ONTARIO POWER GENERATION

Report

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PICKERING NGS PERIODIC SAFETY REVIEW SUMMARY

Pickering NGS Periodic Safety Review Summary

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Revision Summary

Revision Number	Date	Comments
D000	Oct 2017	Draft summary of Global Assessment Report issued for OPG review. (Candesco report K-421417-00113-R00D01)
D001	Feb 2018	Draft summary of Periodic Safety Review issued for OPG feedback. (Candesco report K-421417-00113-R00D02)
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Executive Summary

Ontario Power Generation (OPG) is planning to extend operation of the Pickering Nuclear Generating Station (NGS) to the end of 2024. Six of the station's eight nuclear reactors are operational. These are Pickering A Units 1 and 4 and Pickering B Units 5 to 8. Pickering A Units 2 and 3 are permanently shut down and will remain in a safe storage state throughout the period of extended operation.

OPG has completed a Periodic Safety Review of Pickering NGS to support the decision to extend operation. A Periodic Safety Review is an internationally accepted method of evaluating the safety of an operating nuclear power plant against current standards and identifying practicable enhancements that would further increase safety.

This document is a summary of the Periodic Safety Review, which is referred to as PSR2 because it builds on previous assessments. PSR2 comprises four major elements:

1. Production of a PSR2 Basis Document, which has been reviewed and accepted by Canadian Nuclear Safety Commission (CNSC) staff.
2. A comprehensive assessment of the station for each of fifteen Safety Factors that cover plant design, operation, management, safety analysis, radiological impact on the environment and radiation protection.
3. Production of a Global Assessment Report, which integrates information from the Safety Factor reviews, identifies practicable safety enhancements, and reaches a conclusion on the overall safety of the plant for the extended operating period.
4. Production of an Integrated Implementation Plan, which translates the safety enhancements identified in the Global Assessment Report into specific actions with target completion dates. CNSC staff has confirmed that the Integrated Implementation Plan fulfills regulatory requirements and meets CNSC staff expectations and is acceptable.

PSR2 concludes that the current plant design, operation, processes and management system will ensure continued safe operation of the station both in the short term, and for operation to 2024. The Pickering NGS units will be operated only if fitness for service of the structures, systems and components important to safety is assured. OPG and the Pickering Station Leadership Team are committed to investing in the plant, and focusing the organization to strive for continued improvement in the plant condition, operation and performance.

The Periodic Safety Review of Pickering NGS answers a series of questions to reach a conclusion on the safety of the station now and for operation to 2024 and to develop a set of safety enhancements that will be implemented.

1. What is the basis for saying the plant is safe today?

   The Global Assessment Report describes the current plant safety basis, including the plant design, management system and operating processes, and the means by which personnel are qualified and trained to safely execute their responsibilities. This description accounts for the extensive safety enhancements, including equipment replacements and upgrades,

that have been completed over the life of the station to date. The Global Assessment also describes the plant's multiple, overlapping barriers to the release of radioactivity to the environment. These multiple barriers result in extensive defence-in-depth for the current plant. The assessment describes how the enhancements that will be implemented via the Integrated Implementation Plan will further strengthen safety and defence-in-depth.

2. How does Pickering NGS compare to current safety standards?

   The operating licence issued by the CNSC already requires Pickering NGS to meet many safety standards that are current and that are consistent with global best practice. Nevertheless, the Safety Factor phase of PSR2 assesses the current plant design, processes, performance and management system against specific criteria and additional, modern safety standards that are not already identified as requirements in the operating licence. Differences whose resolution has the potential to enhance safety are identified as "Gaps". The Global Assessment collects Gaps that are similar in nature or that are on the same topic into a series of Global Issues. PSR2 identifies 51 Global Issues.

3. How are the Global Issues resolved?

   The Global Assessment identifies 23 Global Issues that can be resolved in a practicable way to enhance the safety of the station. For these Global Issues, the Global Assessment identifies a total of 35 potential safety enhancements, referred to as proposed Resolution Statements, each of which describes an action or actions that would resolve specific aspects of the associated Global Issue.

   The Global Assessment confirms that the other 28 Global Issues:

   - Were either resolved subsequent to completion of the Safety Factor Reports so no further action is needed, or
   - Are being addressed by ongoing activities outside of the PSR2 process, or
   - Will be resolved through proposed Resolution Statements associated with another Global Issue, or
   - Have no or low safety significance and a practicable resolution is not readily evident, or
   - Will be addressed through combinations of the above.

4. How do the proposed Resolution Statements get implemented?

   The Integrated Implementation Plan, which was produced in the final phase of the Periodic Safety Review, takes the proposed Resolution Statements from the Global Assessment as input, and develops specific actions with target completion dates for each. The Integrated Implementation Plan identifies a total of 63 specific actions, each with documented completion criteria. These actions are included as an appendix to this document. More than half of the actions will be completed in 2018, and all actions are scheduled to be complete by the end of 2020. The safety of the plant is incrementally enhanced as each action in the Integrated Implementation Plan is completed.

5. Is the plant safe to operate in the short-term and through the period of extended operation to 2024?

   The Global Assessment includes a detailed assessment of the defence-in-depth of the station, considers the safety significance of the Global Issues and the safety benefits of the

proposed Resolution Statements, and performs an objective assessment which concludes that the station is currently safe and that it can be operated safely throughout the period of extended operation.

Nineteen of the 35 proposed Resolution Statements and 35 of the 63 specific actions in the Integrated Implementation Plan support the fitness for service or address aging of structures, systems and components that are important to safety, such as the Fuel Channels in the reactor core, the Feeder piping that connects the Fuel Channels to the Heat Transport System piping, the Steam Generators, electrical cables, concrete structures, and other equipment and structures whose safe operation needs to be assured for the operating life of the station. OPG already has comprehensive processes in place to monitor the condition of structures, systems and components important to safety and to undertake the necessary maintenance or component replacement. As a result, many of the actions identified in PSR2 are already underway to ensure the continued fitness for service of structures, systems and components important to safety throughout the extended operating period.

Eleven of the 35 proposed Resolution Statements and 23 of the 63 specific actions in the Integrated Implementation Plan will result in physical enhancements to the station to prevent or mitigate accidents, or in additional safety analysis to confirm the robustness of the plant against postulated accidents considering the period of extended operation. Several of these proposed Resolution Statements build on actions already completed or that are underway to enhance safety based on lessons learned from the Fukushima event that occurred in Japan in 2011. The specific PSR2 actions include design enhancements to restore power to Containment Air Coolers and Hydrogen Igniters to maintain containment integrity for Fukushima-type events, and establishing additional cooling water sources for Units 1,4 for such events. Completion of these actions will ensure that in addition to already meeting the probabilistic safety goals, Units 1,4 will also meet the more challenging administrative safety goals. Units 5-8 already meet these goals and targets.

The remaining 5 proposed Resolution Statements and 5 specific actions in the Integrated Implementation Plan pertain to specific enhancements to align the plant with modern safety standards in other areas. These include actions to interconnect the Units 1,4 and 5-8 Fire Protection Systems, to enhance the overall robustness of fire protection for the station.

In summary, OPG has completed a Periodic Safety Review for Pickering NGS. The Periodic Safety Review has been performed consistent with Canadian regulatory requirements and accepted international practice. The Periodic Safety Review confirms the safety of the current plant and includes enhancements that will increase safety and strengthen defence-in-depth for the period of extended operation. Actions are presently underway to implement many of these enhancements, and actions for all of the enhancements are documented in the Integrated Implementation Plan. The Periodic Safety Review demonstrates that the current plant design, operation, processes and management system will ensure continued safe operation of the station both in the short term, and for extended operation to 2024.

1.0 INTRODUCTION

This report summarizes the methodology and results of a Periodic Safety Review (PSR) that OPG has conducted in support of extending the operation of Pickering NGS Units 1,4 and 5 through 8 to the end of 2024. Units 2 and 3 are permanently shut down and will remain in a safe storage state throughout the period of extended operation. This Periodic Safety Review builds on earlier OPG Integrated Safety Review (ISR) work performed for Pickering NGS and Darlington and other associated assessments, and so is called PSR2. The work has been performed consistent with the requirements of Canadian Nuclear Safety Commission (CNSC) REGDOC-2.3.3, *Periodic Safety Reviews* [R-1].

The objective of PSR2 is to provide an overall assessment of the safety of the plant, to identify practicable safety enhancements that will be implemented, and to assess the acceptability of Pickering NGS for continued operation over the PSR2 period taking the enhancements into account.

PSR2 was performed according to the PSR2 Basis Document [R-2]. The PSR2 Basis Document describes four phases, the first of which is preparation of the Basis Document itself, which establishes the scope and methodology for PSR2. As noted in the PSR2 Basis Document [R-2], the current planning basis for Pickering NGS is that Pickering NGS units will operate until the end of 2024. To align with the anticipated expiry date of the next power reactor operating licence (PROL), for the purposes of PSR2 the review period is assumed to extend until the end of 2028. This review period reflects that some systems and components will be required to remain in service and available for a period of time after the end of commercial operation.

The remaining three PSR2 phases are as follows:

1. Safety Factor Assessments.

   A Safety Factor is an aspect of safety to be assessed in a Periodic Safety Review. PSR2 assessed fifteen Safety Factors, listed in Table 1-1, which cover all aspects of plant design, operation, management, safety analysis, radiological impact on the environment and radiation protection. Each Safety Factor Report is comprised of assessments of review tasks suggested in IAEA SSG-25, *Periodic Safety Review of Nuclear Power Plants* [R-3], and REGDOC-2.3.3 [R-1] and clarified in the PSR2 Basis Document [R-2]. The Safety Factor reports also document the results of the assessments of Pickering NGS against relevant modern Laws, Regulations, Codes and Standards that are not already requirements per the current operating licence and consider OPG Program effectiveness reviews.

   PSR2 includes a review of other sources of information that could provide useful information on the safety of continued operation. These complementary reviews considered actions in the earlier plan for extending operation of Pickering B to 2020, referred to as the Continued Operations Plan (COP) [R-4]. They also considered the Fukushima Action Items (FAIs) [R-5] established after the Fukushima accident in 2011 to confirm and enhance safety at OPG stations.

   The Safety Factor phase identifies Gaps where the plant design or programs do not fully meet a review task or a safety significant element of a modern Law, Regulation, Code or Standard, or where a COP or FAI action is applicable to PSR2. Gaps represent

opportunities to enhance safety over and above current requirements, and are the input to the next phase of PSR2.

2. Global Assessment

   The assessment of the safety of continued operation is documented in the Pickering NGS Global Assessment Report [R-6]. The Global Assessment takes into account the Gaps identified in the Safety Factor Reports and complementary reviews. The Global Assessment consolidates similar Gaps into Global Issues, and develops proposed Resolution Statements for each Global Issue. The Global Assessment presents an assessment of the five levels of defence-in-depth, including consideration of other findings, such as Strengths (areas where Pickering NGS meets or exceeds modern requirements) and enhancements proposed through the Global Issue resolutions, in order to make a conclusion on the overall safety of extended operation of the plant.

3. Integrated Implementation Plan

   Preparation of the Integrated Implementation Plan (IIP) [R-7] involves transforming proposed Global Issue Resolution Statements resulting from the Global Assessment into actions with corresponding schedules for implementation prior to the end of 2020.

Section 2.0 of this report presents an overview of the methodology of the Periodic Safety Review; Section 3.0 presents a high-level view of the safety of Pickering NGS at the time of PSR2 and identifies the major physical modifications that will be made to the station as part of the IIP to further enhance safety; Section 4.0 summarizes the review of the plant against modern expectations; Section 5.0 presents the assessment of acceptability of extended operation; Section 6.0 summarizes the IIP action groupings; and Section 7.0 presents the conclusion of the assessment of overall acceptability of operation of the plant.

Table 1-1: Safety Factors Required by REGDOC-2.3.3

Safety Factor #	Topic
1	Plant Design
2	Actual Condition of Structures, Systems and Components Important to Safety
3	Equipment Qualification
4	Aging
5	Deterministic Safety Analysis
6	Probabilistic Safety Assessment
7	Hazard Analysis
8	Safety Performance
9	Use of Experience from Other Plants and Research Findings
10	Organization, the Management System and Safety Culture
11	Procedures
12	Human Factors
13	Emergency Planning
14	Radiological Impact on the Environment
15	Radiation Protection

2.0 OVERVIEW OF THE PERIODIC SAFETY REVIEW PROCESS

The requirements for a Periodic Safety Review are defined in REGDOC-2.3.3 [R-1]. The specific process followed in PSR2 is described in the PSR2 Basis Document [R-2] and outlined below. The PSR2 Basis Document, along with other PSR2 deliverables discussed in this section, fulfills the requirements of REGDOC-2.3.3.

Subsequent to acceptance of the PSR2 Basis Document by CNSC staff, the Safety Factor Reports and complementary reviews were completed, as discussed in Section 1.0. The Safety Factor Reports present the assessments of the review tasks for each Safety Factor, conformance with modern Laws, Regulations, Codes and Standards, and OPG Program effectiveness. In addition, the Safety Factor Reports include assessments of inputs from the following sources:

1. Pickering 1 and 4 integrated safety assessments performed during the Pickering A Return to Service;
2. Darlington ISR results applicable to PSR2, which included assessments of OPG programs and processes; and
3. OPG commitments to the CNSC and open CNSC action items.

The Gaps identified in the Safety Factor Reports and the complementary reviews provided the input to the Global Assessment process, which consists of the following elements:

1. Consolidation of Gaps into Global Issues.

   Gaps with clear similarity in themes or topical areas are consolidated into a specific Global Issue.

2. Prioritization of the Global Issues.

   Each Global Issue is prioritized for its potential enhancement of nuclear safety. The prioritization process comprises deterministic and probabilistic considerations.

3. Development of proposed Global Issue resolutions.

   Global Issues with a high or medium potential impact on nuclear safety are evaluated for resolution. Where the Global Issues have not already been resolved subsequent to the Safety Factor phase, proposed Resolution Statements to address the Global Issues are developed. Generally, Global Issues for which the potential impact on nuclear safety is very low or low and a practicable solution is not readily evident are classed as Acceptable Deviations and enhancement actions are not developed.

4. Assessment of Defence-in-Depth.

   The adequacy of the provisions for defence-in-depth is confirmed by demonstrating that the Pickering NGS design and operation are aligned with the specific safety principles covered in IAEA SRS-46 [R-8], taking into account the Strengths and proposed Resolution Statements, and the impact of Acceptable Deviations.

