



Supplementary Information

Written submission from Ontario Power Generation Inc.

In the Matter of

Ontario Power Generation Inc., Pickering Nuclear Generating Station

Request for a ten-year renewal of its Nuclear Power Reactor Operating Licence for the Pickering Nuclear Generating Station

**Commission Public Hearing
Part 2**

June 2018

Renseignements supplémentaires

Mémoire d'Ontario Power Generation Inc.

À l'égard d'

Ontario Power Generation Inc., centrale nucléaire de Pickering

Demande de renouvellement, pour une période de dix ans, de son permis d'exploitation d'un réacteur nucléaire de puissance à la centrale nucléaire de Pickering

**Audience publique de la Commission
Partie 2**

Juin 2018

Securing Ontario's Clean Power Future

ONTARIO **POWER** GENERATION

Supplemental Written Submission In Support of the Renewal of Pickering's POWER REACTOR OPERATING LICENCE



Public Hearing Part 2
Scheduled for:
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1.0 INTRODUCTION

OPG is applying to the Canadian Nuclear Safety Commission (CNSC) for a 10-year renewal of its Power Reactor Operating Licence for the Pickering Nuclear Generating Station (NGS). The current licence expires in August, 2018, and the requested licence renewal would cover continued commercial operation through to the end of 2024, and transition to safe storage by 2028.

OPG's Commission Member Document (CMD) 18-H6.1 and April 4, 2018 Part 1 Hearing presentation (CMD 18-H6.1A) summarize the evidence that demonstrates the Pickering NGS meets all the legal requirements of the Nuclear Safety and Control Act and the associated Regulations, and that OPG is qualified to carry on the licensed activities and makes adequate provisions to protect the health, safety and security of persons and the environment, and maintain national security and measures required to implement international obligations.

Section 1 of this CMD re-iterates the case for licence renewal and OPG's commitments for the safe and reliable operation of the Pickering NGS. Section 2 provides clarification on items discussed at the Part 1 Hearing and Section 3 addresses other matters of interest.

OPG is proud of the strong performance and many significant achievements of the Pickering NGS during the current licence term. This record of accomplishment is a testament to the diligence and passion for excellence that all personnel are committed to, each and every day, in support of the safe and reliable operation of the station. Pickering has demonstrated safe and reliable operation during the current licence term. The plant is not the same as it was when it first started to operate – it is better; the design and operation of Pickering NGS has significantly improved over the years, and the plant performance is getting even better. In fact, Pickering NGS heads towards the next licence renewal period with some performance measures that are the best ever in plant history. Following are some highlights of what has been accomplished at the Pickering NGS. These are just a few examples that demonstrate why the Commission and the public can be confident in the continued safe operation of Pickering NGS.

During the current licence term, Pickering NGS has continued to demonstrate strong safety performance that is in the industry's top quartile. For instance, in 2014, Pickering reached 11 million hours without a single lost-time accident; and, in 2017, Pickering had its best-ever All Injury Rate with a remarkable value of 0.06. In November 2016, OPG received the Canadian Electricity Association's President's Gold Award of Excellence for Employee Safety in recognition of the company-wide All Injury Rate and Accident Severity Rate performance for 2013, 2014 and 2015. Furthermore, in each of 2015 and 2016, the station received the CNSC integrated plant rating of Fully Satisfactory (the highest rating from the regulator) based on the CNSC's evaluation of the 14 Safety and Control Areas.

Station reliability has improved significantly due to investments and improvements made over the licensing period. As a result, two of Pickering's units have had record operational runs - Unit 5 at 632 days and Unit 1 at 622 days. This can only happen because the plant is being maintained well. Combined with its best forced loss rate performance in site history (average of 4% over 2015 to 2017), Pickering NGS is continuing to achieve improved and more reliable operation, which in turn improves nuclear safety at the station.

Comprehensive safety analyses, both deterministic and probabilistic, confirm that the Pickering NGS design is robust and very safe. Moreover, in collaboration with industry, a first-of-a-kind whole-site risk assessment was performed to support that the overall risk of the entire Pickering site is low. This work is at the forefront of international progress on probabilistic safety assessment. The CNSC noted that *"the Whole-Site PSA results as included in OPG's submission provides a good characterization of the whole-site risk"*.

As safe as Pickering NGS has been, nuclear safety has been enhanced over the current licence term with a number of significant safety improvements that OPG implemented, including physical plant improvements to safety systems, substantial investments to put in place emergency mitigating equipment Phase 1 and 2, and procedure improvements. The emergency mitigating equipment was utilized during a recent large-scale emergency exercise, Exercise Unified Control (December 2017), which demonstrated the robustness of both on-site and off-site emergency preparedness measures.

Furthermore, an extensive Periodic Safety Review was conducted in concert with the licence renewal application, and it has concluded that Pickering NGS has in place effective programs and processes for continued safe operation through 2024. Through OPG's Integrated Aging Management Program, appropriate maintenance, testing and monitoring are ongoing at Pickering NGS, with particular attention to major components such as fuel channels, steam generators, and feeders assuring that the plant is fit-for-service and safe throughout the continued operating period. In addition, OPG is pursuing plant modifications, identified in the Periodic Safety Review Integrated Implementation Plan which was accepted by the CNSC, to further enhance the safety of the plant. The Pickering NGS is safer today than it has ever been, and with the Periodic Safety Review modifications, Pickering NGS will be even safer during the next licence term.

Watch a Video on Nuclear Safety and Pickering Defence in Depth

http://hatchstudios.com/clients/opg_pickering_defence_in_depth.mp4

OPG is particularly mindful of its social licence and the need to ensure protection of the public and the environment. OPG has an extremely strong record of accomplishment in this area. OPG continues to demonstrate that the radiological releases into air and water from Pickering reactor operations are at levels that are far below regulatory limits and hence are protective of public health and the environment. The environmental monitoring program regularly samples, for example, water, air, milk, plants and soil to ensure that both radiological and non-radiological emissions remain at safe levels. OPG posts the environmental monitoring results on its external website to provide transparency for local communities and interested members of the public. Pickering NGS was recently issued a fish authorization by Fisheries and Oceans Canada, in acknowledgement of the protective measures which OPG has undertaken for aquatic life and the participation in biodiversity and wildlife habitat programs. OPG will continue to show environmental stewardship in biodiversity and wildlife habitat programs.

OPG also works to develop positive relationships with local communities, including those near the Pickering facility and Indigenous communities, as well as with stakeholder groups that have a longstanding interest in the safety of nuclear power. OPG recognizes that members of the public, stakeholder groups, and local communities have a legitimate interest in the operations of the Pickering NGS; the way in which it is operated and managed; and the means by which OPG keeps the risks to human health and safety, and to the environment, at a low level. OPG therefore shares information on facility operations and performance with members of the public, to enable interested individuals to monitor the safety of the plant and OPG's management record.

Pickering's comprehensive public information program strives to ensure clear understanding of our operations and activities. This includes, but is not limited to, the operation of a Public Information Centre, a public phone line, a quarterly newsletter delivered to 120,000 homes and businesses, community programming, updates to municipal councils, stakeholder tours and annual community information sessions.

OPG's Indigenous Relations Policy provides guidance and direction to ensure that meaningful discussions and information sharing occurs with Indigenous communities across the entire province. In June 2017, OPG made changes to its Supply Chain policies and processes to encourage and support those Indigenous businesses who have a desire to become active vendors in the OPG supply chain. A minimum 5% Indigenous content goal is now assigned to bids and OPG encourages our existing vendors to formulate joint ventures and sub-contracting opportunities. As a company OPG has successfully partnered with the Indigenous communities on hydro-electric projects. In each case, the First Nation is an equity partner and will earn a long-term, stable source of revenue. These First Nations also benefited from the construction of the facilities through employment and procurement. Part of Indigenous engagement takes place through our Corporate Citizenship Program. In 2017, OPG funded 84 Indigenous community projects focused on youth, science, culture and sports. At the end of 2017, OPG Nuclear employed 91 self-identified Indigenous peoples with 29 directly working at Pickering. This is in keeping with OPG's social licence, which is a strategic imperative (i.e., one of four OPG priorities) that includes diversity and inclusion. Ensuring diversity by employing Indigenous people in OPG is an important part of this imperative.

OPG is committed to ensuring staff are qualified and competent to operate the plant, and this will be maintained through the next licence period, including sufficient staff numbers. The Pickering leadership team is continuously focused on ensuring an engaged workforce that is aligned around common goals. Alignment and engagement starts with awareness, understanding, and commitment by all levels of the organization. Long-term hiring strategies are in place to address staffing needs through to and beyond the shutdown of the station. Staff engagement and motivation will remain a key focus at Pickering, to ensure continued safe and reliable operation.

The transitioning of the station from commercial operation, at the end of 2024, to a safe storage state is being carefully planned. OPG has proven its ability to undertake such a transition with the successful safe storage of Units 2 and 3. Well-established procedures exist for the associated activities of reactor defueling and dewatering, as Pickering NGS utilizes these procedures during unit outages and they were successfully used as part of the Darlington Unit 2 refurbishment project.

OPG is committed to the responsible and comprehensive management of all its radioactive waste. In the interim, OPG has been safely storing radioactive waste at its licensed waste management facilities located at the Bruce, Pickering and Darlington nuclear sites for over 40 years meeting all environmental and regulatory requirements. OPG continues to work towards providing long term solutions for its radioactive waste.

