER PLANTS,

(ii) A set of operating policies and principles,

(iii) Accident management procedures and/or guides for design basis and beyond design basis accidents, including overall strategies for recovery.

4.2 The licensee shall not restart the reactor after a serious process failure or a potential serious process failure, without the prior written approval of the Commission, or prior written consent of a person authorized by the Commission.

4.3 The licensee shall notify and report in accordance with CNSC regulatory document REGDOC 3.1.1 REPORTING REQUIREMENTS FOR NUCLEAR POWER PLANTS [Amended 2014.12]

5. Safety Analysis

5.1 The licensee shall implement and maintain a safety analysis program in accordance with CNSC regulatory documents: [Amended 2015.12]

(i) REGDOC-2.4.1 DETERMINISTIC SAFETY ANALYSIS,

(ii) REDGOC-2.4.2 PROBABILISTIC SAFETY ASSESSMENT (PSA) FOR NUCLEAR POWER PLANTS.

5.2 The licensee shall ensure that design and analysis computer codes and software used to support the safe operation of the nuclear facility are in accordance with CSA standard N286.7 QUALITY ASSURANCE OF ANALYTICAL, SCIENTIFIC AND DESIGN COMPUTER PROGRAMS FOR NUCLEAR POWER PLANTS.

6. Physical Design

6.1 The licensee shall implement and maintain a design program.

6.2 The licensee shall implement and maintain a pressure boundary program in accordance with CSA standard N285.0 GENERAL REQUIREMENTS FOR PRESSURE-RETAINING SYSTEMS AND COMPONENTS IN CANDU NUCLEAR POWER PLANTS and have in place a formal agreement that is acceptable to the Commission or a person authorized by the Commission with an Authorized Inspection Agency.

6.3 The licensee shall implement and maintain an environmental qualification program in accordance with CSA standard N290.13 ENVIRONMENTAL QUALIFICATION OF EQUIPMENT FOR CANDU NUCLEAR POWER PLANTS

7. Fitness for Service

7.1 The licensee shall implement and maintain programs to ensure fitness for service of systems, structures and components in accordance with CNSC regulatory documents and CSA standards:

(i) S-210 MAINTENANCE PROGRAMS FOR NUCLEAR POWER PLANTS

(ii) RD/GD-98 RELIABILITY PROGRAMS FOR NUCLEAR POWER PLANTS

(iii) RD-334 AGING MANAGEMENT FOR NUCLEAR POWER PLANTS

(iv) N285.4 PERIODIC INSPECTION OF CANDU NUCLEAR POWER PLANT COMPONENTS

(v) N285.5 PERIODIC INSPECTION OF CANDU NUCLEAR POWER PLANT CONTAINMENT COMPONENTS

(vi) N287.7 In-Service Examination and Testing Requirements for concrete Containment Structures for CANDU Nuclear Power Plants

These programs shall include an in-service inspection program for the safety significant balance of plant pressure retaining systems and components, and safety-related structures.

8. Radiation Protection

8.1 The licensee shall implement and maintain a radiation protection program, which includes a set of action levels. When the licensee becomes aware that an action level has been reached, the licensee shall notify the Commission within seven days.

9. Conventional Health and Safety

9.1 The licensee shall implement and maintain a conventional health and safety program.

10. Environmental Protection

10.1 The licensee shall implement and maintain programs to ensure environmental protection in accordance with:

(i) CNSC regulatory document S-296 ENVIRONMENTAL PROTECTION POLICIES, PROGRAMS AND PROCEDURES AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS,

(ii) CSA standard N288.1 GUIDELINES FOR CALCULATING DERIVED RELEASE LIMITS FOR RADIOACTIVE MATERIAL IN AIRBORNE AND LIQUID EFFLUENTS FOR NORMAL OPERATION OF NUCLEAR FACILITIES,

(iii) CSA standard N288.4 ENVIRONMENTAL MONITORING PROGRAMS AT CLASS I NUCLEAR FACILITIES AND URANIUM MINES AND MILLS.

In addition, the licensee shall undertake specific measures to control releases of nuclear and hazardous substances in accordance with applicable limits and to monitor effluents.

10.2 The licensee shall have a set of environmental action levels for nuclear substances. When the licensee becomes aware that an environmental action level has been reached, the licensee shall notify the Commission within seven days.

11. Emergency Management and Fire Protection

11.1 The licensee shall implement and maintain an emergency preparedness program, and conduct exercises in accordance with CNSC regulatory document RD-353 TESTING THE IMPLEMENTATION OF EMERGENCY MEASURES.

11.2 The licensee shall implement and maintain a fire protection program in accordance with CSA standard N293 FIRE PROTECTION FOR CANDU NUCLEAR POWER PLANTS.

12. Waste Management

12.1 The licensee shall implement and maintain a waste management program. The licensee shall manage low and intermediate-level radioactive waste in accordance with CSA standard N292.3 MANAGEMENT OF LOW AND INTERMEDIATE-LEVEL RADIOACTIVE WASTE.

12.2 The licensee shall implement and maintain a decommissioning strategy in accordance with CSA standard N294 DECOMMISSIONING OF FACILITIES CONTAINING NUCLEAR SUBSTANCES.

13. Security

13.1 The licensee shall implement and maintain a security program in accordance with CNSC regulatory documents:

- (i) S-298 NUCLEAR RESPONSE FORCE STANDARD,
- (ii) RD-363 NUCLEAR SECURITY OFFICER MEDICAL, PHYSICAL, AND PSYCHOLOGICAL FITNESS,
- (iii) RD-321 CRITERIA FOR PHYSICAL PROTECTION SYSTEMS AND DEVICES AT HIGH-SECURITY SITES,
- (iv) RD-361 CRITERIA FOR EXPLOSIVE SUBSTANCE DETECTION, X-RAY IMAGING, AND METAL DETECTION DEVICES AT HIGH-SECURITY SITES.

14. Safeguards and Non-Proliferation

14.1 The licensee shall implement and maintain a safeguards program and undertake all measures required to ensure safeguards implementation at the nuclear facility, including physical inventory accounting and reporting of inventory changes in accordance with CNSC regulatory document RD-336 ACCOUNTING AND REPORTING OF NUCLEAR MATERIAL. [Amended 2014.12]

15. Packaging and Transport

15.1 The licensee shall implement and maintain a packaging and transport program.

16. Nuclear Facility-Specific

16.1 The licensee shall implement and maintain a program for Cobalt-60 to cover activities described under Part IV) (v) and (vi) of this licence. The licensee shall provide a written report upon receipt of a Cobalt-60 sealed source.

16.2 The licensee shall implement and maintain a continued operations plan and a sustainable operations plan. The licensee shall confirm to the Commission, in writing and no later than June 30, 2017, the end date of commercial operations of all Pickering units.

16.3 The licensee shall obtain the written approval of the Commission, or written consent of a person authorized by the Commission, prior to the removal of any established regulatory hold point.

16.4 The licensee shall limit the activities of import and export of nuclear substances to those occurring as contaminants in laundry, packaging, shielding or equipment. [Added 2017.10]

SIGNED at OTTAWA OCT 2 6 2017

M. Binder

Michael Binder
President
CANADIAN NUCLEAR SAFETY COMMISSION