The Global Assessment Report documents the results of the elements listed above and the assessment of overall acceptability of extended operation of Pickering NGS over the PSR2 period.

The final phase of the Periodic Safety Review is the development of the IIP, which defines actions derived from the proposed Resolution Statements to address the Global Issues identified in the Global Assessment. The IIP Actions include new initiatives as well as existing initiatives. The latter generally comprise the ongoing execution of existing OPG programs, with the timeframe extended to cover operation to 2024.

In addition to initial internal review by the Periodic Safety Review preparation teams, a number of targeted and overall reviews were performed during the Periodic Safety Review process. These reviews are:

1. Review of the methodologies, Gaps, Global Issues, proposed Resolution Statements, IIP Actions and overall conclusions by a third party Expert Panel, comprised of experienced individuals who are familiar with the design and operation of Pickering NGS (and other nuclear plants) and who have demonstrated leadership in the Nuclear Industry, participating in external review committees and initiatives.
2. Review of the Periodic Safety Review reports by OPG's PSR2 project staff members and by OPG Subject Matter Experts.
3. Review and approval of proposed Global Issue Resolution Statements, the overall Global Assessment Report conclusions, and the IIP Actions and schedule by OPG's Senior Management Scope Review Board [R-9].
4. Authorization of and a commitment to execute the IIP by OPG's Senior Vice President – Pickering.

An action tracking and management system has been established for OPG and regulatory oversight, and an IIP change management process has been implemented to ensure that IIP Actions are completed according to the schedule in the IIP.

3.0 OVERALL PLANT PERFORMANCE

As noted above, the Safety Factor Reports contain assessments of the current state of the plant against modern expectations of programs and nuclear plant design. This section presents an overview of Pickering NGS's management system and organization, the current state of the plant's design, and an overview of current programs and processes to provide context for the Safety Factor and complementary reviews. In addition, the Global Assessment uses the current state of the programs and plant as a component in its assessment of the safety of extended operation of the plant.

3.1 Management and Organization

Nuclear safety is a core value at OPG. This is reflected in OPG Policy N-POL-0001, *Nuclear Safety Policy* [R-10], that is endorsed by OPG's Board of Directors. The policy places nuclear safety as the overriding priority above that of cost, schedule and production. It requires that all employees conduct themselves in a manner consistent with the behaviour of a healthy nuclear safety culture. Such conduct requires that staff always consider how their everyday activities can impact on the fundamental safety functions of the station.

OPG has established extensive programs and procedures and employs qualified staff to safely and effectively manage its nuclear plants. The programs and training were developed based on regulatory requirements, Canadian Standards Association (CSA) standards, International Atomic Energy Agency (IAEA) Guides, World Association of Nuclear Operators (WANO) recommendations and best nuclear industry practices from around the world. As part of continuous improvement, the programs and training are kept up to date, based on audits, self-assessments, benchmarking, and ongoing use of industry operating experience (OPEX).

The existing corporate structure supports well-defined lines of responsibility throughout the organization. In particular, the appropriate functions are in place and adequately staffed to support and enhance nuclear safety at all levels of defence-in-depth.

Pickering NGS management is committed to continuously strengthen the safety culture within the Pickering NGS organization. The health of safety culture is identified as a Strength for Pickering NGS (see Appendix B).

3.2 Plant Design Features

Pickering NGS was designed and built to high standards using the principles of defence-in-depth. The design includes a number of robust active and passive safety characteristics, as well as engineered and administrative safety features. These characteristics and features prevent accidents and/or mitigate accident progression should one occur.

3.2.1 Major Modifications Since Initial Operation

Numerous modifications to enhance safety have been made to Units 1,4 and Units 5-8 since the units commenced operation. These enhancements reflect OPG's continuous improvement philosophy and they bring the station into closer alignment with modern codes and standards. Key modifications that have been made to Units 1,4 include:

- Replacement of Fuel Channels
- Shutdown System Enhancement by adding independent trip parameters and trip logic
- Replacement of reactor system control computers
- Comprehensive Fire Protection System upgrade
- Emergency Coolant Injection Recovery System safety enhancements to assure that fuel can be cooled under certain accident conditions
- Emergency Boiler Water Supply System installation to assure boiler cooling water makeup under certain accident conditions
- Installation of independent stack monitors to isolate containment when high radioactivity is present in the containment exhaust
- Safety enhancements to the Low and High Pressure Service Water Systems to improve the capacity and reliability of emergency cooling to nuclear systems
- Safety enhancements to the Uninterruptible Power Supply
- Instrument Air System reliability improvements
- Environmental qualification implementation
- Seismic improvements

The key modifications that have been made to Units 5-8 are as follows:

- Installation of a third Emergency Power Generator
- Standby Generator governor and controls upgrade
- Fire protection upgrades in key areas of the plant

In addition, a number of other major enhancements have been made that apply to Units 1,4 and Units 5-8. These are:

- Enhancement of the Electrical Power System for multiple sources of backup power (this has been identified as a Strength for Pickering NGS in Appendix B)
- Installation of Hydrogen Igniters and Passive Auto-catalytic Recombiners in containment
- Installation of Critical Safety Parameter Monitoring equipment
- Provision of Emergency Mitigating Equipment (EME) for Beyond Design Basis Accidents (BDBA)

In summary, Pickering NGS has been continually upgraded and extensively modernized over its decades of operation to align it, as much as practicable, with current industry best practices. Pickering NGS will continue to implement physical changes to enhance safety. In particular, physical changes will be implemented as part of the IIP per the following Global Issues (GI):

1. GI-27 - Implement design changes to Pickering 1,4 to provide connection of the firewater system as an emergency cooling source to the Steam Generators, the Heat Transport System (HTS), and the calandria vessel to provide additional barriers for preventing accident progression to a severe accident. These safety enhancements augment the

existing EME provisions for post-BDBA fuel cooling and will improve the margins to probabilistic safety goals;

2. GI-40 - Complete the installation of the Phase 2 Emergency Mitigating Equipment, which includes supplying cooling water, and power to essential loads via EME generators, to allow for operation of Air Cooling Units (ACUs), Hydrogen Igniters, and the Filtered Air Discharge System (FADS) during BDBAs to protect Containment integrity; and
3. GI-48 - Interconnect the Pickering 1,4 and Pickering 5-8 Fire Protection System water supplies to meet the safety intent of CSA N293-12.

The IIP Actions and target completion dates are presented in Appendix C for these and the other Global Issues.

3.3 Programs and Processes

Pickering NGS is operated and maintained in accordance with current nuclear industry codes and standards consistent with regulatory and safety requirements and industry best practice. Normal plant operation is controlled by detailed, validated and formally approved procedures. The programs comprising Pickering's Nuclear Management System are aligned with modern industry best practice, as evidenced by the few PSR2 Gaps identified in the related Safety Factor Reports, and they typically support multiple levels of defence-in-depth. Some of the key programs are listed and summarized below:

- **Engineering Change Control:** This program ensures that all modifications to Structures, Systems, and Components (SSCs) important to safety, including software and station engineered tooling, are planned, designed, installed, commissioned, decommissioned, placed into service or removed from service within the Safe Operating Envelope (SOE), design basis and plant licensing conditions.

  An aspect of this program, specifically the implementation of Human Factors Engineering, is identified as a Strength for Pickering NGS (see Appendix B).

- **Equipment Reliability:** This program defines the requirements for establishing and maintaining optimum levels of reliability for components important to nuclear safety, production, and environmental protection. Reliable performance of components means very low numbers of component failures, equipment is kept in good operating condition, and redundancy is maintained on key systems.

  This program is identified as a Strength for Pickering NGS. System Health reporting, which is an integral element of the Equipment Reliability Program, is also identified as a Strength for Pickering NGS (see Appendix B).

- **Risk and Reliability Program:** This program establishes a framework for the development and use of Probabilistic Safety Assessment (PSA) as a tool for determining the impact of station configuration changes on margins to PSA safety goals.

  An aspect of this program, specifically Operationalization of Probabilistic Safety Assessments, is identified as a Strength for Pickering NGS (see Appendix B). The PSA is used to support conduct of engineering, maintenance and operation at Pickering NGS.

- **Reactor Safety Program:** This program defines the key elements for the management of issues related to deterministic nuclear safety analysis, generic safety issues (CANDU Safety Issues) and the following components of safe operation:
    - Safety Analysis Basis
    - SOE
    - BDBA Management
    - Safety Reports

  Deterministic Safety Analysis is assessed as a Strength for Pickering NGS. In addition, implementation of the SOE program is identified as a separate Strength (see Appendix B).
- **Human Performance Program:** This program provides guidance to reduce the probability and consequences of human error associated with the worker-machine interface required to operate, maintain and support Pickering NGS.

  Conventional Health and Safety, a key indicator of the Human Performance Program, has met or exceeded performance objectives and all applicable regulatory requirements.

3.4 Continuous Improvement

The continuous improvement process through which OPG strives to improve the safety and performance of its nuclear power plants is longstanding, ongoing, and covers all aspects of operation. Current performance is compared to management expectations, industry standards of excellence, internal and external OPEX, and regulatory requirements to identify areas with opportunities for improvement, prepare action plans and incorporate enhancements.

Established programs and processes are used to identify and address areas for improvement. OPG participates with industry partners in developing new or revised codes and standards, in research and development activities, in the application of emerging technologies, and in the exchange of OPEX. This is done through membership in organizations such as WANO, INPO, the CANDU Owners Group, the CSA and the Electric Power Research Institute.

The following sections describe some of the more significant areas of ongoing improvement.

3.4.1 Fukushima Operating Experience

Following the March 2011 earthquake in Japan, the safety systems at the Fukushima Daiichi Nuclear Power Plant operated as designed and the reactors were automatically shut down. However, the tsunami that followed disabled power to critical support systems.

OPG acted promptly to understand what had happened at Fukushima Daiichi and confirmed that the OPG nuclear fleet remained safe for continued operation. OPG has completed additional assessments including those requested by the CNSC to review the impact of a similar event (that is, an event resulting in a total loss of all AC power, subsequently resulting in a total loss of heat sinks) at OPG stations. Enhancements to provisions to maintain or re-establish the Control, Cool, Contain and Monitor safety functions were assessed to determine those that are most practicable to implement and also meet specified requirements. Several enhancements

have been implemented and additional ones are being implemented (see the descriptions of GI-27 and GI-40 presented in Section 3.2.1 and in Appendix C).

From a PSA perspective, the Pickering NGS Units 1,4 and 5-8 Level 1 and Level 2 At-Power Internal Events Risk Assessments have been updated as part of the Fukushima Action Item update, and demonstrate the benefits of the Fukushima enhancements.

A Mutual Aid Agreement for Nuclear Emergency Support [R-11] is in place with all Canadian nuclear utilities to provide support in the event of an emergency.

OPG continues to have a strong presence in international forums and with all operators of Canadian nuclear generating stations to ensure that the lessons learned from the 2011 Fukushima accident are applied at Pickering NGS.

Implementation of Fukushima Action Items is identified as a Strength for Pickering NGS (see Appendix B).

3.4.2 Pickering B ISR Continued Operations Plan

The purpose of the Pickering B ISR Continued Operations Plan (COP) was to document the progress of improvement actions that provide the technical basis for the continued operation of Pickering 5-8. These improvement actions were originally identified in the 2011 Pickering B ISR IIP and supplemented with new actions.

Implementation of the COP has supplemented existing OPG Programs and processes to provide the technical basis for continued operation beyond 2015 for approximately five additional years to 2020.

3.4.3 Radiation Protection Initiatives

Consistent with the policy of continuous improvement, OPG identifies and implements strategic improvement initiatives which would further reduce radiation exposures, to ensure that doses will be As Low As Reasonably Achievable (ALARA) during continued operation. These strategic initiatives include radiation source elimination, shielding, and worker protection. The use of advanced technology to enhance radiation protection has been identified as a Strength for Pickering NGS (see Appendix B).

4.0 RESULTS OF THE SAFETY FACTOR REVIEW AND GAP EVALUATION

As discussed in Sections 1.0 and 2.0, the assessments presented in the Safety Factor Reports determine if the intent of the review tasks is met and whether the current state of the plant design and operation conforms with the safety-significant elements of modern Laws, Regulations, Codes, and Standards.

A number of Gaps were identified in the Safety Factor Reports and in the complementary reviews of the Pickering B COP and the FAIs. However, none of the fifteen Safety Factor Reports or the two complementary reviews identified any fundamental safety issues. Overall, OPG has in place effective programs and processes for continued safe operation of the Pickering NGS through to the end of 2024.

As noted in Section 2.0, Gaps with clear similarity in themes or topical areas are consolidated into a specific Global Issue. For example, governance issues, where their resolution would require modification to OPG governance documentation, are grouped into a single Global Issue. For Gaps related to the implementation or effectiveness of governance, but where the governance itself is adequate, a distinct Global Issue for Governance Implementation/Effectiveness Issues is identified. The consolidation of Gaps also considers the expected differences between the level of safety significance of Gaps and their resolutions. For example, Gaps related to Steam Generator Fitness for Service (FFS) and Fiberglass Reinforced Plastic Material FFS are consolidated into separate Global Issues.

The Global Issues resulting from the consolidation of Gaps and for which proposed Resolution Statements are developed are listed in Appendix C. As noted in Section 2.0, resolutions are not developed for Global Issues for which the potential impact on nuclear safety is very low or low and a practicable resolution is not readily evident, or for which the resolution has already been completed, so these Global Issues are not listed in Appendix C. The appendix shows the proposed Resolution Statement(s) and IIP Actions associated with each Global Issue listed.

The CNSC uses a Safety and Control Area (SCA) framework to assess licensee conformance with regulatory requirements and expectations. The 14 SCAs cover all facility programs. Appendix A shows how the Global Issues for which there are proposed Resolution Statements align with the 14 SCAs.

5.0 ASSESSMENT OF OVERALL ACCEPTABILITY OF CONTINUED OPERATION

Overall acceptability of operation of the plant for the extended operating period is evaluated on the basis of a balanced view of all PSR2 results. The evaluation considers enhancements associated with the Global Issue proposed Resolution Statements, Strengths, Acceptable Deviations, and the assessment of defence-in-depth. Global Issues have been discussed in Section 4.0 above; Strengths, Acceptable Deviations, and the Defence-in-Depth Assessment are discussed in this section.