In its Licence Application submitted to the CNSC, and as further described in CMDs 18-H6.1 and 18-H6.1A, Pickering made a set of six major commitments related to the continued safe and reliable operation of the plant through the requested licence term. These are:

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

In summary, the information presented in support of the Pickering licence renewal demonstrates that Pickering NGS has achieved strong and improving performance during the licensing period, operating safely and reliably; and that the managed processes are in place to ensure continued safe and reliable operation over the next licensing period.

OPG therefore requests a 10-year renewal of the Pickering Power Reactor Operating Licence given that OPG is qualified to operate the Pickering Nuclear Generating Station and will make adequate provision for the protection of the environment, the health and safety of persons, and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.

2.0 Clarifications from Part 1 Hearing

2.1 Clarification on Emergency Mitigation Equipment and Periodic Safety Review Safety Enhancements

At the Pickering licence renewal Part 1 hearing, discussions related to the Fukushima Action Items and the Periodic Safety Review (PSR) safety enhancements that are committed in the Integrated Implementation Plan (IIP) did not clearly outline the distinction between these two projects.

OPG would like to re-iterate that the generic Fukushima Action Items have remained closed since 2015, and Emergency Mitigating Equipment Phase 1 and 2 are implemented and available for service. The Periodic Safety Review modifications are separate from the Fukushima Action Item work and provide more, diverse ways to cool the fuel. The following provides further details to clarify the distinction between these two projects.

Fukushima Action Items

Following the Fukushima Daiichi accident, the CNSC raised 36 generic Fukushima Action Items (FAIs) for all Canadian nuclear utilities to ensure that the key lessons learned from this event were appropriately incorporated into their nuclear operations.

As part of the response, provision of Emergency Mitigation Equipment and associated modifications were identified and installed. The goal of the Emergency Mitigation Equipment is to ensure fuel cooling, containment and instrumentation for monitoring plant status can be maintained following a postulated loss of all off-site and on-site AC power as occurred during the Fukushima accident.

The implementation of EME was conducted at OPG in two phases.

- The initial phase (Phase 1) uses portable pumps to quickly restore fuel cooling by injecting lake water into the Heat Transport system, Steam Generators, Calandria vessel or the Irradiated Fuel Bays using a variety of deployment routes. It also uses small portable generators to power instrumentation for monitoring. The intent of Phase 1 deployment is to quickly respond to a Beyond Design Basis Accident (BDBA) and prevent it from progressing to a severe accident. Phase 1 EME has been installed and is available at Pickering since mid 2012.
- Phase 2 EME consisting of equipment such as large portable generators, provide backup electrical power for long-term operation of existing plant systems, to protect containment integrity and to support additional options for severe accident management thereby assisting the longer term process of restoring the site to a safe and stable state.

Figure 1 below depicts the flexible deployment of Phase 1 and 2 Emergency Mitigating Equipment provisions. Figure 2 and 3 show examples of Phase 2 EME and Phase 1 EME, respectively.

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http://hatchstudios.com/clients/opg_pickering_defence_in_depth.mp4

Simplified CANDU Nuclear Generating Station showing Phase 1 and 2 Emergency Mitigating Equipment

Revised March 2018 (not drawn to scale)

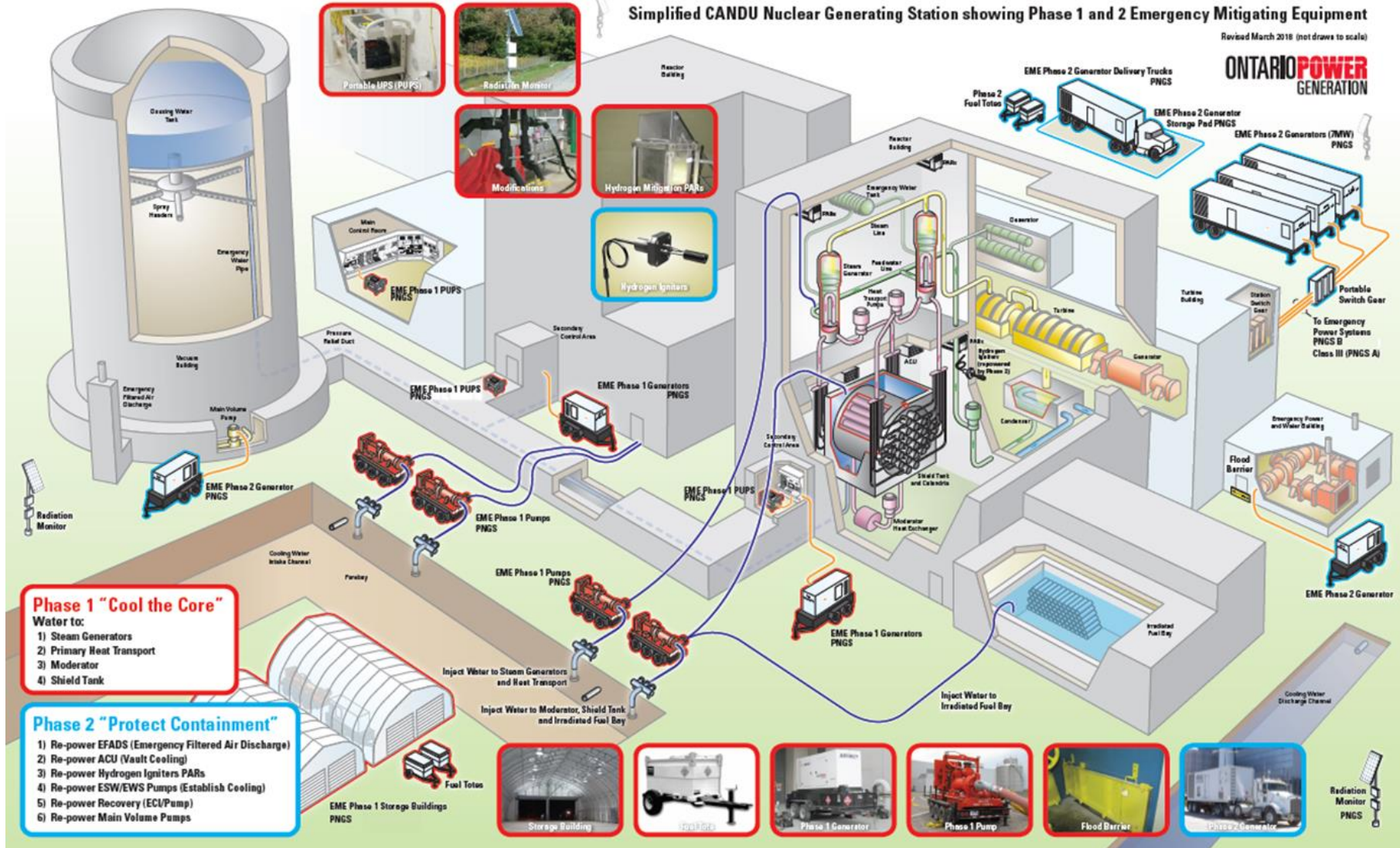


Figure 1: EME Phase 1 and 2 Equipment Deployment



Figure 2: EME Phase 2 fans for ensuring control of Hydrogen in the Irradiated Fuel Bays (left); and five EME Phase 2 generators ready for deployment (right)



Figure 3: Phase 1 EME Ready for Deployment

OPG has also demonstrated that EME can be quickly deployed with ample time to mitigate a wide range of extremely unlikely events, as proven in the December 2017 Exercise Unified Control. In addition, operator training includes response to beyond design-basis events and the operation of EME. In order to demonstrate OPG's emergency response capability, Pickering maintains an extensive drill and exercise program. This program validates emergency plans and procedures, and provides the emergency response organization with the opportunity to improve and sustain their emergency response capability. EME is regularly maintained and tested to ensure it is ready for deployment. Exercise Unified Control further demonstrated the robustness of emergency preparedness of OPG and off-site response partners.

Periodic Safety Review

In support of Pickering extended operation to 2024, OPG has completed a Periodic Safety Review (PSR) in accordance with CNSC Regulatory Document 2.3.3, *Periodic Safety Reviews*, and International Atomic Energy Agency's (IAEA) Safety Standards Series, Specific Safety Guide No. SSG-25, *Periodic Safety Review for Nuclear Power Plants*.

In accordance with CNSC Regulatory Document 2.3.3 one element of the PSR consists of conducting Safety Factor reviews to identify the extent to which Pickering and its programs meet modern codes and standards and are effective.

Under Safety Factor *SF6: Probabilistic Safety Assessment*, one of the objectives was to determine whether the results of the Probabilistic Safety Assessment (PSA) show that the risks are sufficiently low for all hazards, and that the PSA results meet relevant probabilistic safety criteria.

OPG has set more challenging expectations through per-unit Administrative Safety Goals, which are aligned with the requirements for constructing a new nuclear power plant even though the PSA per unit Safety Goals are met for all Pickering units as shown in Figures 4 and 5. When the post-Fukushima safety enhancements were factored into the PSA, Pickering NGS 5-8 was estimated to satisfy the per-unit Administrative Safety Goals in all areas as shown in Figure 4. However, as can be seen in Figure 5, the estimated PSA reduction for Units 1, 4 still remained above OPG’s more conservative per-unit Administrative Safety Goal for some initiating events.