5.1 Pickering NGS Strengths Identified in PSR2

The Pickering NGS Strengths are used in the Global Assessment as indicators of alignment with modern codes, standards, and practices, and in the development of proposed Resolution Statements for Global Issues. They are also used in the Defence-in-Depth Assessment described in Section 5.2 to demonstrate fulfillment of the safety requirements of defence-in-depth.

REGDOC-2.3.3 [R-1] defines strengths as current practices that are “equivalent to or better than those established in modern codes and standards, practices”. Positive findings in PSR2 are identified as possible strengths if there is clear evidence that Pickering NGS and/or OPG programs are equivalent to or surpass the provisions of modern requirements and practices or review task objectives.

The following sources were reviewed for explicit statements of strength or discussions that indicated a strength:

- Safety Factor Reports
- Codes and Standards Assessments
- Complementary reviews of the Pickering B COP [R-4] and the Fukushima Action Items [R-5]
- Independent Third Party Assessments

  These sources, such as the CNSCs Regulatory Oversight Report [R-12], were used to corroborate indications identified in the three sources listed above.
- CNSC feedback on PSR2

A total of 24 Strengths are identified for Pickering NGS. They are listed in Appendix B, which also shows the levels of defence-in-depth supported by each Strength.

5.2 Defence-in-Depth

Defence-in-depth is a comprehensive approach to safety. It establishes five levels, each designed to prevent an accident from occurring, to mitigate an accident should one occur, or to prevent an accident from degrading to a more serious event. The general objective of defence-in-depth is to ensure that a single equipment or human failure at one level of the five levels of defence, and even a combination of failures at one level of defence, would not jeopardize the integrity of subsequent levels. In this way, defence-in-depth provides multiple, redundant safety provisions for the protection of the public and the environment.

The approach taken in this assessment was based on IAEA Safety Report Series No. 46, *Assessment of Defence in Depth for Nuclear Power Plants* [R-8]. The approach analyzed the five independent levels of defence. All levels of defence-in-depth rely on multiple barriers of protection to prevent or limit equipment failures or human errors and mitigate the consequences should these failures or errors occur. The intent of the review was to confirm that, for each of the five levels of defence, the barriers will be effective for the period of extended operation.

The scope considers the following elements of PSR2:

- The Strengths that have been identified in the PSR2 process, and how they support the baseline plant meeting the requirements of defence-in-depth.
- The positive impact on defence-in-depth of the proposed enhancements associated with the Global Issue proposed Resolution Statements.
- Confirmation that Acceptable Deviations do not have a significant adverse effect on defence-in-depth, either individually or in aggregate.

The results of the assessment for the five levels of defence-in-depth are summarized below.

Level 1 – Prevention of abnormal operation and failures

The first level of defence requires a high quality in the design and construction of the plant with barriers to prevent the occurrence of abnormal operating conditions. This is particularly important for the physical barriers surrounding the radioactive material in the fuel.

The assessment has confirmed that effective Level 1 barriers are ensured through the original conservative design supplemented by design improvements implemented since initial operation (some of which are discussed in Section 3.2), comprehensive programs in place, including effective operating and maintenance programs to ensure continued fitness for service and operation within the design basis, and ongoing continuous improvements based on national and international OPEX and evolving regulatory requirements. Given the focus and priority placed on equipment reliability to address the findings in the areas of equipment condition, this level of defence will continue to be strong and effective for Pickering NGS.

Level 2 – Control of abnormal operation and detection of failures

The second level of defence is the provision of barriers to prevent or control abnormal process conditions, with an objective to bring the plant back to normal operating conditions. The plant design possesses a number of strong features regarding Level 2 defence-in-depth. Digital computerized monitoring is used extensively in the design. Automatic reactor control features detect and respond to abnormal conditions before these conditions progress to the point that safety provisions in the next level of barriers are required to act.

A well-established framework of operating procedures is in place to respond to equipment malfunctions in a timely manner, thereby ensuring that the plant stays within its well-defined SOE.

The assessment of Level 2 defence-in-depth confirms that the provisions in place are mature and robust and will be enhanced by completion of proposed Resolution Statements related to Level 2.

Level 3 – Control of accidents within the design basis

The third level of defence is the barriers to minimize the consequences of accidents should they occur by providing inherent safety features, fail-safe design, additional equipment, and mitigating procedures. Pickering NGS has multiple heat removal systems supported by multiple electrical systems.

The Pickering NGS Safety Reports [R-13][R-14] demonstrate the effectiveness of the automatic responses of the safety systems and that regulatory dose limits are met for postulated accidents. In addition, confirmation of the effectiveness of the Level 3 barriers has been significantly enhanced with the completion of the CNSC S-294 [R-15] compliant PSA. The station design is of a high quality that includes extensive mitigating provisions, comprehensive accident management procedures, and a robust set of safety analyses.

Twenty-one strengths associated with Level 3 defences support the conclusion that Pickering NGS has strong Level 3 barriers.

Level 4 – Control of severe plant conditions, including prevention of accident progression and mitigation of the consequences of severe accidents

The fourth level of defence includes barriers to prevent severe plant conditions or control them should they occur, for example, operator action to maintain water in the calandria such that fuel cooling is assured.

The measures considered at the first three levels of defence will ensure maintenance of the structural integrity of the core and limit potential radiation hazards for members of the public for accidents within the design basis. Pickering NGS Units 1,4 and 5-8 also have complementary design features for BDBAs. These design features include redundant power systems, design adequacy for internal and external hazards, and hydrogen igniters and Passive Auto-catalytic Recombiners. If actions identified in Operating Manuals and Abnormal Incident Manuals are unsuccessful in terminating the accident progression, actions will be taken per the Emergency Mitigating Equipment Guidelines to prevent the accident from progressing to a severe accident. In addition, OPG has adequate plans, staff, facilities and equipment in place for dealing with a full range of emergencies.

The complete implementation of Severe Accident Management Guidelines and the OPEX from the 2011 Fukushima event has also significantly strengthened this level. OPG is continuing to implement enhancements, namely, completion of the installation of the Phase 2 Emergency Mitigating Equipment, which includes supplying cooling water, and power to essential loads via EME generators, to allow for operation of ACUs and Hydrogen Igniters for Pickering NGS Units 1,4 and 5-8, and connection of the firewater system to the EBWS, the HTS, and the calandria as an emergency cooling source for Pickering NGS Units 1,4 (see IIP Actions for GI-40 and GI-27, respectively, in Appendix C), that will further strengthen defence-in-depth Level 4.

Level 5 – Mitigation of radiological consequences of significant releases of radioactive materials

The fifth level of defence is associated with the management and mitigation of off-site radiological consequences should an accident occur.

The coordinated emergency response capability of the various response organizations and the implementation of OPEX from the 2011 Fukushima event support the strength of the Level 5 defence-in-depth provisions. Implementation of the planned improvement initiatives will further enhance the barriers for Level 5 at Pickering NGS.

In conclusion, a review of the five levels of defence performed in support of the Global Assessment has confirmed that Pickering NGS meets the defence-in-depth requirements, as a robust set of barriers is in place for the five levels of defence. The adequacy of these provisions has been confirmed by the comprehensive PSAs. No additional Gaps were identified or improvements required beyond those being addressed by the Global Issue proposed Resolution Statements. The levels of defence, particularly Levels 3 and 4, will be further strengthened as the planned safety improvements are implemented.

5.3 Acceptable Deviations

An assessment was performed to determine if Gaps that were not individually significant could become more significant when their collective effect was considered. The interaction assessment focused on the Gaps that were categorized as Acceptable Deviations, which includes Gaps with a very low safety significance or low overall safety significance for which a practicable solution is not readily evident and, consequently, there would be no further consideration beyond the Global Assessment. The assessment of Acceptable Deviations confirms there is no impact on the conclusion of the Defence-in-Depth Assessment or the Global Assessment, either individually or in aggregate.

6.0 THE INTEGRATED IMPLEMENTATION PLAN

As discussed in Section 2.0, the IIP is completed in the final phase of the Periodic Safety Review process and defines the actions derived from the proposed Resolution Statements to address the Global Issues identified in the Global Assessment.

The Global Assessment identified 51 Global Issues. Dispositions of 28 of these Global Issues were categorized in the Global Assessment as follows and, thus, proposed Resolution Statements are not required:

- The Global Issue is either resolved subsequent to completion of the Safety Factor Reports so no further action is needed, or
- The Global Issue is being addressed by ongoing activities outside of the PSR2 process, or
- The Global Issue will be resolved through proposed Resolution Statements associated with another Global Issue, or
- The Global Issue has very low safety significance or low safety significance and a practicable resolution is not readily evident, or
- The Global Issue will be addressed through combinations of the above.

The Global Assessment identified 35 proposed Resolution Statements for the remaining 23 Global Issues. Specific actions to enhance safety were prepared in the IIP for these proposed Resolution Statements, resulting in 63 IIP Actions. These 63 IIP Actions may be grouped as follows:

- 35 specific actions to support fitness for service or address aging of SSCs that are important to safety, such as the Fuel Channels and the Heat Transport System piping;
- 23 specific actions to implement physical enhancements to the station to prevent or mitigate accidents, or perform additional safety analysis to confirm the robustness of the plant against postulated accidents considering the period of extended operation; and
- 5 specific actions to align the plant with modern safety standards in other areas.

More than half of these actions are scheduled in the IIP to be completed in 2018, and all actions are scheduled to be complete by the end of 2020. The IIP Actions and target completion dates are shown in Appendix C.

The Expert Panel concluded that the IIP provided a balanced and comprehensive set of activities which addresses the results from the Global Assessment. The Expert Panel also concluded that the IIP had been prepared in a manner consistent with the regulatory requirements and with the PSR Basis Document and that successful IIP implementation will ensure that the Pickering station will be safe to operate both in the short term and for extended operation.

7.0 CONCLUSIONS OF THE PICKERING NGS PSR2

7.1 PSR2 Review and Acceptance by the CNSC

According to CNSC REGDOC-2.3.3 [R-1], the reports produced in each phase of a Periodic Safety Review must be submitted to the CNSC. In particular, CNSC staff confirms that the PSR2 Basis Document is acceptable, reviews the Safety Factor Reports and the Global Assessment Report, and confirms that the IIP is acceptable.

The CNSC accepted the PSR2 Basis Document [R-2]. The PSR2 Safety Factor Reports and the complementary reviews were submitted to the CNSC. CNSC staff reviewed the reports and their comments have been taken into account in the subsequent elements of PSR2, including the identification of additional Gaps. The Global Assessment Report [R-6] was submitted to the CNSC. CNSC staff reviewed the Global Assessment Report and their comments have been taken into account in the IIP. The IIP [R-7] was submitted to CNSC staff, who confirmed that it fulfills regulatory requirements and meets CNSC staff expectations and is acceptable [R-16].

7.2 Conclusion of the Assessment of Overall Acceptability of Operation of the Plant

The Periodic Safety Review demonstrates that Pickering NGS will operate safely during the extended operating period. Activities are in progress and planned that will further enhance safe plant operation. The justification for this conclusion is based on the following:

Current Plant State:

i) The Pickering Station Leadership Team has effectively aligned the organization to significantly improve performance in a number of key focus areas. Station performance improvement has been recognized through industry reviews. The plant is safe, and is operated safely.

ii) OPG has comprehensive programs in place to ensure the condition of SSCs important to safety at Pickering 1,4 and Pickering 5-8 is well understood, to assess the level of fitness for service, and to effectively take action to maintain good plant condition. This has led to continuous improvement in the condition of the plant, and plant performance.

iii) OPG has made significant improvements to the Pickering plant design and processes. The plant design enhancements, discussed in Section 3.2, together with the process enhancements, closely align the plant with safety-significant requirements of modern codes and standards (which in some cases are beyond current requirements), and enhance defence-in-depth. In particular, enhancements made in response to the 2011 Fukushima accident have reduced, and will further reduce, the risk associated with BDBAs.

iv) Design and operation of the plant meet the current deterministic safety analysis dose limits, and processes are in place to ensure the safety analysis accounts for any additional aging effects associated with extended operation. The Probabilistic Safety Assessment shows that the OPG risk-based Safety Goals for Core Damage Frequency and Large Release Frequency are met. Initiatives have been proposed to further enhance the margins to these goals.

v) Radiological dose performance and environmental impact performance are significantly better than regulatory limits. Programs in place ensure the ongoing effectiveness of the radiological protection of workers, the public and the environment.

Results of the Periodic Safety Review:

i) The Global Assessment identifies 24 Strengths (refer to Section 5.1), indicating that Pickering NGS is well aligned with modern codes, standards and practices in key areas.

ii) The Global Assessment identifies 51 Global Issues. Proposed Resolution Statements for Global Issues are developed, and many are in progress to further enhance safety, including enhancements to further reduce the risk associated with BDBAs (see IIP Actions for Global Issues GI-27 and GI-40 in Appendix C). Most of the proposed Global Issue proposed Resolution Statement actions reflect existing work programs and plans at the station. In particular, for the Global Issues of highest safety significance (that is, fitness for service to cover the extended operating period), OPG was already fully aware of these issues and is actively working on addressing them for the extended operating period. None of the Global Issues identify a safety concern that requires additional planned or urgent action to be taken. Specific IIP Actions in the Integrated Implementation Plan have been identified to address the Global Issues.

iii) The Global Issues of highest safety significance pertain to fitness for service of SSCs important to safety over the extended operating period. Units will be operated only if fitness for service of SSCs important to safety is assured. OPG has comprehensive programs in place to ensure the condition of SSCs important to safety is well understood, to assess the level of fitness for service, and to effectively take action to maintain good plant condition. The proposed Resolution Statements for these Global Issues will ensure the ongoing fitness for service of SSCs for the operational life of the plant, and these plans are actively being progressed.

iv) The Global Assessment includes a Resolution Statement that proposes the investigation and implementation of design, operational, and/or analytical options to further enhance margins to probabilistic Safety Goals. The IIP commits to providing alternative cooling sources and to enhance power supplies to systems that will further protect Containment integrity under accident conditions.

v) The assessment of Acceptable Deviations confirms there is no impact on the conclusion of the Global Assessment, either individually or in aggregate.

vi) The assessment of defence-in-depth of the plant includes a detailed review and confirmation of the adequacy of the provisions for each level of defence. This is based on an assessment of how the related safety principles for each level of defence-in-depth are met, taking into account the plant design, the ongoing operations and maintenance activities at the plant, the identified Strengths, as well as the proposed enhancements identified in the Global Assessment process and that will be implemented through the IIP. The assessment also accounts for the aggregate effect of Acceptable Deviations. The Defence-in-Depth Assessment shows that Pickering Units 1,4 and Pickering Units 5-8 design and operation have adequate and effective barriers in all levels of defence-in-depth.

vii) The IIP comprises a total of 63 specific actions, which will implement the 35 Global Assessment proposed Resolution Statements. More than half of the specific actions in the IIP are planned for completion by the end of 2018, and all are planned for completion by the end of 2020.

viii) OPG's organizational structure and management system provides the requisite processes, tools, resources and oversight that will ensure continued safe operation of the plant.