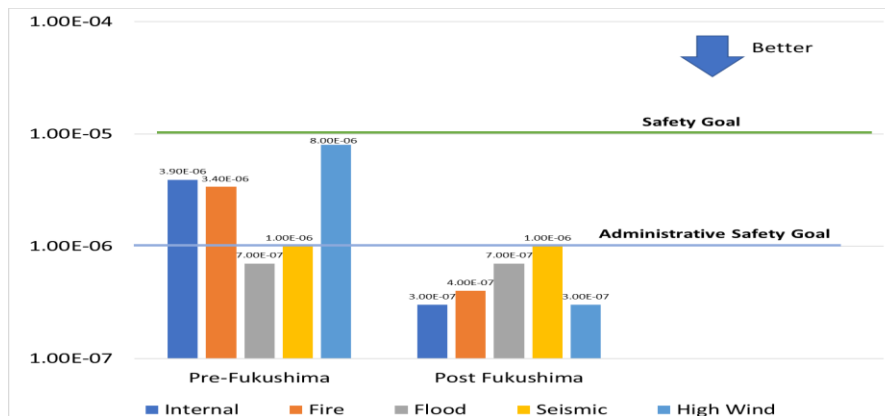


Figure 4: Estimated Units 5-8 per unit Large Release Frequency reduction provided by the post-Fukushima safety enhancements

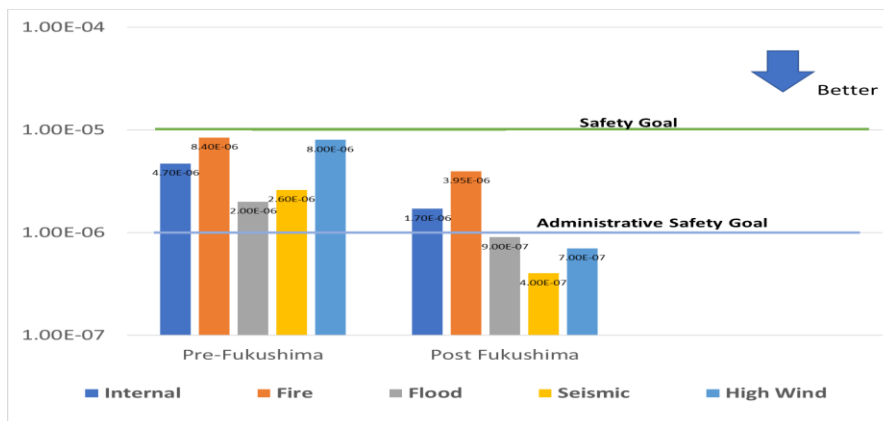


Figure 5: Estimated Units 1, 4 per unit Large Release Frequency reduction provided by the post-Fukushima safety enhancements

As a result of this PSR work, OPG committed in the IIP to implement plant modifications that further enhance safety. Additional piping connections and associated valves will be installed to allow the Pickering firewater system to provide an additional diverse and independent source of water for fuel cooling to the heat transport system, steam generators, the calandria vessel.

Following the completion of these enhancements as per the IIP Actions, Pickering NGS 1, 4 PSA estimated per-unit Large Release Frequency is expected to be better than the Administrative Safety Goal, further improving on plant safety, as shown in Figure 6. The modifications are underway and on track to be completed by December 2020 per the IIP.

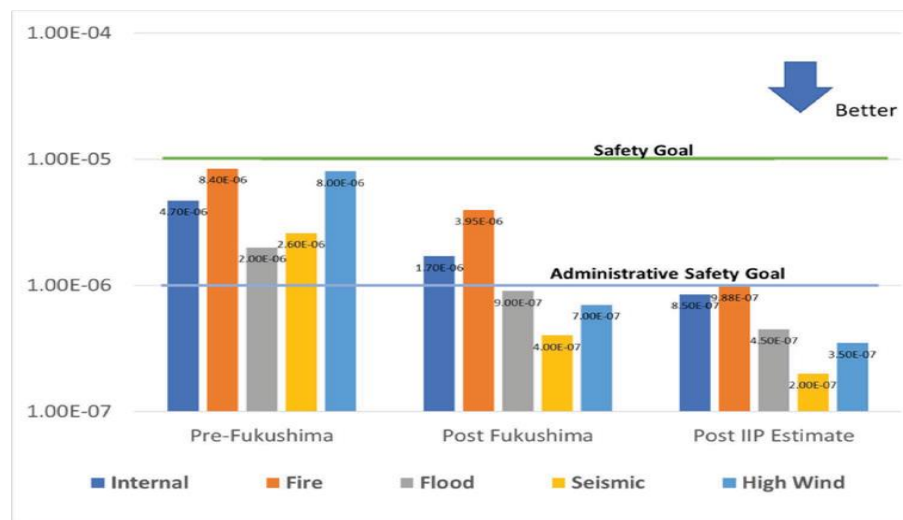


Figure 6: Estimated Large Release Frequency reduction for Units 1, 4 for pre-Fukushima, post-Fukushima safety enhancements and post-IIP safety enhancements

2.2 Use of Fission Chambers

At the Part 1 Hearing, the Commission requested additional information regarding enriched uranium in the fission chambers at Pickering.

Fission chambers were acquired in 1994 for use in the Pickering A Shutdown System Enhancement (SDSE). Three fission chambers are provided per unit, one for each of the triplicated trip channels of SDSE.

Fission chambers were chosen for SDSE to provide a reactor power measurement device which is diverse and independent from the existing shutdown system ion chambers and are commonly used for detection of neutrons.

The fission chamber electrodes are coated with a thin layer of enriched uranium. The coating is comprised of 93% U-235, 5.5% U-238, 1 % U-234 and 0.5% U-236 and weighs about 3.5 grams.

The fission chambers (Model# 900353-104) were obtained under AECB licence from Gamma-Metrics in the United States. The fission chambers consist of two concentric cylindrical aluminum electrodes electro-plated with a thermal neutron sensitive uranium compound coating, insulators and fill gas and a third concentric guard (ground) outer electrode.

The fission chamber is located within a self-contained welded pressure-tight titanium housing, which forms part of a hermetically sealed environmentally qualified section of the system. The electrodes are completely enclosed within the fission chambers.

Currently, fourteen fission chambers owned by Pickering are located on site. Six are installed in Units 1 and 4 (three each), two (which were installed prior to Pickering A layout) are located on Unit 2, and the remaining six spares are stored in a secure location (a locked area with restricted access) within the station. The storage and handling of the fission chambers meets the applicable Safeguards requirements for fissionable material as per the Pickering Power Reactor Operating Licence.

It should be noted that twelve additional fission chambers are also used at Pickering within the Core Discharge Monitors which are owned, operated and controlled by the International Atomic Energy Agency (IAEA) as part of their safeguards system.

3.0 Other Items of Interest

The following sections address some of the recurring themes in the Pickering licence renewal interventions and address some specific technical issues raised.

3.1 Fitness for Service

Several interventions, for example CMD 18-H6.24, 18-H6.56, 18-H6.60, 18-H6.63, and 18-H6.155, claim that the age of the Pickering plant makes it unsafe. This is not the case. OPG is committed to ensuring systems, structures and components at the plant are fit for service to the end of 2024, and that inspection programs will ensure fitness for service during the next licence period.

Ensuring fitness for service is part of the culture at OPG that permeates the organization and its many programs. OPG has a thorough Equipment Reliability Program that requires appropriate maintenance, testing, inspections, monitoring, and component replacement be conducted to ensure structures, systems and components remain fit for service and the plant is safe to operate at all times. Details of this program are provided in Addendum A.

As part of the Periodic Safety Review, OPG has assessed the condition of Pickering structures, systems and components (over 500,000) and has concluded that effective maintenance plans are in place to support safe and reliable operation to the end of 2024 and transition to safe storage by 2028.

OPG has and continues to make significant investments to modernize and to improve the reliability and safety of the plant.

Highlights

- ✓ Fitness for service of major components is confirmed
- ✓ Equipment is well maintained to ensure performance requirements are met throughout life of the plant
- ✓ Fuel channels are fit for service to end of station life
- ✓ Periodic inspections confirm major components remain fit for service

One key programmatic element of the Equipment Reliability Program is aging management. The Aging Management Program and the activities it drives through long term planning are key to ensuring critical equipment aging is proactively managed such that operation of the nuclear power plant remains within the licensing basis of the facility and ensures station safety and operational goals are met in the long term. OPG produces and regularly updates major components' Life Cycle Management Plans (LCMP) which ensure that the activities to assure fitness for service are well defined and that these activities are planned and coordinated. The plan is optimized by ongoing assessment of component condition. Execution of the plan requires projections to be made regarding fitness for service for the planned life of the components. This process ensures the effects of component aging are known, understood and managed, allowing for operation of the reactor to target end of life with mitigating actions implemented as required.

The following provides details regarding the management of specific aging mechanisms for major components (feeders, steam generators, and fuel channels) per OPG's aging management program and dispels misconceptions noted in intervenor comments.

Feeders

For feeders, the main focus is pipe wall thinning which is generally caused by flow accelerated corrosion. Based on baseline inspections of all Pickering feeders, and subsequent repeat inspections and analysis, feeder flow accelerated corrosion is well understood and effectively managed. All feeders are reassessed after each inspection campaign, and the leading feeders (i.e., those with reduced margin) are closely monitored. Industry-wide, there is no known incident of a feeder failure due to flow accelerated corrosion; this mechanism is predictable and manageable. Feeder stress analyses for reduced feeder wall thickness are performed per ASME Pressure and Vessel Codes and industry accepted guidelines to support feeder fitness for service. Pressure burst tests have demonstrated feeder pipes maintain structural integrity at much lower wall thicknesses.

While there have been instances of feeder cracking in industry, this is not a plausible aging mechanism for Pickering feeders due to the low residual stress from fabrication. In addition, embrittlement has never been observed in feeder pipes as the material is fully ductile at operating temperature and pressure. On the feeder pipe exterior, corrosion exposed to dry ambient conditions is self-limiting due to the formation of a protective oxide layer.

Following every outage, pursuant to Licence Condition 7.1 and CSA N285.4-05, OPG provides the CNSC a feeder piping and components inspection report. Any feeder found outside the CSA acceptance criteria is re-assessed and the component disposition sent to the CNSC for acceptance.

If a feeder is assessed not to be fit for continued operation, it is replaced according to OPG's feeder replacement plan, documented in the feeder LCMP. In fact, Pickering has replaced feeders in the past and maintains procedures, tooling and expertise should future replacements be required. At no time will any feeder be operated if it is not fit for service according to CSA Standards.

Steam Generators

The main tube aging mechanism in Pickering steam generators is under-deposit pitting corrosion. As part of the Check and Plan aspects of the steam generator LCMP strategy, Condition Monitoring Assessments and Operational Assessments are performed after every inspection campaign. This ensures that pre-existing degradation is behaving as predicted and to ensure all in-service tubes remain fit for service until the next inspection. This assessment forms an integral part of the steam generator disposition process, which is submitted to the CNSC for acceptance.

Any steam generator tubes that are assessed not fit for service are taken out of service by plugging the tube. This is a controlled, qualified process governed by industry and regulatory codes and standards. At no time will any steam generator tube be operated if it is not fit for service according to CSA Standards.

Fuel Channels

A brief summary of fuel channel aging mechanisms follows, along with how each is managed to ensure fitness for service.

OPG has dedicated a substantial amount of effort to the continued safe operation of fuel channels, through many years of targeted monitoring of aging mechanisms. OPG, together with industry partners, has invested in Research and Development (R&D) to understand future fuel channel component properties, and to refine assessment methodologies to assure fuel channel fitness-for-service. This R&D has been validated through regular inspections which confirm fuel channel component properties and ensure that fuel channels remain fit for service. In addition, to provide a better understanding of pressure tube aging mechanisms, pressure tubes are removed from the reactors and sent to laboratories for sampling, inspection, and testing.

Regular inspections of pressure tubes ensure the limits of pressure tube sag, wall thickness and diameter are not reached, per CSA Standard N285.4. OPG does not predict reaching any of the volumetric and dimensional limitations prior to the target end of life with margin.

To address tube to tube variability, models are developed with upper or lower bounds, to be used as conservative inputs for use in fitness-for-service assessments.

Pressure tube to calandria tube contact is not predicted on any fuel channel prior to predicted end of life. Regular monitoring and repositioning of annulus spacers is performed, to ensure adequate gap is maintained and the risk of blister formation is acceptably low.

Pressure tube axial elongation is being managed through inspections and maintenance, to ensure the fuel channels remain on bearing as required by CSA Standard N285.4. Maintenance is planned on units as required to reposition the limiting channels prior to reaching their limits. This strategy has been provided to the CNSC in the Fuel Channels LCMP. Once this planned maintenance has been completed, no fuel channel will reach its end-of-life bearing travel limit. Maintenance to reposition fuel channels has safely and successfully been executed by OPG numerous times in the past outages.

Deuterium ingress, and its impact on material properties of pressure tubes, is closely monitored by OPG through regular sampling in the body of tube and rolled joint regions. The OPG strategy exceeds the requirements of CSA Standard N285.4. This sampling ensures that measured deuterium concentrations, which are converted to hydrogen equivalent $[H_{eq}]$ concentrations, remain within acceptable $[H_{eq}]$ limits defined in CSA Standard N285.8, and that rates of change in $[H_{eq}]$ concentration are understood and within limits in the CSA Standard N285.4. Based on all sampling to date OPG continues to demonstrate compliance with the maximum $[H_{eq}]$ limits specified in CSA N285.8 as well as being within the maximum rate of change in $[H_{eq}]$ concentration specified in CSA N285.4. These inspections also serve to validate the models that predict future behavior of deuterium ingress. Variability amongst pressure tubes is accounted for by conservatively applying the upper bound of deuterium ingress models in fitness for service assessments. It should be noted that at the end of 2024 the Pickering pressure tubes hydrogen isotope equivalent concentration, $[H_{eq}]$ will be less than 100 ppm which is well within the currently approved limit of the fracture toughness model for pressure tube material.

There are established relationships between temperature, flux and their impact on fuel channel aging. For example, deuterium ingress to the pressure tube material is a function of temperature and time, so time spent with the heat transport system hot ("hot hours") is used to model deuterium ingress. Equivalent full power hours which is a measure of time spent under full power neutron flux conditions, is used to model mechanisms associated with flux, such as pressure tube deformation.

The appropriate metric that is applicable to the aging mechanism is used where required, with a conversion factor that enables interchanging the two measures for modelling purposes. Time Online (TOL) is not a metric that is used for fuel channel assessments, as it does not provide insight into the temperature or flux to which fuel channels are exposed. Because Pickering units operate at lower pressures, temperatures and flux than Bruce or Darlington units, fuel channel component aging takes place at a relatively slower rate.

To address aging mechanisms in the uninspected population of fuel channels, CSA N285.8 requires core assessments for aging mechanisms related to flaws and pressure tube to calandria tube contact. These are prepared and updated based on all accumulated inspection data and the latest engineering models as inputs to assess the risk from the uninspected population of channels. These assure that the risk of pressure tube rupture remains acceptably low. Similarly, demonstration of fracture protection and leak-before-break are required by CSA Standard N285.8. OPG continues to demonstrate fracture protection and leak-before-break by using methodologies and acceptance criteria that are concurred by CNSC.

With respect to leak-before-break assessment, leak detection by dew point meters is effective, based on modelling of the annulus gas system (AGS) using thermal hydraulic analysis code. OPG is confident that the annulus gas system will detect leakage from pressure tubes and supports the leak-before-break philosophy. This is supported by the fact that the thermal hydraulic analysis code used by OPG has been benchmarked against moisture injection tests carried out on reactor units. Reliability of the annulus gas system is maintained by ensuring that the dew point meters are calibrated regularly and system beetles, which detect the presence of liquid, are tested regularly.

The Annulus Gas System (AGS) circulates CO₂ (with a small amount of O₂) through the annuli between the pressure and calandria tubes to reduce heat transfer and detects any leakage of fluid into the annuli through cracks in the pressure tubes. The leakage detection function supports the leak-before-break philosophy which asserts that a break in the pressure tube will be preceded by a leak. Once a leak is detected, the heat transport system can be depressurised before the crack reaches critical crack length and rapidly propagates.

Nevertheless, assessments of leak-before-break take into consideration any potential unavailability of annulus gas system moisture detection. In the very unlikely event that a pressure tube develops a leak before actions are taken based on leak-before-break, the consequences are mitigated. A pressure tube rupture is a postulated design basis event. OPG has procedures, systems and barriers in place to mitigate the consequences. Staff are trained in these procedures in the class room, and provided regular refresher training and testing on the simulator. The two occurrences of break-before-leak events in CANDU history (fuel channels P2G16 and B6N06) did not result in any significant consequence to the public, per design. It should be noted that all Pickering Unit 1 to 4 pressure tubes have been replaced in the 1980's and have fewer equivalent full power hours than the Pickering 5 to 8 pressure tubes.

In the event that results, research findings, or industry operating experience challenges the validity of fitness-for-service assessments of Pickering fuel channels, OPG will evaluate the impact of these results, in accordance with internal corrective action processes and the licensing basis requirements.

If projections of conditions suggest future departure from the FFS envelope, mitigating actions are available and will be implemented in order to remain within the envelope. For example, single fuel channel replacement may be employed in a postulated extreme case where assessment of a given pressure tube flaw is unable to satisfy FFS criteria. At no time will any fuel channel be operated if it is not fit for service according to CSA Standards.

Summary:

OPG continues to operate its reactors safely and within the licensing basis, with the integrity of major components assured for the remainder of planned operation. The fitness-for-service (FFS) framework also ensures that, through periodic inspection, OPG continually understands the condition of the major components, and is able to predict component condition and ensure future operation remains within the acceptance FFS envelope.

OPG can confidently state that major components will remain fit for service up to the end of commercial operation. This confidence is derived from a mature, well-defined life cycle management program that is based on years of operating experience and supporting research. In addition, OPG, together with industry partners, has invested in R&D to understand future behavior of pressure tube aging mechanisms, and to refine methodologies to assure fuel channel fitness-for-service. This R&D has been validated through regular inspections, to confirm fuel channel degradation behavior and to ensure that fuel channels remain fit for service. This program produces fitness-for-service assessments that are aligned with all licensing requirements. Based on the established programmatic controls for managing major component aging, including an extensive inspection and maintenance program, sound technical assessments, and the implementation of mitigating measures where required, OPG is confident that Pickering major components will remain fit for service to the end of 2024.

3.2 Environmental Protection

The following is in response to intervenor comments related to Pickering's environmental protection program, for example, CMD 18-H6.19, 18-H6.55 to 58, 18-H6-77, 18-H6.82, and 18-H6.141.

OPG is committed to ensuring that the impacts of plant operation to the public, workers, and the environment are low and will continue to be of low risk and adequately mitigated, while continuing to provide the various societal and environmental benefits of plant operation.

Pickering has an effective environmental protection program that meets or exceeds all applicable regulatory requirements and related objectives. Ontario Power Generation's (OPG) Environmental Policy, OPG-POL-0021, provides direction related to environmental performance and environmental management.