In summary, the current plant design, operation, processes and management system will ensure continued safe operation of Pickering 1,4 and Pickering 5-8 both in the short term, and for extended operation. Completion of the actions identified in the IIP will further enhance safety. OPG and the Pickering Station Leadership Team are committed to investing in the plant, and focusing the organization to strive for continued improvement in the plant condition, operation and performance.

8.0 ACRONYMS AND ABBREVIATIONS

AFS	Available for Service
AIFB	Auxiliary Irradiated Fuel Bay
ALARA	As Low As Reasonably Achievable
BDBA	Beyond Design Basis Accident
CA	Condition Assessment
CANDU	CANada Deuterium Uranium
CHR	Component Health Report
CNSC	Canadian Nuclear Safety Commission
COP	Continued Operations Plan
CSA	Canadian Standards Association
CSI	CANDU Safety Issue
CT	Calandria Tube
DA	Deaerators
EBWS	Emergency Boiler Water System
EME	Emergency Mitigating Equipment
EQ	Environmental Qualification
EQA	Environmental Qualification Assessment
FAI	Fukushima Action Item
FCRP2024	Fuel Channel Readiness Plan in Support of Operation to the end of 2024
FFS	Fitness for Service
FADS	Filtered Air Discharge System
FM	Fueling Machine
GI	Global Issue
HTS	Heat Transport System
IAEA	International Atomic Energy Agency
IAM	Integrated Aging Management
IFB	Irradiated Fuel Bay
IIP	Integrated Implementation Plan
INPO	Institute of Nuclear Power Operations
ISR	Integrated Safety Review
LCMP	Life Cycle Management Plan

LISS	Liquid Injection Shutdown System
LOCA	Loss of Coolant Accident
LOF	Loss of Flow
MVVP	Main Vacuum Volume Pump
NFPA	National Fire Protection Association
NGS	Nuclear Generating Station
NOP	Neutron Overpower
NPP	Nuclear Power Plant
OPEX	Operating Experience
OPG	Ontario Power Generation
PIP	Periodic Inspection Program
PLBB	Probabilistic Leak Before Break
PRD	Pressure Relief Duct
PROL	Power Reactor Operating Licence
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review
PSR2	Periodic Safety Review 2
RB	Reactor Building
RS	Resolution Statement
SBLOCA	Small Break Loss of Coolant Accident
SCA	Safety and Control Area
SHR	System Health Report
SOE	Safe Operating Envelope
SSCs	Structures, Systems and Components
VB	Vacuum Building
WANO	World Association of Nuclear Operators

9.0 REFERENCES

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[R-2] OPG Report, Pickering NGS Periodic Safety Review 2 (PSR2) Basis Document, P-REP-03680-00001-R002, June 2016.

[R-3] IAEA Specific Safety Guide, *Periodic Safety Review of Nuclear Power Plants*, SSG-25, March 2013.

[R-4] OPG Report, Pickering 5-8 Continued Operations Plan Review in Support of PNGS Periodic Safety Review 2 (PSR2), P-REP-03680-00024-R000, January 2017.

[R-5] OPG Report, Fukushima Action Item Review in Support of PNGS Periodic Safety Review 2 (PSR2), P-REP-03680-00022 R000, February 6, 2017.

[R-6] OPG Report, *Pickering NGS Global Assessment Report*, P-REP-03680-00032 R001, February 2018.

[R-7] OPG Report, Pickering NGS Periodic Safety Review 2 (PSR2) Integrated Implementation Plan, P-REP-03680-00031-R001, March 1, 2018.

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[R-15] CNSC Standard, Probabilistic Safety Assessment (PSA) for Nuclear Power Plants, S-294, April 2005.

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[R-17] OPG Report, Pickering NGS PSR2 Safety Factor 1 Report: Plant Design, P-REP-03680-00008 R000, March 2017.

[R-18] OPG Report, Pickering NGS PSR2 Safety Factor 2 Report: Actual Condition of Structures, Systems and Components Important to Safety, P-REP-03680-00005 R001, March 2017.

[R-19] OPG Report, Pickering NGS PSR2 Safety Factor 3 Report: Equipment Qualification, P-REP-03680-00006 R000, July 2016.

[R-20] OPG Report, Pickering NGS PSR2 Safety Factor 4 Report: Aging, P-REP-03680-00007 R000, July 2016.

[R-21] OPG Report, Pickering NGS PSR2 Safety Factor 5 Report: Deterministic Safety Analysis, P-REP-03680-00009 R000, March 2017.

[R-22] OPG Report, Pickering NGS PSR2 Safety Factor 6 Report: Probabilistic Safety Assessment, P-REP-03680-00010 R000, March 2017.

[R-23] OPG Report, Pickering NGS PSR2 Safety Factor 7 Report: Hazard Analysis, P-REP-03680-00011 R000, March 2017.

[R-24] OPG Report, Pickering NGS PSR2 Safety Factor 8 Report: Safety Performance, P-REP-03680-00012 R000, December 2016.

[R-25] OPG Report, Pickering NGS PSR2 Safety Factor 9 Report: Use of Experience from Other Plants and Research Findings, P-REP-03680-00013 R000, October 2016.

[R-26] OPG Report, Pickering NGS PSR2 Safety Factor 10 Report: Organization, the Management System and Safety Culture, P-REP-03680-00014 R000, December 2016.

[R-27] OPG Report, Pickering NGS PSR2 Safety Factor 11 Report: Procedures, P-REP-03680-00015 R000, October 2016.

[R-28] OPG Report, Pickering NGS PSR2 Safety Factor 12 Report: Human Factors, P-REP-03680-00016 R000, December 2016.

[R-29] OPG Report, Pickering NGS PSR2 Safety Factor 13 Report: Emergency Planning, P-REP-03680-00017 R000, December 2016.

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[R-33] OPG Report, Pickering PSR2 Law, Regulation, Code and Standard Reviews Associated with Safety Factors 9, 11, and 15, P-REP-03680-0586480 R000, September 2016.

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[R-35] OPG Report, Pickering PSR2 Law, Regulation, Code and Standard Reviews Associated with Safety Factors 1, 5, 6, and 7, P-REP-03680-00020 R000, March 2017.

[R-36] CNSC Reports, CNSC Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2012, 2013.

[R-37] CNSC Regulatory Document, *Deterministic Safety Analysis*, REGDOC-2.4.1, May 2014.

[R-38] CNSC Regulatory Document, Probabilistic Safety Assessment (PSA) for Nuclear Power Plants, REGDOC-2.4.2, May 2014.

Appendix A: PSR2 Results by CNSC Safety and Control Area

REGDOC-2.3.3 [R-1] specifies that PSRs be comprised of the assessments of 15 Safety Factors, which are identical to the 14 Safety Factors specified in the IAEA's guidance, SSG-25 [R-3], plus Radiation Protection. The CNSC evaluates and reports nuclear power plant safety performance according to 14 Safety and Control Areas (SCA) to confirm that licensees meet expectations for the provision of measures to protect health, safety and the environment and with respect to Canada's international obligations. Although the Safety Factors and the SCAs are not the same, there are significant similarities. The PSR2 Global Issues are presented in this appendix in the context of the Safety and Control Areas to facilitate understanding of how the PSR2 results support and will enhance performance in each of the SCAs.

Table A-1 lists the SCAs in the first column and the Safety Factors in the column headings in the first row. A check mark in a cell indicates that the Safety Factor correlates partially or totally to the SCA. In many cases, several Safety Factors are related to a single SCA, and some safety factors are relevant to multiple SCAs. Shading in a row indicates that the SCA is not within the scope of the Periodic Safety Review.

The table indicates that the emphasis of a Periodic Safety Review is on reactor safety, including design, operating programs and performance, safety analysis, radiation protection and impact on the environment. Licensee programs that are not directly related to reactor safety, such as security, safeguards, conventional health and safety, etc., are subject to regulatory oversight outside of the Periodic Safety Review process.

This appendix states the purpose of each SCA, identifies the Safety Factors applicable to each SCA and summarizes the findings of PSR2 for each SCA. Appendix C provides a composite list of the Global Issues and Global Issue proposed Resolution Statements that are discussed under each SCA, as well as the IIP Actions associated with each proposed Resolution Statement.

The CNSC publishes an annual regulatory oversight report, organized by SCA, which provides the CNSC's assessment of the nuclear power industry's safety performance. Each SCA discussion in this section includes the CNSC's rating of Pickering NGS's safety performance for that SCA from the reports of the last five years as an indicator of future safety performance. This is followed by a summary of PSR2 results indicating Pickering NGS's conformance with modern requirements and expectations, which has a direct bearing on extended operation.

The CNSC has assessed Pickering Nuclear Generating Station's overall performance as satisfactory or fully satisfactory over the last five years [R-36][R-12].

Table A-1: Mapping of Safety Factors to Safety and Control Areas

Safety and Control Area / Safety Factor	1 Plant Design	2 Actual Condition of Structures, Systems and Components Important to Safety	3 Equipment Qualification	4 Aging	5 Deterministic Safety Analysis	6 Probabilistic Safety Assessment	7 Hazard Analysis	8 Safety Performance	9 Use of Experience from other NPPs and Research Findings	10 Organization, the Management System and Safety Culture	11 Procedures	12 Human Factors	13 Emergency Planning	14 Radiological Impact on the Environment	15 Radiation Protection
Management system									✓	✓	✓	✓			
Human performance management										✓	✓	✓			
Operating performance								✓	✓	✓	✓				
Safety analysis					✓	✓	✓								
Physical design	✓	✓	✓	✓											
Fitness for service	✓	✓	✓	✓	✓	✓									
Radiation protection	✓							✓		✓					✓
Conventional health and safety															
Environmental protection								✓						✓	
Emergency management and fire protection													✓		
Waste management															
Security															
Safeguards and non-proliferation															
Packaging and transport															

A.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 healthy safety culture.

PSR2 addressed specific aspects of the Management System SCA in the Organization, Management System, and Safety Culture [R-26], Procedures [R-27], Use of Experience from Other Nuclear Power Plants and Research Findings [R-25], and Human Factors [R-28] Safety Factors. In addition to the 42 review tasks associated with these Safety Factors, OPG programs and 12 modern codes and standards related to the management subject area were assessed.

The assessment of the Safety Factor on Organization, Management System, and Safety Culture states that the review “has confirmed that the Pickering NGS organization, the management system and safety culture are adequate and effective for ensuring the safe operation of the plant” [R-26].

There are no Global Issues listed in Appendix C that are associated with the Management System SCA.

The CNSC has consistently assessed the Management System SCA as satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including Strengths shown in Appendix B,

- S-01, Management,
- S-10, Healthy Safety Culture, and
- S-19, Use of Operating Experience and Research Findings,

indicate that this will continue during extended operation.

A.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 licensees have sufficient staff in all relevant job areas with the necessary knowledge, skills, procedures and tools in place to safely carry out their duties.

PSR2 addressed specific aspects of human performance in the Organization, Management System, and Safety Culture [R-26], Procedures [R-27], and Human Factors [R-28] Safety Factors.

The assessment of the Safety Factor on Human Factors states that the review "has confirmed that the various human factors that may affect the safe operation of Pickering NGS have been appropriately addressed” [R-28].

There are no Global Issues listed in Appendix C that are associated with the Human Performance Management SCA.

The CNSC has consistently assessed the Human Performance Management SCA as satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including Strengths shown in Appendix B,

- S-10, Healthy Safety Culture,
- S-16, Human Factors Engineering Program,
- S-20, Minimum Staff Complement Management, and
- S-21, Training,

indicate that this will continue during extended operation.

A.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.

PSR2 addressed specific aspects of the Operating Performance SCA in the Safety Performance [R-24], Use of Experience form Other Plants and of Research Findings [R-25], Organization, Management System, and Safety Culture [R-26], and Procedures [R-27] Safety Factors.

The assessment of the Safety Factor on Safety Performance states that the review "has confirmed that the safety performance indicators and records of operating experience, including the evaluation of root causes of plant events, exist and are utilized to ensure the safe operation of Pickering NGS" [R-24].

The assessment of the Safety Factor on Use of Experience from Other Nuclear Power Plants and Research Findings states that the review "has confirmed for Pickering NGS that there is adequate feedback of relevant experience from other nuclear power plants and from findings of research, and that this is used to introduce reasonable and practicable safety improvements at the plant or in the operating organization" [R-25].

There are no Global Issues listed in Appendix C that are related to the Operating Performance SCA.

The CNSC has consistently assessed the Operating Performance SCA as satisfactory or fully satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including Strengths shown in Appendix B,

- S-01, Management,
- S-10, Healthy Safety Culture,
- S-18, Comprehensive Set of Performance Indicators, and
- S-19, Use of Operating Experience and Research Findings,

indicate that this will continue during extended operation.

A.4 Safety Analysis

The Safety Analysis SCA pertains to maintaining the safety analysis that supports the 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 preventive measures and strategies in reducing the effects of such hazards.

PSR2 addressed specific aspects of the Safety Analysis SCA in the Deterministic Safety Analysis [R-21], Probabilistic Safety Assessment [R-22], and Hazard Analysis [R-23] Safety Factors.

The assessments in the deterministic safety analysis and probabilistic safety assessment Safety Factor Reports state that the analysis-related programs and procedures at OPG are comprehensive, resulting in a systematic and disciplined approach to identifying, prioritizing and addressing safety analysis issues [R-21][R-22]. The hazard analysis Safety Factor Report states that the review "has confirmed the adequacy of protection of Pickering NGS against internal and external hazards, with account taken of plant design (including confirmation that analyses/methods address the condition of SSCs important to safety), site characteristics, and current analytical methods, safety standards and knowledge" [R-23].

The assessments confirmed that analyses documented in the Safety Report or stand-alone assessments demonstrate that regulatory safety limits and industry best practice safety goals are met [R-22].

Five Global Issues related to the Safety Analysis SCA are listed in Appendix C. These may be summarized as follows:

1. GI-24, GI-25, and GI-31: The Resolution Statements for GI-24 and GI-25 propose updating the deterministic analysis or assessment to demonstrate the safety of the plant to the end of the extended operating period. The Resolution Statements for GI-31 propose completion of the implementation plan for REGDOC-2.4.1 [R-37] with consideration of extended operation. Work on GI-31 resolution is in progress.
2. GI-27 and GI-32: The Resolution Statements for GI-27 propose completion of actions from the PSA improvement plan, and consideration of additional practicable design, operational and/or analytical enhancements that will improve the margins to the probabilistic safety goals. The Resolution Statement for GI-32 proposes completion of the implementation plan for REGDOC-2.4.2 [R-38] with consideration of extended operation. The work on these Resolution Statements is in progress.

The CNSC has consistently assessed the Safety Analysis SCA as satisfactory or fully satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including Strengths shown in Appendix B,

- S-06, Deterministic Safety Analysis,
- S-07, Probabilistic Safety Assessment,
- S-08, Operationalization of Probabilistic Safety Assessment, and
- S-09, Implementation of Safe Operating Envelope Program,

and the enhancements to safety through resolution of the Global Issues, indicate that this will continue during extended operation.

A.5 Physical Design

The Physical Design SCA relates to activities that affect 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.

PSR2 addressed specific aspects of the Physical Design SCA in the review of Plant Design [R-17], Equipment Qualification [R-19], Aging [R-20] and Actual Condition of SSCs Important to Safety [R-18] Safety Factors. The majority of review tasks for the Aging [R-20] and Actual Condition of SSCs Important to Safety [R-18] Safety Factors are relevant to the Fitness for Service SCA, so these aspects are discussed in Section A.6.

Four Global Issues shown in Appendix C are related to the Plant Design and Equipment Qualification Safety Factors. They may be summarized as follows:

1. There are two Global Issues related to equipment qualification. The Resolution Statement for GI-9 proposes documenting the seismic capacity of spent fuel basket stacking arrangements. The Resolution Statement for GI-12 ensures that equipment qualifications will continue to be valid for operation beyond the year 2020. The work on GI-12 is actively progressing.
2. There are two Global Issues related to fire protection. The Resolution Statement for GI-47 proposes installation of wrenches and locks on the Pickering 058 Yard Fire Protection System to satisfy Fire Protection Code NFPA 24. This work has been initiated. The Resolution Statement for GI-48 proposes connecting the Pickering 1,4 and Pickering 5-8 Fire Protection Systems to satisfy the intent of CSA N293.

The Plant Design Safety Factor Report states that the review "has confirmed, by assessment against the current licensing basis and applicable standards, requirements and practices, that the design of Pickering NGS and its documentation are adequate" [R-17].

The CNSC has consistently assessed the Physical Design SCA as satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including Strengths shown in Appendix B,

- S-14, Heat Removal Systems,
- S-15, Electric Power System, and
- S-17, Environmental Qualification Program.

and the enhancements to safety through resolution of the Global Issues, indicate that this will continue during extended operation.

A.6 Fitness for Service

The Fitness for Service SCA covers activities that affect the physical condition of structures, systems and components 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.

PSR2 addressed specific aspects of the Fitness for Service SCA in the review of Plant Design [R-17], Environmental Qualification [R-19], Deterministic Safety Analysis and Probabilistic

Safety Assessment [R-21][R-22], Aging [R-20], and Actual Condition of SSCs Important to Safety [R-18] Safety Factors. The conclusions of the review of the first two Safety Factors are provided in Section A.5; the conclusions of the review of the Safety Analysis Safety Factors are provided in Section A.4. The results of the Safety Factor Reports on Aging and Actual Condition of SSCs Important to Safety are discussed under this SCA.

OPG manages the aging and obsolescence of SSCs through the Integrated Aging Management (IAM) Program. The IAM Program is consistent with best industry practices and ensures the safe long term operation of the station.

The IAM Program establishes an integrated set of activities that ensure:

- The long term health of SSCs,
- The high operational reliability of equipment, and
- The safety and operating margins are monitored and maintained.

The condition of Major Components, consisting of Fuel Channels, Feeders, Steam Generators, and Reactor Components and Structures is managed by rigorous Life Cycle Management Plans (LCMPs) stipulated by the IAM Program.

To support the station equipment reliability program, a comprehensive assessment of the plant condition is documented in a series of Condition Assessments. The associated Safety Factor Report [R-18] identified 18 Gaps, the majority of which require system fitness for service assessments and LCMP updates to cover the extended operating period. Similar Gaps were identified in the Pickering B Continued Operations Plan Review [R-4]. Global Issues GI-1 through GI-4 and GI-19 address these Gaps. The proposed resolutions for all condition assessments have been consolidated into one proposed Resolution Statement under GI-8, with the exception of condition assessment of safety-related civil structures (non-containment), which has been captured in GI-43. Work is actively underway to update condition assessments and confirm assurance of fitness for service for safety-related SSCs for the extended operating period. Much of this work is already complete for 2024.

There are four additional Global Issues associated with the condition of or understanding the condition of systems, as follows:

1. An assessment of Class 1 piping and component service limits has been completed. However, the assessment needs to be updated to account for environmental factors to confirm the adequacy of the assessment. This is captured in the proposed Resolution Statement for GI-5. The assessment does not apply to Major Components.
2. As a consequence of revision to the Criticality Coding, which is used for determining cable risk rating, the cable surveillance program needs to be assessed for the impact of the revision and the surveillance plan adjusted accordingly. The proposed action is captured in the Resolution Statement for GI-6.
3. The Resolution Statement for GI-10 proposes completion of mitigation of lrradiated Fuel Bay leakage to the liner interspace that is already in progress.
4. Assessments were completed confirming the adequacy of buried piping. GI-7 proposes activities to update the Buried Piping Program asset management plan and risk ranking for the extended operating period, and to update governance to reflect a graded approach in the event that any leakage in fuel oil piping occurs.

The review of modern codes and standards related to Fitness for Service resulted in one Global Issue shown in Appendix C. The review of CSA N285.4, *Periodic Inspection of CANDU Nuclear Power Plant Components*, identified a number of Gaps resulting from changes between the 2005 and the 2009 versions that have been consolidated under Global Issue GI-50. The GI-50 Resolution Statements propose changes to align Periodic Inspection Program (PIP) governance and the PIPs with the new version, as well as an assessment of the impact of code concessions granted by the CNSC on extended operation.

The Aging Safety Factor Report states that the review, "has confirmed that aging aspects affecting SSCs important to safety are being effectively managed and that an effective aging management program is in place at Pickering NGS" [R-20]. The Safety Factor Report on Actual Condition of SSCs Important to Safety states, "This assessment has not identified any major concerns that the SSCs will continue to operate as per the design basis requirements during life extension" [R-18].

The CNSC has consistently assessed the Fitness for Service SCA as satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including Strengths shown in Appendix B,

- S-02, Effective Equipment Reliability Program,
- S-03, Major Components Program, and
- S-04, System and Component Health Reporting,

and the enhancements to safety through resolution of the Global Issues, indicate that this will continue during extended operation.

A.7 Radiation Protection

The Radiation Protection SCA covers the implementation of a radiation protection program in accordance with the Radiation Protection Regulations. This program must ensure that contamination and radiation doses received are monitored and controlled.

PSR2 addressed specific aspects of the Radiation Protection SCA in the Plant Design [R-17], Safety Performance [R-24], Organization, Management, and Safety Culture [R-26], and Radiation Protection [R-31] Safety Factor Reports.

The assessments in the Safety Factor phase did not identify any Gaps in the Radiation Protection governance and design and equipment. Consequently, there are no Global Issues listed in Appendix C that are related to the Radiation Protection SCA.

The Radiation Protection Safety Factor Report states that the review, "confirmed that Radiation Protection has been adequately accounted for in the design and operation of Pickering NGS, and that Radiation Protection provisions (including design and equipment) provide adequate protection of persons from the harmful effects of radiation and ensure that contamination and radiation exposures and doses to persons are monitored and controlled and maintained ALARA" [R-31].

The CNSC has consistently assessed the Radiation Protection SCA as satisfactory or fully satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including Strengths shown in Appendix B,

- S-12, Dose to Public,
- S-13, Radiation Exposure Performance, and
- S-24, Advanced Technology to Support Radiation Protection,

indicate that this will continue during extended operation.

A.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 Conventional Health and Safety SCA is not within the scope of PSR2.

A.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 PSR2 review of the Safety Performance [R-24] and Radiological Impact on the Environment [R-30] Safety Factor confirmed that the Pickering NGS operating organization has an adequate program for the surveillance of the radiological and non-radiological impacts of the station on the environment.

The Safety Factor on Radiological Impact on the Environment states that the review “has confirmed that Pickering NGS has an adequate and effective program for monitoring the radiological impact of the plant on the environment, which ensures that emissions are properly controlled and are as low as reasonably achievable”. It also states that, “a comprehensive program for monitoring and controlling effluent releases is in place” [R-30].

No Global Issues were created that impact the Environmental Protection SCA.

The CNSC has consistently assessed the Environmental Protection SCA as satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including the Strength shown in Appendix B,

- S-23, Environmental Protection Program,

indicate that this will continue during extended operation.

A.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 including any results of exercise participation.

The Emergency Management and Fire Protection SCA was addressed in the PSR2 review of the Emergency Planning [R-29] Safety Factor. This Safety Factor Report includes the fire response assessment results while fire protection operations, design and analysis are

discussed and rated in the appropriate SCA of operating performance, safety analysis or physical design.

Two Global Issues are listed in Appendix C that relate to the Emergency Management and Fire Protection SCA, GI-26 and GI-40. The Resolution Statement for GI-26 proposes enhancement of the Emergency Response Projection software to address multi-unit BDBA scenarios. The work to address GI-26 is in progress. The Resolution Statement for GI-40 proposes completion of the installation of the last of the Emergency Mitigating Equipment. Installation of this equipment is in progress.

The Emergency Planning Safety Factor Report states that the review "has confirmed that OPG Nuclear has: a) adequate plans, staff, facilities and equipment in place for dealing with emergencies, and b) there are adequate arrangements in place for regular emergency training and exercises, and interaction and coordination with local and national authorities" [R-29].

The CNSC has consistently assessed the Emergency Management and Fire Protection SCA as satisfactory over the last five years [R-36][R-12]. The positive results of PSR2 related to this SCA, including Strengths shown in Appendix B,

- S-05, Implementation of Fukushima Action Items,
- S-11, Relationship with Stakeholders and Public, and
- S-22, Emergency Management,

and the enhancements to safety through resolution of the Global Issues, indicate that this will continue during extended operation.

A.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 also covers the planning for decommissioning.

The Waste Management SCA is not within the scope of PSR2.

A.12 Security

The Security SCA 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.

The Security SCA is not within the scope of PSR2.

A.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 Canada/IAEA safeguards agreements as well as all other measures arising from the Treaty on the Non-Proliferation of Nuclear Weapons.

The Safeguards and Non-Proliferation SCA is not within the scope of PSR2.

A.14 Packaging and Transport

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

The packaging and transport SCA is not within the scope of PSR2.

Appendix B: Strengths Used in the Defence-in-Depth Assessment

Strength ID	Strength Title and Description	Defence-in-Depth Level
S-01	**Management** The Pickering Station Leadership Team has effectively aligned the organization to significantly improve performance in several focus areas.	1, 2, 3, 4, 5
S-02	**Effective Equipment Reliability Program** Pickering NGS' Equipment Reliability Program implementation and execution of the program is a station priority. The station management team monitors implementation, and leaders enforce accountability. Obsolescence Management and Performance Monitoring, Condition Assessments, and Predictive Maintenance are also noted as taking into consideration the long-term aging management assessments.	1, 2, 3, 4
S-03	**Major Components Program** Strong governance framework with comprehensive programs is in place for Major Component Life Cycle Management Plans, addressing the full spectrum of disciplines, including administrative, engineering, inspection, maintenance, training, quality assurance, engineering change control in conjunction with application of OPEX and research findings.	1, 2, 3, 4
S-04	**System and Component Health Reporting** The conditions of the Pickering NGS SSCs are tracked in System and Component Health Reports that are aligned with industry best practices.	1
S-05	**Implementation of Fukushima Action Items** Pickering NGS has implemented and is continuing to enhance significant provisions to prevent and mitigate severe accident progression and protect Containment integrity and enhance defence-in-depth against BDBAs.	4, 5
S-06	**Deterministic Safety Analysis** The deterministic safety analysis is robust and effectively implemented.	1, 2, 3, 4

Strength ID	Strength Title and Description	Defence-in-Depth Level
S-07	**Probabilistic Safety Assessment** The PSA program meets or exceeds performance objectives. OPG has developed and implemented a process of maintenance of the probabilistic risk assessment model to ensure that the model is representative of the actual plant configuration and operation and testing at the station.	1, 2, 3, 4
S-08	**Operationalization of Probabilistic Safety Assessment** Probabilistic Safety Assessment (PSA) is used to support conduct of engineering, maintenance and operation.	1, 2, 3, 4
S-09	**Implementation of Safe Operating Envelope Program** Comprehensive program in place for systematic application of Safe Operating Envelope (SOE) definition, implementation and maintenance (to end of station life).	1,2,3
S-10	**Healthy Safety Culture** Pickering has a healthy Nuclear Safety Culture and a respect for nuclear safety and there is a strong bias to put safety over production. Pickering has formally implemented Nuclear Safety Culture Monitoring Panels for regular monitoring of safety behaviour to promote use of error-free performance tools, risk-informed decision making and questioning attitude in day-to-day activities throughout the organization.	1, 2, 3, 4
S-11	**Relationship with Stakeholders and Public** OPG has fostered a strong relationship with stakeholders and interested public. A longstanding positive relationship with the community is in place to promote communication, education and awareness regarding the role of nuclear power and the overriding priority being placed on safety and environment.	4, 5
S-12	**Dose to Public** The dose to the off-site public resulting from operation of the station is very much less than the dose from background radiation.	1, 2, 3, 4, 5
S-13	**Radiation Exposure Performance** Radiation protection performance exceeds objectives and application of As Low as Reasonably Achievable (ALARA) meets or exceeds regulatory expectations.	1, 2, 3, 4