This policy, which is approved by the OPG Board of Directors, ensures that:

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

The Environmental Management Program ensures, first and foremost, that no members of the public are exposed to any unsafe level of radiation. Pickering keeps emissions to a minimum, far below regulatory limits. Second, Pickering maintains extensive monitoring programs that measure levels of radiation in the environment, verify that levels are low and to ensure prompt detection of any changes from baseline levels so that appropriate actions can be taken.

Highlights of the program during the current licence period are as follows:

Highlights

- ✓ Internal performance targets are more stringent than regulatory requirements
- ✓ Environmental releases are monitored and results made available to the public
- ✓ Groundwater monitoring locations are sampled annually
- ✓ Public dose remains a small fraction of the regulatory limit
- ✓ Environmental Risk Assessment and Predictive Effects Assessment confirms no significant impacts to environment
- ✓ Issuance of a Fisheries Act authorization

Environmental Safeguards and Public Dose

The goal of OPG's comprehensive environmental protection program is to continually minimize impacts from station operation to the environment and to the public. This is achieved by ensuring that there are multiple barriers in place to control and minimize radioactive emissions to the environment and to ensure all emissions are monitored. The framework to control emissions is based on the guiding principle of keeping radiation impacts to the public and the environment As Low As Reasonably Achievable (ALARA). This is achieved by establishing operational emission limits to ensure that the dose to the public does not exceed the legal limit and in fact is kept far below that limit. There have been no Derived Release Limit (DRL) or Action Level exceedances on an annual basis for emissions to air or water. DRL and Action Levels are established in accordance with the approved CSA N288.1 standard. The dose to the public from Pickering NGS has consistently been orders of magnitude lower than the legal limit.

The annual dose to the critical group (the urban resident adult) from 2013 to 2017 ranged from 1.1 – 1.8 μSv or approximately 0.2% of the regulatory dose limit. The protection of the most exposed critical group ensures that other populations near Pickering NGS are protected. This is supported by the routine environmental monitoring of radiological emissions and their potential impacts on the public, including measurement of radionuclides in air, water, soil, vegetation, and food products taken near Pickering NGS as well as other background locations in the province. The CNSC also conducts independent sampling and has posted results which demonstrate Pickering monitoring results are consistent with the CNSC results.

As shown in Figure 7, the radiation dose to the public resulting from the operation of the Pickering Nuclear Generating Station is a very small fraction of the estimated annual average natural background radiation dose around the station and thus the risk to the public is low.

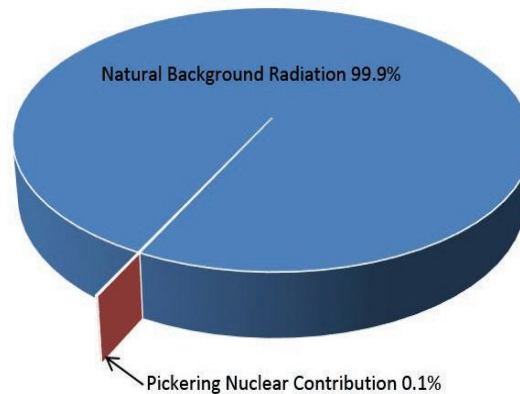


Figure 7: Radioactive Dose to Public versus Natural Background Radiation

Environmental Performance

In the spirit of continuous improvement, internal targets are set to drive improvement and limit impacts to the environment. During the licensing period, there has been steady improved performance year over year in the areas of environmental infractions, spills, conventional emissions and waste management. Radiological emissions remain low and work continues to reduce emissions even further. In 2017 the tritium emissions to air at Pickering Nuclear was a very small fraction (0.45 percent) of the annual Derived Release Limit which if exceeded would result in a member of the public (represented by a member of the most affected critical group, i.e., the urban resident) receiving a dose equivalent to the legal limit of 1000 μ Sv.

OPG has an extensive groundwater monitoring program around the Pickering site. This program continues to inform and identify onsite flow characteristics. The flow of groundwater on the site is towards station sumps which are all sampled before being discharged to the environment and any contaminants in the sump are reported to the CNSC. Monitoring is designed to detect changes to on-site groundwater quality to ensure timely detection of potential impacts. In the 2017 third quarter report on Environmental Emissions Data for Pickering Nuclear, published on OPG.com, OPG began posting site perimeter monitoring well data in response to requests for more information. This report states that “Groundwater monitoring is conducted at monitoring wells around the Pickering site perimeter, including along the Lake Ontario shoreline, to confirm that there are no adverse off-site impacts from tritium in groundwater.” Twenty-eight data points covering the site boundary are presented, demonstrating that there are no significant offsite adverse environmental effects associated with groundwater.

Fisheries Act Authorization

Impingement – Occurs when fish are taken up in the water and caught in the screens that keep external objects and substances out of the cooling water – which results in the loss of those fish.

Entrainment - Occurs when very small fish eggs and small young are able to pass through the screens and are carried through the turbine condenser system.

In 2010, OPG began installing a fish diversion system (FDS) on a seasonal basis to protect the aquatic fish community during the taking of cooling water from Lake Ontario. The FDS, which consist of 2000 linear feet of netting, has proved to be greater than 80 percent effective in reducing fish impingement. In fact, in January of this year Fisheries and Oceans Canada acknowledged the FDS as an integral component of OPG's mitigation measures and issued a Fisheries Act authorization for the residual effects. The authorization was obtained following over a year of significant discussions on the extent of the residual effect, proposed offsets including the Big Island Wetland restored by OPG in 2014, committed wetland restoration in Duffins Creek and support to the Ontario Federation of Anglers and Hunters for the Bring Back the Salmon project. OPG also participated in a number of engagement sessions with local Indigenous groups to keep them informed of work being done in this area.

This authorization now provides a mechanism for OPG to not only report on the residual effects but a means of demonstrating the effectiveness of the offset measures.

Since 2011, with the exception of 2015 and 2017, Pickering Nuclear has met the 80 percent fish impingement reduction target based on CNSC accepted methodology. In the two years where the target has not been met, the contributing factors have been due to a breach in the net and unexpected environmental conditions. Where there have been challenges to the system, OPG has completed investigations and implemented measures to minimise recurrence where practical. In addition, OPG provides offsets to compensate for fish losses.

Environmental Risk Assessment

In addition to regular monitoring programs, risks to humans and the environment were recently assessed in an updated Environmental Risk Assessment that focused on operations of Pickering site facilities from the year of 2011 to 2015. The assessment consisted of a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (EcoRA) for the risks of radiological and non-radiological contaminants and physical stressors associated with Pickering and its activities.

The HHRA assessed the risks of non-radiological contaminants and radionuclides to off-site members of the public (i.e. critical groups that are used for dose calculations). Predicted exposures from Pickering NGS emission sources were evaluated on the basis of potential toxicological effects from non-carcinogenic Contaminants of Potential Concern (COPCs), cancer risk from carcinogens, and radiation exposure from radionuclides. Human receptors evaluated include off-site members of the public, specifically those critical groups used for dose calculations in the annual OPG Environment Monitoring Program reports within approximately 20 km of the Pickering NGS site. Measured and modeled concentrations of COPCs were evaluated against screening benchmarks that are protective of human health. Radiological stressors were also assessed.

The HHRA concluded for radiological contaminants that the annual dose to the critical group (the urban resident adult) during this five-year period was approximately 0.12% of the regulatory public dose limit of 1000 $\mu\text{Sv/a}$. The HHRA results indicated that likely exposure levels for non-radiological contaminants are below benchmark values, and therefore no adverse effects on human receptors are expected

The EcoRA identified a number of plant and animal receptors known as Valued Ecosystem Components (VECs) to be assessed at their most exposed locations near or within the Pickering NGS site. The assessment of these receptors for the EcoRA focused on the nearshore in Lake Ontario, the Pickering NGS site, and Frenchman's Bay.

In general, the EcoRA showed that the exposure levels for non-radiological contaminants are below benchmark values. Where benchmark values were exceeded, the effects are highly localized and therefore the receptor populations are not expected to experience any adverse effects due to non-radiological releases from Pickering NGS operations.

Radiation doses were calculated for fish, aquatic plants or invertebrates, and riparian birds and mammals at the Pickering NGS outfall and Frenchman's Bay; and for terrestrial plants or invertebrates, and terrestrial birds and mammals on the Pickering NGS site. Calculated doses were compared to accepted dose benchmarks for aquatic and terrestrial biota. The radiation doses calculated for all VECs at all locations were well below benchmark values (i.e., no adverse effects on plant and animal life).

In addition to evaluating the effects of Pickering NGS emissions, the EcoRA also considered the thermal effects of the cooling water discharge, storm water discharge and impingement and entrainment of aquatic organisms at the cooling water intake.

Thermal Effects

The Environmental Risk Assessment included an assessment of effects from the thermal plume. This assessment considered both cold water and warm water species at different life stages. Specifically, thermal impacts on Round Whitefish embryos (a cold water species) have been a long-standing concern for nuclear stations. OPG has worked collaboratively with CNSC and Environment Climate Change Canada (ECCC) to develop a thermal survival model for Round Whitefish embryos incorporating recent CANDU Owners Group research. This model was applied considering three years of measured lake temperatures from the thermal plume and compared to the survival loss of 10% relative to the reference locations which is the threshold for no-effect level for Round Whitefish embryo survival.