Strength ID	Strength Title and Description	Defence-in-Depth Level
S-14	**Heat Removal Systems** Pickering NGS has made modifications to achieve multiple overlapping heat removal provisions for normal operation and design basis events, and for Beyond Design Basis conditions.	1, 2, 3, 4
S-15	**Electrical Power System** Pickering NGS has implemented design modifications to provide standby and Emergency Power Systems to provide the necessary electrical power to maintain the plant in a safe shutdown state and ensure nuclear safety in Design Basis Accidents and Beyond Design Basis conditions, and support Severe Accident Management actions.	1, 2, 3, 4, 5
S-16	**Human Factors Engineering Program** A robust human factors engineering program has been established.	1, 2, 3, 4
S-17	**Environmental Qualification Program** The Environmental Qualification Program at OPG is fully developed.	1, 2, 3
S-18	**Comprehensive Set of Performance Indicators** A comprehensive set of station performance indicators is in place to monitor operations.	1, 2, 3, 4, 5
S-19	**Use of Operating Experience and Research Findings** Rigour in the identification and application of OPEX and of research findings, and support of a senior advisory team for Research & Development issue identification and action implementation.	1, 2, 3, 4, 5
S-20	**Minimum Staff Complement Management** An online computer program for monitoring staffing level for minimum complement roles, as well as forecasting future staffing needs, thereby ensuring minimum complement coverage, is effectively managed on a continuous basis.	1, 2, 3, 4
S-21	**Training** A mature training and certification program is in place that includes a rigorous and comprehensive training program for selecting and training candidates.	1, 2, 3, 4, 5

Strength ID	Strength Title and Description	Defence-in-Depth Level
S-22	**Emergency Management** A mature emergency response infrastructure is in place, and the requisite qualified manpower and expertise are maintained. As well, a mutual aid emergency support agreement among the Canadian nuclear operators has been established for inter-utility emergency support. Pickering has a well established Severe Accident Management Program.	3, 4, 5
S-23	**Environmental Protection Program** The Environmental Protection Program is robust.	1, 2, 3, 4, 5
S-24	**Advanced Technology to Support Radiation Protection** Remotely controlled technology in place to simulate radiation environments and hazards is providing a safe learning environment for training and practicing radiation protection procedures.	1, 2, 3, 4

Appendix C: Global Issue, Proposed Resolution Statement, and IIP Action Summaries

The Global Issues resulting from the consolidation of Gaps and for which there are proposed Resolution Statements, along with the associated IIP actions, are presented in this appendix. The information is presented as exemplified below, along with a description of each of the columns.

1 Global Issue/ Safety and Control Area	2 Global Issue Title	3 Proposed Resolution Statement and IIP Action #s	4 Proposed Resolution Statement Summary	5 Defence-in-Depth Level
GI-27 04 - Safety Analysis (A.4)	Pickering 1,4 Probabilistic Safety Assessment	GI-27-RS1 G27-RS1-04-23.1	Complete actions from PSA improvement plan.	3, 4
		GI-27-RS2 G27-RS2-04-24.1 G27-RS2-04-24.2 G27-RS2-04-24.3	Investigate and implement additional practicable design, operational, and/or analytical enhancements to further improve Pickering 1,4 Severe Core Damage Frequency and Large Release Frequency.	4

6 IIP Action #	7 IIP Action Information	8 Unit	9 TCD
G27-RS1-04-23.1	**Complete Fire Modeling Refinements**	014	2018-09-30
Action:	Complete Phase 2 fire-model refinements.		
Completion Criteria:	Phase 2 fire-model refinements completed and reported to CNSC.		
G27-RS2-04-24.1	**Upgrade Pickering NGS Unit 1,4 Emergency Boiler Water System (EBWS)**	014	2020-12-31
Action:	Upgrade Pickering NGS Unit 1,4 emergency cooling connections from the Pickering NGS firewater system to Pickering NGS Unit 1,4 EBWS.		
Completion Criteria:	Emergency cooling pipe connections from the Pickering NGS Firewater system to Pickering NGS Unit 1,4 EBWS designed, installed, commissioned, and Available For Service (AFS).		

Content of Appendix C Tables

(1) **Global Issue/Safety and Control Area:**

- **a.** Global Issue (GI) number, as identified in the GAR.
- **b.** CNSC Safety and Control Area number and description, as defined in CNSC REGDOC-2.3.3, to which the Global Issue is associated. (A.x) refers to the section in Appendix A "PSR Results by CNSC Safety and Control Area".

(2) **Global Issue Title:** Title of the GI, as identified in the GAR.

(3) **Proposed Resolution Statement and IIP Action #s:**

a. Unique numerical Resolution Statement for the Global Issue, as identified in the GAR.

b. Unique numerical IIP Action tracking reference used to manage the IIP Action in the PSR2 database. Each of these is discussed in more detail, under Item (6) "IIP Action **#**".

(4) **Proposed Resolution Statement Summary:** The proposed Resolution Statement for the associated Global Issue, as identified in the GAR.

(5) **Defence-in-Depth Level:** Level(s) of defence-in-depth that will be improved by each IIP action.

(6) **IIP Action #:** Unique numerical IIP Action tracking reference used to manage the IIP Action in the PSR2 database. The IIP Action # includes the GI number (27 in the above example) and the SCA number to which it is associated (4 in the above example).

(7) **IIP Action Information:** Title, specific action(s), and completion criteria for each IIP action.

(8) **Unit:** Pickering NGS unit(s) to which the IIP Action is applicable.

- 014 represents Pickering NGS Units 1,4,
- 058 represents Pickering NGS Units 5-8,
- 018 represents common systems of Pickering NGS.

(9) **TCD:** IIP Action target completion date.

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-1 06 - Fitness for Service (A.6)	Fitness for Service for Fuel Channels	GI-1-RS1 G01-RS1-06-01.1 G01-RS1-06-01.2 G01-RS1-06-01.3 G01-RS1-06-01.4	Complete CSA N285.8 Compliance Plan activities, including responding to comments.	1,2,3
		GI-1-RS2 G01-RS2-06-02.1	Review and revise if/as required the CSA N285.4 compliant Periodic Inspection Plans for Fuel Channels for Pickering NGS to cover the extended operating period.	1,2,3
		GI-1-RS3 G01-RS3-06-03.1	Update the Fuel Channel Life Cycle Management Plan for Pickering 1,4 for the extended operating period.	1,2,3
		GI-1-RS4 G01-RS4-06-04.1 G01-RS4-06-04.2 G01-RS4-06-04.3 G01-RS4-06-04.4 G01-RS4-06-04.5	Update the structure of the Fuel Channels LCMP.	1,2,3

IIP Action #	IIP Action Information	Unit	TCD
G01-RS1-06-01.1	**Provide Revised OPG CSA N285.8 Compliance Plan**	018	2019-06-30
Action:	Revise OPG CSA N285.8 Compliance Plan and request closure of the associated action item, as required.		
Completion Criteria:	This action is considered complete when closure request is submitted.		
G01-RS1-06-01.2	**Define Nominal Cooldown Transient for use in Probabilistic Leak-Before-Break (PLBB) Analyses**	018	2018-06-30
Action:	Propose Nominal Cooldown Transient for use in Probabilistic Leak-Before-Break (PLBB)		
Completion Criteria:	OPG to submit closure request for the PLBB nominal cooldown transient issue to CNSC.		
G01-RS1-06-01.3	**Provide to CNSC documented evidence that validation of PLBB code is complete**	018	2018-03-31
Action:	OPG to document evidence that validation of PLBB code is complete.		
Completion Criteria:	OPG to submit closure request for the validation of PLBB code issue to CNSC.		
G01-RS1-06-01.4	**Address the Probabilistic Core Assessment Flaw Removal Issue**	018	2018-06-30
Action:	OPG to document resolution to address the Probabilistic Core Assessment Flaw Removal issue.		
Completion Criteria:	OPG to submit closure request of the Probabilistic Core Assessment Flaw Removal issue.		
G01-RS2-06-02.1	**Update Pickering NGS Fuel Channel Periodic Inspection Plan (PIP) for Operation to the end of 2024.**	018	2018-12-31
Action:	Update the Fuel Channel Periodic Inspection Plans in support of Pickering NGS operation to the end of 2024.		
Completion Criteria:	This action is considered complete when the updated Periodic Inspection Plans has been submitted to CNSC.		

IIP Action #	IIP Action Information	Unit	TCD
G01-RS3-06-03.1	**Submit 2018 Fuel Channel Life Cycle Management Plan (LCMP) Update that includes Pickering NGS U1 and U4 Operation to the end of 2024**	014	2018-11-30
Action:	Update 2018 Fuel Channel LCMP to address operation of Pickering NGS Unit 1 and Unit 4 until the end of 2024.		
Completion Criteria:	This action is considered complete when the 2018 Fuel Channel LCMP update has been submitted to CNSC.		
G01-RS4-06-04.1	**Develop Pickering NGS Fuel Channel Readiness Plan in Support of Operation to the end of 2024 (FCRP2024)**	018	2018-03-31
Action:	Prepare and update, as necessary, the “Pickering NGS Fuel Channel Readiness Plan in Support of Operation to 2024” that documents and provides the status of the work required in support of Pickering NGS operation to the end of 2024.		
Completion Criteria:	This action is considered complete when the “Pickering NGS Fuel Channel Readiness Plan in Support of Operation to 2024” has been submitted to CNSC.		
G01-RS4-06-04.2	**Update and Submit 2018 Fuel Channel Life Cycle Management Plan (LCMP) and the Pickering NGS Fuel Channel Readiness Plan in Support of Operation to the end of 2024 (FCRP2024)**	018	2018-11-30
Action:	Incorporate the results of the Pickering NGS FCRP2024 activities into Fuel Channel assessments/evaluations and identify actions to mitigate aging effects, as required. Update the FCRP2024 and the 2018 LCMP accordingly.		
Completion Criteria:	This action is considered complete when the FCRP2024 update and the 2018 Fuel Channel LCMP update have been submitted to CNSC.		
G01-RS4-06-04.3	**Update and Submit 2019 Fuel Channel Life Cycle Management Plan (LCMP) and the Pickering NGS Fuel Channel Readiness Plan in Support of Operation to the end of 2024 (FCRP2024)**	018	2019-11-30
Action:	Incorporate the results of the Pickering NGS FCRP2024 activities into Fuel Channel assessments/evaluations and identify actions to mitigate aging effects, as required. Update the FCRP2024 and the 2019 LCMP accordingly.		
Completion Criteria:	This action is considered complete when the FCRP2024 update and the 2019 Fuel Channel LCMP update have been submitted to CNSC.		

IIP Action #	IIP Action Information	Unit	TCD
G01-RS4-06-04.4	**Update and Submit 2020 Fuel Channel Life Cycle Management Plan (LCMP) and the Pickering NGS Fuel Channel Readiness Plan in Support of Operation to the end of 2024 (FCRP2024)**	018	2020-11-30
Action:	Incorporate the results of the Pickering NGS FCRP2024 activities into Fuel Channel assessments/evaluations and identify actions to mitigate aging effects, as required. Update the FCRP2024 and the 2020 LCMP accordingly.		
Completion Criteria:	This action is considered complete when the FCRP2024 update and the 2020 Fuel Channel LCMP update have been submitted to CNSC.		
G01-RS4-06-04.5	**Submit Confirmatory Fuel Channels Fitness for Service Correspondence**	018	2020-11-30
Action:	Prepare correspondence confirming that the 2020 Fuel Channel LCMP complies with REGDOC-2.6.3 and includes all activities required to demonstrate Fuel Channel Fitness for Service in support of Pickering NGS operations to the end of 2024.		
Completion Criteria:	This action is considered complete when the correspondence has been submitted to CNSC.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-2 06 - Fitness for Service (A.6)	Fitness for Service for Feeders	GI-2-RS1 G02-RS1-06-05.1	Update the Feeders Life Cycle Management Plan for Pickering 1,4 for the extended operating period based on updated fitness-for-service assessment.	1,2,3

IIP Action #	IIP Action Information	Unit	TCD
G02-RS1-06-05.1	**Submit 2018 Feeders Life Cycle Management Plan (LCMP) Update that includes Pickering NGS U1 and U4 operations to the end of 2024**	014	2018-11-30
Action:	Update Feeders LCMP that addresses operation of Pickering NGS Unit 1 and Unit 4 to the end of 2024 and submit to CNSC.		
Completion Criteria:	This action is considered complete when: • Feeders LCMP has been updated to include Pickering NGS Unit 1 and Unit 4 operation to the end of 2024. • Updated LCMP has been submitted to CNSC.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-3 06 - Fitness for Service (A.6)	Fitness for Service for Steam Generators	GI-3-RS1 G03-RS1-06-06.1	Update the Steam Generators Life Cycle Management Plan for Pickering 1,4 for the extended operating period based on updated fitness-for-service assessment.	1,2,3

IIP Action #	IIP Action Information	Unit	TCD
G03-RS1-06-06.1	**Submit 2018 Steam Generators Life Cycle Management Plan (LCMP) update that includes Pickering NGS U1 and U4 operations to the end of 2024**	014	2018-11-30
Action:	Update Steam Generators Life Cycle Management Plan (LCMP) that addresses operation of Pickering Unit 1 and Unit 4 to the end of 2024 and submit to CNSC.		
Completion Criteria:	This action is considered complete when: • Steam Generators LCMP has been updated to include Pickering NGS Unit 1 and Unit 4 operation to the end of 2024. • Updated LCMP has been submitted to CNSC.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-4 06 - Fitness for Service (A.6)	Fitness for Service for Reactor Components and Structures	GI-4-RS1 G04-RS1-06-07.1	Update the Reactor Components and Structures Life Cycle Management Plan for Pickering 1,4 for the extended operating period based on updated fitness-for-service assessment.	1,2,3
		GI-4-RS2 G04-RS2-06-08.1 G04-RS2-06-08.2	Perform measurements of Calandria Tube/Liquid Injection Shutdown System nozzle gaps on Units 5-8 to refine the gap closure rates. Using this new measurement data, update analyses as required, to demonstrate Fitness for Service.	1,2,3

IIP Action #	IIP Action Information	Unit	TCD
G04-RS1-06-07.1	**Submit 2018 Reactor Components Life Cycle Management Plan (LCMP) update that includes Pickering NGS U1 and U4 Operation to the end of 2024**	014	2018-11-30
Action:	Update Reactor Components and Structures Life Cycle Management Plan (LCMP) that addresses operation of Pickering NGS Unit 1 and Unit 4 to the end of 2024 and submit to CNSC.		
Completion Criteria:	This action is considered complete when: • Reactor Components and Structures has been updated to include Pickering NGS Unit 1 and Unit 4 operation to the end of 2024. • Updated LCMP has been submitted to CNSC.		
G04-RS2-06-08.1	**Perform CT-LISS nozzle gap measurements as required on Pickering NGS Unit 6**	6	2018-12-31
Action:	Per LCMP, perform Pickering NGS Unit 6 CT-LISS nozzle gap inspections and conduct FFS assessment.		
Completion Criteria:	Post planned outage FFS report has been submitted to CNSC.		