The estimated survival losses at the plume stations compared to the reference stations, were all below the survival loss of 10% with the exception of one winter season (2011-2012). The threshold no-effect level of 10% relative survival loss was exceeded (10.8%) at one station which represents only a small fraction of the suitable habitat (1.2%) in the plume area. In addition, new research by Ontario Ministry of Natural Resources and Forestry indicates that the Round Whitefish population is lake wide which further supports that the thermal plume from Pickering is not having an adverse effect on Round Whitefish embryo survival.

Since climate change and potential increased lake water temperature may be a concern, OPG continues to monitor ambient lake temperature for adaptive management purposes. The monitoring data since 1997 shows no trend in increasing water temperatures. It is expected that any changes in ambient water temperatures up to 2024 will be within the normal year to year variation. OPG has committed to monitor two additional winter seasons starting in winter 2018-2019 and to assess the potential for thermal effects to Round Whitefish embryos which will be incorporated into future updates of the Environmental Risk Assessment.

Storm Water Discharges

OPG has a Ministry of Environment and Climate Change Environmental Compliance Approval to discharge storm water from the site drainage system. Through this Environmental Compliance Approval, OPG is obligated to sample and monitor storm water collected in dyked areas prior to discharging to site drainage system.

There are no Environmental Compliance Approval requirements for routine monitoring of the site drainage system (storm water). OPG has included monitoring of the storm water catchment areas as part of past studies and more recently as part of the update of the Environmental Risk Assessment.

This storm water sampling campaign was comprehensive, containing a number of catchment areas, four monitoring events and a detailed list of analytes including acute toxicity testing to effectively characterize the storm water runoff from the Pickering site. The monitoring results concluded that the final concentration in each of the discharge channels, and in the lake, resulting from storm water runoff were below the benchmarks values. Future storm water sampling will be carried out to be consistent with the requirements of CSA N288.6-12 to periodically review major facility changes and incorporate into the Environmental Risk Assessment accordingly.

Overall, the Environmental Risk Assessment confirms that Pickering NGS continues to operate in a manner that is protective of human and ecological receptors residing in the surrounding area. These reports are available to the public at www.opg.com.

Predictive Effects Assessment

In 2017, OPG completed a Predictive Effects Assessment (PEA) to evaluate the potential for adverse effects to human health and the environment from the activities associated with transitioning the station from end of commercial operation to a Safe Storage with Surveillance state. The PEA encompasses both the Stabilization Phase and the Safe Storage with Surveillance Phase.

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

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

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

Environmental Stewardship

Pickering's Biodiversity and Natural Areas Management Program is established to protect, maintain and enhance the natural environment around the Pickering site. The program continues to provide tree planting, butterfly gardens and numerous other initiatives. In 2017, OPG Nuclear Operations received the "Conservation Certification" for 2017 - 2019 from the international Wildlife Habitat Council and Pickering Nuclear has twice been recognized as Wildlife Habitat of the Year.

In the next Licence Term

- ✓ Impacts of plant operation to the environment and the public will continue to be of low risk and adequately mitigated
- ✓ Transparency and appropriate public consultations have been upheld and will continue
- ✓ OPG will continue to invest in Pickering to support environmental protection

3.3 Emergency Preparedness

The following addresses a number of interventions, for example, CMD 18-H6.19, 18-H6.24, 18-H6.56, 18-H6.57, 18-H6.60, 18-H6.62 to 64, 18-H6.66, and 18-H6.76, related to OPG's emergency preparedness and public awareness.

OPG is committed to ensuring that the impacts of plant operation to the public, workers, and the environment will continue to be of low risk and adequately mitigated.

Pickering NGS has an effective emergency preparedness program that meets or exceeds all applicable regulatory requirements and related objectives.

Highlights

Expect the unexpected, and be prepared for it...

- ✓ OPG has a robust emergency preparedness program
- ✓ Plans integrated with the Municipality/Province/ Federal/International partners
- ✓ "Exercise Unified Control" demonstrated readiness on a large scale
- ✓ Distribution of KI pills completed

In addition, substantial upgrades to the station Emergency Mitigating Equipment (EME) have been undertaken, which improves response to beyond design-basis events, and mitigates the risks of severe accidents.

The objective of the OPG Nuclear Emergency Preparedness program is to ensure OPG has adequate provisions for the preparedness and response capability that would mitigate the effects of accidental releases of radioactive material. To ensure this capability, Pickering NGS practices the response capability of staff through simulated emergencies, and maintains plans and procedures and regularly trains staff to ensure that this capability is sustained including response in the extremely unlikely event of a nuclear emergency involving multiple units and deployment of EME (as shown in Figure 8).



Figure 8: Deployment of Emergency Mitigation Equipment

Drills and exercises are an important aspect of the OPG emergency preparedness program. The conduct of vigorous drills and exercises at OPG, based on an all-hazards approach, is a critical component of maintaining this robust emergency management capability. The all hazards approach considers technological and human-caused hazards. Pickering NGS maintains an extensive exercise program that includes the planning and conducting of drills and exercises, and critical evaluation to learn from them and drive improvements. The drill and exercise regime includes both Design Basis Accidents and Beyond Design Basis Accidents and is designed to ensure that all major elements of its emergency plans are periodically tested. OPG's drill and exercise program is reviewed periodically by international industry experts and audited by the CNSC.

During the current licence period, OPG has completed many program enhancements to ensure conformance with regulatory requirements.

As part of the Pickering Periodic Safety Review, Emergency Planning was reviewed. This review has confirmed that OPG Nuclear has in place adequate plans, staff, facilities and equipment for dealing with emergencies. In addition, arrangements are in place for emergency training and exercises, and interaction and coordination with local, provincial, and national authorities.

The provincial Office of the Fire Marshall and Emergency Management updated the Provincial Nuclear Emergency Response Plan in December 2017 to incorporate lessons learned from recent international emergencies and best practices. The Pickering PNERP Implementing Plan was approved at the end of March 2018. As a result, OPG is updating its emergency plans and providing support to off-site authorities to ensure conformity with the approved PNERP Master Plan.

OPG is in discussions with the Durham Region and the City of Toronto and is committed to providing support needed to implement the updated PNERP provisions.

Public Communication and Awareness

OPG, regional and municipal governments work with the Province of Ontario in providing public information on nuclear emergency preparedness.

Each organization maintains webpages with radiation/nuclear preparedness information. For example:

- Ontario's Office of the Fire Marshall and Emergency Management (OFMEM) maintains a Nuclear Preparedness webpage with links to the PNERP, PNERP Implementing Plans, and designated municipality websites.
- OPG's website provides a clear outline of emergency preparedness accountabilities and instructions, as well as related links including Potassium Iodide (KI) order site www.preparetobesafe.ca. Over the last 30 months since the website was established there have been over 38,000 orders for KI pills placed and delivered. Approximately 21,000 orders have been from residents in the 10-50 km region.
- Durham Region's website provides nuclear emergency preparedness information such as public alerting and protective actions, as well as a KI information page that includes a list of participating pharmacies, Environmental Helpline number, and links to the Ministry of Health and Long-Term Care (MOHLTC), OFMEM, and www.preparetobesafe.ca
- The City of Toronto provides nuclear emergency preparedness information, including the Telehealth Ontario number and links to the OFMEM and www.preparetobesafe.ca.
- Ontario's Ministry of Health and Long Term Care (MOHLTC) webpage provides links to the Radiation Health Response Plan, KI Guidelines and KI Fact Sheet. The Radiation Health Response Plan was issued to health stakeholders through multiple channels such as the Ontario Medical Association, College of Physicians and Surgeons of Ontario, Local Health Integration Network, and Public Health Units.

OPG facilitates the distribution of Potassium Iodide (KI) fact sheets to various agencies, including Telehealth Ontario, Toronto 311 and Durham Helpline operators. Durham provides health care providers with related information, including the MOHLTC KI fact sheet along with supporting information through their DurhamMD site. Toronto provides fact sheets to all divisions and councilors for the Primary (Detailed Planning) Zone areas. In conjunction with the pre-distribution of KI pills to local residents, KI fact sheets were also provided to both residents, and municipal staff and councilors.

OPG, with the support of the Province, Durham Region, and the City of Toronto, issued a emergency preparedness public information document, entitled '*Never be in the Dark with Your Safety*', to residences and businesses located in the primary zone of Pickering in May 2014. This document was produced with extensive public consultation and was very well received by residents. Packaged as a functional flashlight, the document provides guidance on what to expect in the unlikely event of a nuclear emergency and how to prepare prior to an emergency.

In 2015 OPG supported distribution of potassium iodide (KI) pills to all homes and businesses within the primary zone, as well as developing a process for people within 50 km to obtain the pills. OPG participated in the Provincial Working Group which oversaw distribution of KI pills. The Working Group also included members from the Emergency Management Office, Toronto Office of Emergency Management and Durham Health. All parties worked together to develop and implement a program that would fit the needs of the communities surrounding Pickering Nuclear.

At the same time, a communication campaign was developed, beginning with focus groups established in the primary zones. A two-part communications strategy for pre-distribution and distribution campaigns was implemented, with the pre-distribution campaign being a focused intensive education campaign that raised public awareness of KI distribution by explaining why it was taking place, and what it meant.

As part of the overall campaign, a website was created (www.preparetobesafe.ca). The website's purpose was to provide an online site for people within 50 km of Pickering NGS to order KI pills and provide information using FAQs (Frequently Asked Questions).