IIP Action #	IIP Action Information	Unit	TCD
G04-RS2-06-08.2	**Perform CT-LISS nozzle gap measurements as required on Pickering NGS Unit 5**	5	2020-09-30
Action:	Per LCMP, perform Pickering NGS Unit 5 CT-LISS nozzle gap inspections and conduct FFS assessment.		
Completion Criteria:	Post planned outage FFS report has been submitted to CNSC.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-5 06 - Fitness for Service (A.6)	Completeness of Class 1 Piping/ Components Service Limits Assessment (Excluding Major Components)	GI-5-RS1 G05-RS1-06-09.1	Confirm the adequacy of the service limits assessments for Nuclear Class 1 piping (excluding Major Components) after accounting for impact of environmental factors.	1,2,3

IIP Action #	IIP Action Information	Unit	TCD
G05-RS1-06-09.1	**Confirm service limits assessments for Nuclear Class 1 Piping include environmental factors**	018	2020-12-31
Action:	Prepare a formal report on service limits assessments. The formal report will include an assessment of the impact of environmental factors.		
Completion Criteria:	Pickering NGS formal service limits assessment report including impact of environmental factors is complete.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-6 06 - Fitness for Service (A.6)	Impact of the Revised Criticality Coding on the Cable Surveillance Program	GI-6-RS1 G06-RS1-06-10.1	Reassess the impact of the changes in the cable criticality coding and update the scope of the cable surveillance plan.	1, 2, 3, 4

IIP Action #	IIP Action Information	Unit	TCD
G06-RS1-06-10.1	**Assess the impact of the changes in criticality coding on cables**	018	2018-12-31
Action:	Review changes in criticality coding on cables as a result of the Criticality Code review project performed by OPG and update the cable surveillance plan as required.		
Completion Criteria:	Electrical cable surveillance plan updated to reflect changes in criticality coding.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-7 06 - Fitness for Service (A.6)	Pickering Buried Piping Fitness for the Extended Operating Period	GI-7-RS1 G07-RS1-06-11.1	Update the buried piping program asset management plan and risk ranking for the extended operating period.	3, 4
		GI-7-RS2 G07-RS2-06-12.1	Update governance to reflect a graded approach in the event of leakage in fuel oil piping.	1

IIP Action #	IIP Action Information	Unit	TCD
G07-RS1-06-11.1	**Update the Buried Piping Program Asset Management Plan and Risk Ranking document**	018	2019-03-31
Action:	Update the Buried Piping Program Asset Management Plan and Risk Ranking document to support commercial operation to the end of 2024.		
Completion Criteria:	Buried Piping Program Asset Management Plan updated to include buried piping Asset Management requirements to support commercial operation to the end of 2024.		
G07-RS2-06-12.1	**Update Buried Piping Program Requirements**	018	2020-03-31
Action:	Update the Buried Piping Program Requirements to include a graded approach for repairs of fuel oil piping.		
Completion Criteria:	OPG Buried Piping Program Requirements updated to include a graded approach for repairs of fuel oil piping.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-8 06 - Fitness for Service (A.6)	Completion/Updating of the Condition Assessments	GI-8-RS1 G08-RS1-06-13.1 G08-RS1-06-13.2 G08-RS1-06-13.3 G08-RS1-06-13.4 G08-RS1-06-13.5 G08-RS1-06-13.6 G08-RS1-06-13.7 G08-RS1-06-13.8	Complete and update Condition Assessments for the piping systems and commodity groups in PSR2 scope for station operation for the extended operating period.	1, 2, 3
		GI-8-RS2 G08-RS2-06-14.1	Develop and implement a process to track and report aging-management-related actions from the Condition Assessment recommendations.	1

IIP Action #	IIP Action Information	Unit	TCD
G08-RS1-06-13.1	**Develop a risk based approach for aging management of critical piping systems**	018	2018-09-30
Action:	Develop a risk based approach for aging management of critical piping systems, and incorporate that approach in OPG governance.		
Completion Criteria:	Piping system risk based approach methodology established and incorporated into OPG governance.		

IIP Action #	IIP Action Information	Unit	TCD
G08-RS1-06-13.2	**Complete the Condition Assessments consistent with the revised Reactor Safety Criticality Codes**	018	2019-03-31
Action:	Complete Scoping and Screening per the Aging Management Process.		
Completion Criteria:	Scoping and Screening complete for commodity groups in PSR2 scope.		
G08-RS1-06-13.3	**Complete Condition Assessments for the piping systems in PSR2 scope to support Pickering NGS commercial operation to the end of 2024**	018	2019-06-30
Action:	Complete Condition Assessments for piping systems per the Aging Management Process.		
Completion Criteria:	Condition Assessments for piping systems are complete and action plans incorporated into associated health reports.		
G08-RS1-06-13.4	**Complete Condition Assessments for commodity groups in PSR2 scope to support Pickering NGS commercial operation to the end of 2024**	018	2019-03-31
Action:	Complete Condition Assessments per the Aging Management Process.		
Completion Criteria:	Condition Assessments are complete and action plans incorporated into associated health reports.		
G08-RS1-06-13.5	**Complete Condition Assessments for the Irradiated Fuel Bays (IFB) to support Pickering NGS commercial operation to the end of 2024.**	018	2018-06-30
Action:	Complete Condition Assessments for IFBs per the Aging Management Process.		
Completion Criteria:	Condition Assessments for IFBs are complete and action plans incorporated into associated health reports.		
G08-RS1-06-13.6	**Complete Condition Assessments for the Deaerators and the Deaerator Storage Tanks to support Pickering NGS commercial operation to the end of 2024.**	018	2018-06-30
Action:	Complete Condition Assessments for DA and DA Storage tanks per the Aging Management Process.		
Completion Criteria:	Condition Assessments for DA and DA Storage tanks are complete and action plans incorporated into associated health reports		

IIP Action #	IIP Action Information	Unit	TCD
G08-RS1-06-13.7	**Complete Condition Assessments for the Fueling Machines and FM Ball Screws to support Pickering NGS commercial operation to the end of 2024.**	018	2018-06-30
Action:	Complete Condition Assessments for FM and FM ball screws per the Aging Management Process.		
Completion Criteria:	Condition Assessments for FM and FM ball screws are complete and action plans incorporated into associated health reports.		
G08-RS1-06-13.8	**Complete Condition Assessments for the Primary Heat Transport auxiliary piping system, Primary Heat Transport pump discharge valves, and boiler inlet and outlet valves to support Pickering NGS commercial operation to the end of 2024.**	018	2018-06-30
Action:	Complete Condition Assessments for PHT piping, pump discharge valves and boiler inlet & outlet valves per the Aging Management Process.		
Completion Criteria:	Condition Assessments are complete and action plans incorporated into associated health reports.		
G08-RS2-06-14.1	**Develop and implement Condition Assessment action tracking and reporting process including a database.**	018	2018-09-30
Action:	Develop and implement a Condition Assessment (CA) action tracking process and database for reporting of CA action status.		
Completion Criteria:	CA action tracking process and database are developed and populated with CA actions.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-9 05 - Physical Design (A.5)	Seismic Capacity of the Conveyor Tube and Fuel Basket Stacking Arrangement	GI-9-RS1 G09-RS1-05-15.1	Complete the required assessment to support the current fuel basket stacking arrangements in the Pickering NGS IFBs.	1

IIP Action #	IIP Action Information	Unit	TCD
G09-RS1-05-15.1	**Complete Pickering NGS IFB/AIFB fuel basket stacking arrangement assessment**	018	2019-03-31
Action:	Complete and document Pickering NGS IFB/AIFB fuel basket stacking arrangement assessment.		
Completion Criteria:	Pickering NGS IFB/AIFB fuel basket stacking arrangement assessment for frame stacking complete.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-10 06 - Fitness for Service (A.6)	IFB Condition	GI-10-RS1 G10-RS1-06-16.1	Complete the Pickering 5-8 IFB Leakage Mitigation Project to mitigate leaks from IFB-B to the interspace.	1

IIP Action #	IIP Action Information	Unit	TCD
G10-RS1-06-16.1	**Complete Pickering NGS Units 5-8 Irradiated Fuel Bay (IFB) Leakage Mitigation Project.**	058	2019-09-30
Action:	Complete Pickering NGS Units 5-8 IFB Leakage Mitigation Project.		
Completion Criteria:	Pickering NGS Units 5-8 IFB Leak Mitigation Project has been completed.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-12 05 - Physical Design (A.5)	Extending the Environmental Qualification of Equipment	GI-12-RS1 G12-RS1-06-17.1	Complete EQ Assessment re-assessments to support the extended operating period.	3

IIP Action #	IIP Action Information	Unit	TCD
G12-RS1-06-17.1	**Complete Environmental Qualifications Assessments (EQA) to support Pickering NGS extended operations**	018	2019-12-31
Action:	Assess existing EQAs for Environmentally Qualified (EQ) life-limited components to support commercial operation to the end of 2024.		
Completion Criteria:	Assessment of EQAs has been completed and any actions are documented for OPG EQ program resolution.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-19 06 - Fitness for Service (A.6)	FFS of Containment for the Extended Operating Period	GI-19-RS1 G19-RS1-06-18.1	Demonstrate the fitness for service of the foundation steel H-piles for the Pickering A Reactor Building, Vacuum Building and Pressure Relief Duct at the Pickering site for the extended operating period.	1, 2, 3, 4

IIP Action #	IIP Action Information	Unit	TCD
G19-RS1-06-18.1	**Demonstrate FFS of foundation H-piles for Pickering 1,4 Reactor Buildings (RB), Vacuum Building (VB) and Pressure Relief Duct (PRD)**	018	2019-06-30
Action:	Demonstrate fitness for service of the foundation steel H-piles supporting the Pickering 1,4 Reactor Buildings (RB), Vacuum Building (VB), and Pressure Relief Duct (PRD) to support commercial operation to the end of 2024.		
Completion Criteria:	FFS of foundation H-piles for Pickering 1,4 RB, VB and PRD has been demonstrated.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-24 04 - Safety Analysis (A.4)	Safety Analysis to Support the Extended Operating Period	GI-24-RS1 G24-RS1-04-19.1 G24-RS1-04-19.2 G24-RS1-04-19.3 G24-RS1-04-19.4 G24-RS1-04-19.5 G24-RS1-04-19.6 G24-RS1-04-19.7 G24-RS1-04-19.8	Update Heat Transport System aging safety analysis models and perform the required safety analysis of events most impacted by aging (small-break LOCA, loss of flow and neutron overpower) to support extended operation.	2, 3

IIP Action #	IIP Action Information	Unit	TCD
G24-RS1-04-19.1	**Update Heat Transport Aging safety analysis models (Pickering 1,4)**	014	2018-08-31
Action:	Update Safety Analysis models accounting for heat transport system aging for Pickering NGS Units 1,4 operations to the end of 2024.		
Completion Criteria:	This action will be considered complete when Heat Transport Aging safety analysis model for Pickering NGS Units 1,4 has been updated and submitted to CNSC.		

IIP Action #	IIP Action Information	Unit	TCD
G24-RS1-04-19.2	**Complete Loss of Flow (LOF) Safety Analysis accounting for Heat Transport Aging Methodology (Pickering 1,4)**	014	2018-11-30
Action:	Complete required Loss of Flow safety analysis for operation to the end of 2024 for Pickering NGS Units 1,4.		
Completion Criteria:	This action will be considered complete when the required Loss of Flow Safety Analysis for Pickering 1,4 has been submitted to CNSC, addressing the impact of Heat Transport System (HTS) component aging, and demonstrating that adequate safety margins exist for Pickering NGS Units 1,4 operations to the end of 2024.		
G24-RS1-04-19.3	**Complete Small Break Loss of Coolant Accident (SBLOCA) safety analysis accounting for Heat Transport Aging Methodology (Pickering 1,4)**	014	2018-11-30
Action:	Complete required SBLOCA safety analysis for operation to the end of 2024 for Pickering NGS Units 1,4.		
Completion Criteria:	This action will be considered complete when the required SBLOCA Safety Analysis for Pickering 1,4 has been submitted to CNSC, addressing the impact of HTS component aging, and demonstrating that adequate safety margins exist for Pickering NGS Units 1,4 operations to the end of 2024.		
G24-RS1-04-19.4	**Complete Neutron Overpower (NOP) safety analysis accounting for Heat Transport Aging (Pickering 1,4)**	014	2018-11-30
Action:	Complete required NOP safety analysis for operation to the end of 2024 for Pickering NGS Units 1,4.		
Completion Criteria:	This action will be considered complete when the required NOP Safety Analysis for Pickering 1,4 has been submitted to CNSC, addressing the impact of HTS component aging, and demonstrating that adequate safety margins exist for Pickering NGS Units 1,4 operations to the end of 2024.		
G24-RS1-04-19.5	**Update Heat Transport Aging safety analysis models (Pickering 5-8)**	058	2019-01-31
Action:	Update Safety Analysis models accounting for heat transport system aging for Pickering NGS Units 5-8 for operation to the end of 2024.		
Completion Criteria:	This action will be considered complete when Heat Transport Aging safety analysis model for Pickering NGS Units 5-8 has been updated by OPG for operations to the end of 2024.		

IIP Action #	IIP Action Information	Unit	TCD
G24-RS1-04-19.6	**Complete Loss of Flow (LOF) Safety Analysis accounting for Heat Transport Aging Methodology (Pickering 5-8)**	058	2019-05-30
Action:	Complete required Loss of Flow safety analysis for operation to the end of 2024 for Pickering NGS Units 5-8.		
Completion Criteria:	This action will be considered complete when the required Loss of Flow Safety Analysis for Pickering 5-8 has been submitted to CNSC, addressing the impact of HTS component aging, and demonstrating that adequate safety margins exist for Pickering NGS Units 5-8 operations to the end of 2024.		
G24-RS1-04-19.7	**Complete Small Break Loss of Coolant Accident (SBLOCA) safety analysis accounting for Heat Transport Aging Methodology (Pickering 5-8)**	058	2019-05-30
Action:	Complete required SBLOCA safety analysis for operation to the end of 2024 for Pickering NGS Units 5-8.		
Completion Criteria:	This action will be considered complete when the required SBLOCA Safety Analysis for Pickering 5-8 has been submitted to CNSC, addressing the impact of HTS component aging, and demonstrating that adequate safety margins exist for Pickering NGS Units 5-8 operations to the end of 2024.		
G24-RS1-04-19.8	**Complete Neutron Overpower safety analysis accounting for Heat Transport Aging (Pickering 5-8)**	058	2019-05-30
Action:	Complete required Neutron Overpower safety analysis for operation to the end of 2024 for Pickering NGS Units 5-8.		
Completion Criteria:	This action will be considered complete when the required NOP Safety Analysis for Pickering 5-8 has been submitted to CNSC, addressing the impact of HTS component aging, and demonstrating that adequate safety margins exist for Pickering NGS Units 5-8 operations to the end of 2024.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-25 04 - Safety Analysis (A.4)	Category 3 CANDU Safety Issues	GI-25-RS1 G25-RS1-04-20.1	Complete the re-categorization of the large-break LOCA CANDU Safety Issues to Category 2.	3
		GI-25-RS2 G25-RS2-04-21.1	Complete the re-categorization of high-energy piping CANDU Safety Issue to Category 2.	3

IIP Action #	IIP Action Information	Unit	TCD
G25-RS1-04-20.1	**Re-categorization of the Large Break Loss of Coolant Accident (LBLOCA) CANDU Safety Issues (CSI) to Category 2**	018	2020-06-30
Action:	Use a modified limit of operating envelope (LOE) safety analysis methodology to update the LBLOCA analysis and re-categorize LBLOCA CSI to Category 2.		
Completion Criteria:	Updated LBLOCA analysis has been completed and submitted to CNSC as part of request to re-categorize LBLOCA CSI to Category 2.		
G25-RS2-04-21.1	**Re-categorize the CANDU Safety Issue CSI-IH6 to Category 2**	014	2020-06-30
Action:	An assessment has been completed of Pickering NGS Units 1 and 4 high energy pipe-line failures to support re-categorization of CANDU Safety Issue CSI-IH6 to Category 2.		
Completion Criteria:	Assessment of high energy pipe-line failures has been completed and assessment results have been submitted to CNSC as part of request to re-categorize CANDU Safety Issue CSI-IH6 to Category 2.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-26 10 - Emergency Management and Fire Protection (A.10)	Emergency Response Projection Software	GI-26-RS1 G26-RS1-10-22.1	Complete the implementation of upgrades to the computer codes used for emergency response projection.	5

IIP Action #	IIP Action Information	Unit	TCD
G26-RS1-10-22.1	**Develop and implement upgrades to the computer codes used for emergency response projections**	018	2018-09-30
Action:	Develop upgrades to the computer codes used for emergency response projections.		
Completion Criteria:	Emergency response projection computer tools are developed.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-27 04 - Safety Analysis (A.4)	Pickering 1,4 Probabilistic Safety Assessment	GI-27-RS1 G27-RS1-04-23.1	Complete actions from PSA improvement plan.	3, 4
		GI-27-RS2 G27-RS2-04-24.1 G27-RS2-04-24.2 G27-RS2-04-24.3 G27-RS2-04-24.4	Investigate and implement additional practicable design, operational, and/or analytical enhancements to further improve Pickering 1,4 Severe Core Damage Frequency and Large Release Frequency.	4

IIP Action #	IIP Action Information	Unit	TCD
G27-RS1-04-23.1	**Complete Fire Modeling Refinements**	014	2018-09-30
Action:	Complete Phase 2 fire-model refinements.		
Completion Criteria:	Phase 2 fire-model refinements completed and reported to CNSC.		
G27-RS2-04-24.1	**Investigate additional practicable design, operational and/or analytical enhancements**	014	2018-12-31
Action:	Document the results of investigations into practicable design, operational and/or analytical assessments to provide additional mitigation measures to reduce SCDF and LRF towards Admin Safety Goals.		
Completion Criteria:	Investigation into practicable design, operational and/or analytical enhancements completed, documented and submitted to the CNSC.		

IIP Action #	IIP Action Information	Unit	TCD
G27-RS2-04-24.2	**Upgrade Pickering NGS Unit 1,4 Emergency Boiler Water System (EBWS)**	014	2020-12-31
Action:	Upgrade Pickering NGS Unit 1,4 emergency cooling connections from the Pickering NGS firewater system to Pickering NGS Unit 1,4 EBWS.		
Completion Criteria:	Emergency cooling pipe connections from the Pickering NGS Firewater system to Pickering NGS Unit 1,4 EBWS designed, installed, commissioned, and Available For Service (AFS).		
G27-RS2-04-24.3	**Upgrade Pickering NGS Unit 1, 4 Emergency Cooling to Heat Transport System (HTS) Makeup**	014	2020-12-31
Action:	Upgrade Pickering NGS Unit 1,4 emergency cooling to provide additional connections from the Pickering NGS Firewater system to provide to the heat transport system.		
Completion Criteria:	Emergency cooling pipe connections from the Pickering NGS Firewater system to Pickering NGS Unit 1,4 HTS makeup designed, installed, commissioned, and Available For Service (AFS).		
G27-RS2-04-24.4	**Upgrade Pickering NGS Unit 1,4 Calandria Makeup**	014	2020-12-31
Action:	Upgrade Pickering NGS Unit 1,4 emergency cooling by providing pipe connections from the Pickering NGS Firewater system to provide to the Pickering NGS Unit 1,4 Calandria.		
Completion Criteria:	Emergency cooling pipe connections from the Pickering NGS Firewater system to Pickering NGS Unit 1,4 Calandria designed, installed, commissioned, and Available For Service (AFS).		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-31 04 - Safety Analysis (A.4)	Deterministic Safety Analysis	GI-31-RS1 G31-RS1-04-25.1	Complete the Pickering NGS Implementation Plan for CNSC REGDOC-2.4.1.	2, 3
		GI-31-RS2 G31-RS2-04-26.1	Prepare Implementation Plan update for CNSC REGDOC-2.4.1, including consideration of the impact of the extended operating period.	2, 3

IIP Action #	IIP Action Information	Unit	TCD
G31-RS1-04-25.1	**Provide Pickering NGS Safety Report Analysis of Common Mode Events**	018	2018-03-31
Action:	Complete Pickering Units 1,4 and Units 5-8 safety analysis of common mode events.		
Completion Criteria:	Pickering Units 1,4 and Units 5-8 safety analyses of common mode events has been completed.		
G31-RS2-04-26.1	**Update OPG REGDOC-2.4.1 Implementation Plan**	018	2018-03-31
Action:	Update the OPG REGDOC-2.4.1 Implementation Plan to include consideration of commercial operation to the end of 2024.		
Completion Criteria:	OPG REGDOC-2.4.1 Implementation Plan has been updated to support commercial operation to the end of 2024.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-32 04 - Safety Analysis (A.4)	Implementation of REGDOC-2.4.2 PSA Requirements	GI-32-RS1 G32-RS1-04-27.1	Complete the activities in the CNSC REGDOC-2.4.2 Implementation Strategy and update the Strategy in the context of the extended operating period.	2, 3

IIP Action #	IIP Action Information	Unit	TCD
G32-RS1-04-27.1	**Complete the REGDOC-2.4.2 Implementation Strategy**	018	2020-12-31
Action:	Complete the REGDOC-2.4.2 Implementation Strategy.		
Completion Criteria:	REGDOC-2.4.2 Implementation Strategy is complete.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-40 10 – Emergency Management and Fire Protection (A.10)	Accident Management	GI-40-RS1 G40-RS1-10-28.1 G40-RS1-10-28.2 G40-RS1-10-28.3	Ensure the completion of Emergency Mitigating Equipment Phase 2 activities.	3, 4

IIP Action #	IIP Action Information	Unit	TCD
G40-RS1-10-28.1	**Complete Pickering NGS Emergency Mitigating Equipment (EME) Phase 2 project**	018	2018-06-30
Action:	Complete Pickering NGS EME Phase 2 project, which includes restoring cooling water and power to essential loads via EME generators to allow for operation of Air Cooling Units (ACUs), Hydrogen Igniters, and FADS.		
Completion Criteria:	Pickering NGS Phase 2 EME generators field modifications have been completed and declared Available For Service (AFS).		
G40-RS1-10-28.2	**Complete reassessment of Pickering NGS Beyond Design Basis Containment Integrity**	018	2018-12-31
Action:	Complete and document reassessment of Pickering NGS Beyond Design Basis Containment Integrity for post-BDBA containment controlled filtered venting.		
Completion Criteria:	Reassessment of Pickering NGS Beyond Design Basis Containment Integrity for post-BDBA containment controlled filtered venting — including the requirement of a Main Vacuum Volume Pump (MVVP) — completed, documented and submitted to the CNSC.		
G40-RS1-10-28.3	**Upgrade Emergency Mitigating Equipment (EME) Phase 2 to restore the functionality of a Main Vacuum Volume Pump (MVVP)**	018	2019-06-30
Action:	Complete the necessary power and support service connections required to restore the functionality of an MVVP via EME Phase 2.		
Completion Criteria:	Restoration of functionality of an MVVP through Pickering NGS EME Phase 2 is complete and declared Available For Service (AFS).		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-43 06 - Fitness for Service (A.6)	Safety-Related Structures (Non-Containment) for Nuclear Power Plants	GI-43-RS1 G43-RS1-06-29.1	Perform the scope of inspections for non-Containment safety-significant civil structures as per the established preventive maintenance program.	1, 2, 3
		GI-43-RS2 G43-RS2-06-30.1	Develop program governance using a risk-based approach for aging management of safety-significant civil structures for the extended operating period. This applies to non-Containment safety-related civil structures.	1, 2, 3
		GI-43-RS3 G43-RS3-06-31.1	Prepare Condition Assessments as appropriate for safety-significant civil structures for the extended operating period. Recommendations from these Condition Assessments will be tracked and reported along with those related to GI-8. This applies to non-Containment safety-related civil structures.	1, 2, 3

IIP Action #	IIP Action Information	Unit	TCD
G43-RS1-06-29.1	**Complete inspections of Pickering NGS non-Containment safety-significant civil structures**	018	2018-06-30
Action:	Complete inspections of non-Containment safety-significant civil structures.		
Completion Criteria:	Inspections of non-Containment safety-significant civil structures have been completed.		

IIP Action #	IIP Action Information	Unit	TCD
G43-RS2-06-30.1	**Develop a risk-based approach for aging management of non-Containment safety-significant civil structures**	018	2018-09-30
Action:	Develop a risk based approach for aging management of non-Containment safety-significant civil structures, and incorporate that approach into OPG governance.		
Completion Criteria:	Non-Containment safety-significant civil structures risk-based approach methodology has been established and incorporated into OPG governance.		
G43-RS3-06-31.1	**Prepare Condition Assessments as appropriate for non-Containment safety-significant civil structures for Pickering NGS extended operation**	018	2019-06-30
Action:	Complete Condition Assessments for non-containment safety-significant civil structures per the Aging Management Process.		
Completion Criteria:	Pickering NGS Condition Assessments for non-Containment safety-significant civil structures have been completed and action plans integrated with CHRs/SHRs.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-47 05 - Physical Design (A.5)	Fire Protection Code NFPA 24	GI-47-RS1 G47-RS1-05-32.1	Complete installation of wrenches and locks on the 058 Yard Fire Protection System.	2, 3

IIP Action #	IIP Action Information	Unit	TCD
G47-RS1-05-32.1	**Install wrenches and locks on the Pickering NGS 058 Yard Fire Protection System Yard Post indicator valves 058-71450-V37, 058-71450-V3027, and 058-71450-V36**	058	2019-06-30
Action:	Complete installation of wrenches and locks on the Pickering NGS 058 Yard Fire Protection System Yard Post indicator valves 058-71450-V37, 058-71450-V3027, and 058-71450-V36.		
Completion Criteria:	Installation of wrenches and locks on the Pickering NGS 058 Fire Protection System Yard Post indicator valves 058-71450-V37, 058-71450-V3027, and 058-71450-V36 complete.		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-48 05 - Physical Design (A.5)	CSA N293-12 Fire Protection of Nuclear Power Plants	GI-48-RS1 G48-RS1-05-33.1	Provide, as necessary, design and/or operational changes and commissioning/testing to facilitate required interconnection of Pickering 1,4 and Pickering 5-8 Fire Protection System water supplies to meet the safety intent of CSA N293-12 Clause 7.3.2.2 (d).	2, 3

IIP Action #	IIP Action Information	Unit	TCD
G48-RS1-05-33.1	**Design and/or make operational changes to Pickering Units 1,4 and Pickering Units 5-8 Fire Protection System interconnection.**	058	2020-12-31
Action:	Implement design and/or operational changes to interconnect Pickering Units 1,4 and Pickering Units 5-8 Fire Protection System water supplies.		
Completion Criteria:	Pickering NGS Units 5-8 Fire Protection System recommended design and/or operational changes have been implemented and Available For Service (AFS).		

Global Issue/ Safety and Control Area	Global Issue Title	Proposed Resolution Statement and IIP Action #s	Proposed Resolution Statement Summary	Defence-in-Depth Level
GI-50 06 – Fitness for Service (A.6)	N285.4 PIP/Documentation Revision	GI-50-RS1 G50-RS1-06-34.1 G50-RS1-06-34.2	Revise the N285.4 PIPs and governance to align with elements of N285.4-14.	1, 2, 3
		GI-50-RS2 G50-RS2-06-35.1	Assess the impact of extended operation on concessions against CSA N285.4.	1

IIP Action #	IIP Action Information	Unit	TCD
G50-RS1-06-34.1	**Provide CNSC with an update on OPG implementation plans for identified elements of CSA N285.4-14**	018	2018-09-30
Action:	Provide CNSC with an update on OPG implementation plans for identified elements of CSA N285.4-14.		
Completion Criteria:	Update of implementation plans for identified elements of CSA N285.4-14 provided to CNSC.		
G50-RS1-06-34.2	**Documents identified in implementation plans updated and issued as required**	018	2020-12-31
Action:	Documents identified in implementation plans updated and issued.		
Completion Criteria:	Required program documents revised.		
G50-RS2-06-35.1	**Assess the impact of extended operation on concessions against CSA N285.4**	018	2020-12-31
Action:	Assess the impact of N285.4 CNSC accepted program implementation concessions for the extended operating period, and update OPG implementation plans for identified elements for N285.4-14 as necessary.		
Completion Criteria:	Implementation plans updated for identified elements of CSA N285.4-14 as necessary.		