To further improve awareness on emergency planning for local residents, OPG, along with emergency preparedness partners at Durham Region, the City of Toronto and the Province of Ontario, distributed an Emergency Awareness Kit to residents and businesses within the 10 km Primary (Detailed Planning) Zone in November 2017. The approximately 200,000 kits included an updated brochure on what to do in the unlikely event of a nuclear emergency, a pen light and emergency checklist magnet. All were contained in a durable folio box, which was designed to safely store previously distributed KI pills.

In April 2018, OPG repeated the public survey to gauge the effectiveness of the Emergency Awareness Kits that were distributed within the detailed planning zones for Pickering and Darlington. The survey demonstrated that five months following the distribution, retention was high and awareness of emergency preparedness had improved. In addition, area residents are more confident than they were before about what to do in the unlikely event of a nuclear emergency.

Most recently, during Emergency Preparedness Week, Durham Region continued their spring/fall Emergency Preparedness and KI pill awareness campaign via a wide variety of platforms that included newspaper and transit ads, social media, and a child-care newsletter article.

It is evident from the above that information about emergency preparedness and KI pill distribution is widely and easily available to members of the public. If someone in the Toronto or Durham performs an internet search for "KI pills", links appear (such as the KI pills Durham Region and KI pills Toronto) that bring you to the preparetobesafe.ca website to order the pills.

OPG will continue to work with our partners in emergency preparedness to provide the public with updated nuclear emergency preparedness information that is made widely available from a variety of sources.

3.4 Nuclear Waste and Used Fuel Management

The following addresses intervenor comments, for example, CMD 18-H6.55, related to the Irradiated Fuel Bays and plans for long term storage of radioactive waste and used fuel from Pickering.

OPG is committed to ensuring that the impacts of plant operation to the public, workers, and the environment will continue to be of low risk and adequately mitigated, while continuing to provide the various societal and environmental benefits of plant operation.

Highlights

- ✓ OPG has a well established Nuclear Waste program
- ✓ Committed to safely managing nuclear waste in a responsible manner
- ✓ Committed to ensuring future generations are not unduly burdened with managing today's waste
- ✓ Investing to ensure costs of future decommissioning are fully covered

Addendum B provides a brief overview of the irradiated fuel bays and dry storage facilities used to manage and store used fuel on the Pickering site.

As part of the Periodic Safety Review, the condition and operation of the Pickering irradiated fuel bays were assessed. The aim of the review was to ensure the adequacy of the condition of the Pickering Irradiated Fuel Bays for the extended operating period.

In the Pickering NGS PSR Safety Factor 2 report, *Actual Condition of Structures, Systems, and Components Important to Safety*, it is concluded that programs are in place to address required station maintenance and equipment obsolescence and that the Irradiated Fuel Bays and supporting equipment are in good condition and are able to support the station's spent fuel storage strategy.

The assessment identified two issues that need to be addressed. The first issue relates to leakage from the Pickering 5-8 Irradiated Fuel Bay and associated collection sumps into groundwater in the vicinity of the bay. Leakage to groundwater was mitigated by operating procedures and now has been addressed by repairs to the sumps. The majority of the IFB liner repairs are complete and the remaining repairs are in progress and planned to be completed by September 30, 2019 per the IIP action. Another issue relates to the documentation of the Pickering 5-8 seismic capacity of the used fuel basket stacking arrangement. This documentation is being prepared and will be completed by March 31, 2019 per the IIP action.

Plans for long-term management for low and intermediate level waste and used fuel are actively being implemented through development of separate deep geologic repositories (DGRs):

- Low and Intermediate Level Waste Long Term Management: OPG's preferred approach for the long term management of its low and intermediate level waste (L&ILW) is the planned construction of a deep geologic repository (DGR) in a very low permeability limestone, 680 metres below the surface of the Bruce Nuclear site. A DGR is international best practice to provide safe isolation now and for the long-term. Approximately 200,000 cubic metres of L&ILW from OPG owned nuclear facilities is expected to be stored in the DGR. OPG is in the regulatory approvals process for this DGR and is currently addressing a 2017 information request from the Federal Minister of Environment and Climate Change to update the analysis of the potential cumulative environmental effects of the project on the Saugeen Ojibway Nation's (SON) spiritual and cultural relationship with the land. Once OPG provides this response, the Assessment Agency will prepare a Draft Report and potential conditions for public review, prior to submitting a decision package to the Minister.

- Used Nuclear Fuel Long Term Management: The Nuclear Waste Management Organization (NWMO) is responsible for implementing Canada's used fuel long term management plan of Adaptive Phased Management (APM).

Adaptive Phased Management is a technical method and management system carried out in manageable steps and adaptable to changing social conditions and emerging technical knowledge. The APM technical method involves constructing a DGR in which to safely manage the used fuel which is currently stored on site in the Irradiated Fuel Bays and dry storage facility.

The site selection process is ongoing and was narrowed to five possible locations in 2017, with a preferred site expected to be identified in 2023. Following site selection, detailed site characterization, licensing, and construction will be completed. The DGR is currently expected to be available for operation between 2040 and 2045.

OPG is committed to the responsible and comprehensive management of all its radioactive waste. In the interim, OPG has been safely storing radioactive waste at its licensed waste management facilities located at the Bruce, Pickering and Darlington nuclear sites for over 40 years meeting all environmental and regulatory requirements. OPG continues to work towards providing long term solutions for its radioactive waste.

3.5 Transparency

A number of interventions were related to availability of information and transparency, for example CMD 18-H6.55, 18-H6.57, 18-H6.58, 18-H6.62, and 18-H6.155.

OPG is committed to open and transparent communication and to ensure public communications are informative, timely, accurate and material information is disclosed in accordance with applicable legal and regulatory requirements.

As noted in the Part 1 Hearing written submission from OPG, "OPG recognizes that members of the public, stakeholder groups, and local communities have a legitimate interest in the operations of the Pickering NGS; the way in which it is operated and managed; and the means by which OPG keeps the risks to human health and safety, and to the environment, at a low level. OPG therefore shares information on facility operations and performance with members of the public, to enable interested individuals to monitor the safety of the plant and OPG's management record. OPG also works to develop positive relationships with local communities, including those in the vicinity of the Pickering facility and Indigenous communities, as well as with stakeholder groups that have a longstanding interest in the safety of nuclear power."

Information sharing activities are of several types and are listed below:

- OPG uses its public website to provide up-to-date information on the performance of the Pickering station, on environmental assessments, projects, probabilistic safety assessment summaries, and regulatory information such as licensing Hearings. Monthly environmental emissions data in an easy to read format have been published on the OPG website since 2014. The information reported includes radiological emissions to air and water, waste management facility monitoring results, and spills to the environment.

- OPG provides a large amount of background information and other information on nuclear power and on the Pickering NGS operation, both online and at its facilities in Pickering, Ontario.
- OPG establishes and maintains positive relationships with the people in the nearby communities and works to improve and maintain the local environment.
- OPG has developed a program to engage with Indigenous communities that have an interest in the Pickering facility and with the land on which it lies.
- OPG's annual reports to the CNSC on the Environmental Monitoring Program are available to the public on the OPG website.
- OPG Nuclear and Pickering Nuclear Performance reports are produced quarterly. OPG posts performance reports on station operations on a quarterly basis on its website, at www.opg.com.
- Information is also shared electronically with key stakeholders, and ads on station performance are placed in local newspapers.
- For operational status changes or unscheduled operations that may cause public concern or media interest, OPG follows a protocol to provide prompt notification of key community stakeholders.
- OPG maintains a duty on-call position 24 hours a day, seven days a week. In conjunction with the Durham Emergency Management Organization, OPG notifies key community stakeholders of activities or events that may be of interest to the public or media. This is to ensure that the emergency agencies (fire, police, and emergency management) and political offices are aware of events so they can respond accurately if they receive questions from constituents.

OPG also complies with the Freedom of Information and Protection of Privacy Act and Freedom of Information requests. Realizing that during the Hearing process timeliness of response is important to intervenors, Pickering Nuclear has ensured two-way communication channels have been available to the public and has responded to requests received directly, including requests for site visits, from interested parties.

In addition, it should be noted that Pickering NGS has provided more information and documents related to the licence application to the public than ever before. Interested individuals and groups have access to the following Pickering Licence Renewal documents and some of the referenced documents:

- OPG letter – End of Commercial Operation (P-CORR-00531-04930)
- Periodic Safety Review Summary report (P-REP-03680-00033)
- Periodic Safety Review Basis Document (P-REP-03680-00001)
- Periodic Safety Review documents:
 - Fifteen Pickering Periodic Safety Review Safety Factor Reports
 - Pickering NGS Periodic Safety Review 2 – Global Assessment Report (P-CORR-00531-05292)
 - Pickering NGS Periodic Safety Review 2 – Integrated Implementation Plan Revision 1 (P-CORR-00531-05333)
- Pickering B Probabilistic Safety Assessment Summary report (NK30-REP-03611-00021)
- Pickering A Probabilistic Safety Assessment Interim Summary report (NA44-REP-03611-00043)
- Pickering Whole-Site Risk Presentation to Commission, December 14, 2017: CMD 17-M64.1
- Pickering Environmental Risk Assessment Report 2018 (P-REP-07701-00001)
- Pickering Predictive Effects Assessment (P-REP-07701-00002)
- Evacuation Time Estimates Report (P-REP-03490-00079)
- CANDU Owners Group White Paper – Whole-Site Risk (COG-JP-4499-0025 R1)
- Pickering Fish Act Authorization

This is in addition to the safety and performance reports, environmental monitoring reports and other documents regularly posted on www.opg.com.

3.6 Tritium

The following addresses specific issues with the analysis provided in CMD 18-6.65. OPG has had this report independently reviewed by experts, and offers the following contrasting analysis.

The intervenor has estimated public exposure to tritium oxide ("tritium") in the vicinity of Pickering Nuclear, and has interpreted this exposure as a serious health risk, using a novel method which does not follow the accepted standard, CSA N288.1, for estimation of public dose (derived release limits) based on environmental monitoring. His estimate is based only on tritium concentrations and intake rates of air, food and water. In contrast, the accepted procedure to assess public health risk involves dose calculations, using International Commission on Radiation Protection (ICRP) dose coefficients, compared to the public dose limit.

Intake rates used in the author's estimate are significantly overstated. Examples of these, and their impacts on the end result, are identified below:

- The average air inhalation rate is overestimated by using the 95th percentile value, rather than the average value.
- The tritium in air measurement value is misrepresented in the calculation (4.9 Bq/m³ in one table was transcribed as 5.9 Bq/m³ in a later table, for the calculation).
- Exposure via skin absorption is overestimated as 60% fraction of exposure via inhalation, though both the intervenor's cited source and CSA N288.1 recommend a 50% fraction.
- Taking the above factors into account results in overestimates by the author of about a factor of 2 for both inhalation and skin absorption.
- Exposure via food ingestion is overestimated by assuming (without apparent basis) 1/3 of total food intake is obtained locally. In contrast, a Pickering site-specific survey calculated local vegetables at 3.0% of diet and local fruit at 1.5% of diet, for the urban resident critical group (resulting in a 7-fold upward bias). In addition, the tritium in vegetables concentrations used in the estimate are not representative of values measured in garden vegetables at critical group locations in the vicinity of Pickering NGS. Measured tritium concentrations in vegetables at urban residential locations are 4 or more times lower than those used by the author. Combining these two factors results in at least a 28 times upward bias in the author's results for food ingestion.
- The author assumes drinking water is obtained directly from Frenchman's Bay, west of the Pickering NGS site, which is not a drinking water source. This results in the use of a value of 14.8 Bq/L. However, most residents use municipal water: the average tritium concentration in Water Supply Plant water is about 5 Bq/L at the Ajax Water Supply Plant. This causes a 3-fold overestimate in the tritium ingestion from drinking water component.
- In all, exposures to tritium via inhalation, skin absorption, water ingestion, and food ingestion are overstated by factors of approximately 1.8, 2.1, 3, and 28, respectively.

Taking all of this into account it is apparent that his estimate of exposure, even if it were using an accepted methodology, would be quite inaccurate.

In addition to the estimate of public exposure to tritium oxide, the intervention questions the standard dose assessment methodology for another physical form of tritium. The ICRP dose model assumes a 3% conversion of tritium oxide (“HTO”, the author’s label for the form of tritium emitted from Pickering) into organically bound tritium (OBT) in the body following ingestion of HTO. However, the dose coefficients for tritium in CSA N288.1 have been adjusted up by 10% of the ICRP values based on consideration of the OBT question. These are the dose coefficients used in the annual public dose calculation for Pickering NGS. The CNSC has previously reviewed issues around OBT dose coefficient raised by the author, and concluded that the current dose models are acceptable for radiation protection of workers and the public.

The author then proceeds to selectively pick from and interpret various epidemiological studies as supposed evidence of public health effects associated with nuclear facilities. In doing so he ignores study results which contradict his hypothesis or which show decreased health risks. In fact, reading the conclusions of the studies themselves (e.g., Lane 2013, Wanigaratne 2013), one sees that these studies have not found any clustering of cancer incidence or other health effects around the nuclear facilities, nor any relationship between cancer incidence and tritium exposure. In fact, the intervention conclusions are contradictory to the findings of the studies’ authors, and are not consistent with standard practice in epidemiology.

3.7 Community Perspective

The following provides a community perspective for Pickering as noted in some interventions.

In the Community

Pickering Nuclear strives to make a difference and help improve the well-being of the communities that host our operations. OPG believes this is essential to being a good corporate citizen and neighbour. Ensuring the company has earned its social licence to operate in our host communities will always be a focus for OPG and its employees, most of whom not only work, but also live in the community.

Since 1999, the Pickering Nuclear Community Advisory Council (CAC) has helped us to foster community engagement by providing station leadership with a community perspective on Pickering’s station operations. Originally based on Darlington’s Site Planning Committee, the council, which is comprised of local residents, is considered an industry best practice. Groups from neighbouring municipalities as well as foreign countries have sought to learn from this concept, which has proven to be very effective for OPG, the CAC and its members, and the local community.

Locally, support for relicensing among local community leaders remains strong, with 95 per cent having no concerns with continued operations of the station, and with about 60 per cent of the general population supporting continued operations if studies demonstrate safe operations. Provincially, a majority (55 percent) support the extension, but among those most familiar with the announcement, support increases to about 81 per cent.

Equally important is OPG's anecdotal measurement of support through our many public activities and community work in the local vicinity. We do this in part by hosting a public information centre, offering tours and presentations on nuclear power, and by fostering community partnerships in the areas of environment, education, community programs and Indigenous initiatives. Through these relationships, the community has gained confidence in OPG's commitment to operate in a safe, open, transparent, and environmentally responsible manner.

In addition to the more than 150 community partnerships we take part in each year, Pickering Nuclear also offers free, educational programming for children during school breaks. The annual Tuesdays on the Trail program in July and August brings over 16,000 community members to the areas surrounding the Pickering Nuclear site. Our annual March Break program hosts over 3,000 community members on site each year.

OPG pledges to remain committed to continued open communications, to listening to our neighbours, and to incorporating community feedback throughout the licence term. We are committed to continually seeking opportunities to better engage, inform and educate the public on the topic of nuclear power.

A Local Perspective – OPG's Focus on Safety

A CAC member representing Pickering Naturalists on the committee noting effectiveness said: *"For more than ten years, a member of the Pickering Naturalists has served on the Pickering Nuclear Community Advisory Council (CAC). Through our CAC participation, the naturalists club has gained deep insight into the operations of the station operations and we understand the commitment that OPG has made to ongoing training, plant safety culture, maintenance and modernization activities that have led to the safe operation of the facility. We feel that Pickering Nuclear and OPG have made significant contributions over the years in their education programs and biodiversity projects. We believe that their enthusiasm and participation in these activities speaks very highly of the professionalism, sense of environmental responsibility and the spirit of the employees who share our community, and our natural world."*

With safety being top priority at OPG, the Safe Communities of Pickering and Ajax *"supports OPG's application for an operating licence for the Pickering Nuclear generating station because they have demonstrated industry and community leadership in safety."*

The University of Ontario Institute of Technology (UOIT) Dean of Energy Systems and Nuclear Science interacts regularly with OPG and commented *"The safe and reliable operation of the Pickering A and B nuclear-electric generating units demonstrates the soundness of the CANDU design and the accumulated operating experience of Ontario Power Generation. The additional safety enhancements undertaken in response to the Fukushima event further increase the safety robustness of this design. The continuous improvement plans, including foremost the biggest clean air project in Canada in the refurbishment of Darlington Nuclear Station, are testimony to OPG's strong record of compliant and safe operations."*

The Ajax-Pickering Toastmasters group said *"As safety is a top priority for all members of the club, we are aware that OPG has invested heavily to ensure the plant remains safe by modernizing the plant components and increasing inspections and maintenance. We understand that safety of the public and staffs are OPG's top priority and as members of the organization and the community, this provides great assurance. We also receive frequent open transparent communications from OPG on events throughout the year and are thankful to be kept in the loop."*

“OPG, through its many years of operating the Pickering Nuclear station since the late 1970’s, has demonstrated, and continues to exercise its due diligence when it comes to public safety. Its excellent safety record is a matter of public knowledge...we have been pleased with OPG’s exceptional track record for the safe operation of the Pickering station. There is every reason to believe that OPG will continue to uphold its excellent safety record.” Chair Adrian Foster, Canadian Association of Nuclear Host Communities.

A Local Perspective - OPG’s Openness and Transparency

As well, there is confidence in OPG’s open, transparent communications to the community. The Women’s Multicultural Resource and Counselling Centre says *“OPG maintains open, transparent and consistent communications with its host communities and stakeholders.”*

This is echoed by the Town of Ajax who feel *“OPG proactively communicates with Ajax Town Council and residents through face-to-face discussions, public meetings, community newsletters, newspaper advertisements, community information sessions and operating an Information Centre.”*

The CAO of Scientists in School said *“They work closely with various stakeholder groups on a regular basis to ensure that their communication materials are clear and understandable. They send regular updates via their Neighbours Newsletter, host community information sessions and staff their public information centre with knowledgeable people who offer helpful resources and other information. Ontario Power Generation is a true community builder and is a thoughtful, well-prepared neighbour.”*

A Local Perspective - OPG’s Environmental Stewardship

“From a personal perspective, I would be remiss if I did not comment on Ontario Power Generation’s concern for the environment and the safety of the community. I have been a resident of Pickering for over 30 years; the generating station has always been part of our lives. Their concern for and commitment to the environment is obvious.” Cindy Adams, Executive Director, Scientists in School

A Local Perspective – OPG’s Values and Commitment to the Community

“In all our dealings with OPG directly and indirectly, we have found it to be a safe, productive and engaged operator, with a strong connection to its community through both its actions and ongoing communications of all decisions. We are particularly impressed with OPG’s commitment to safety in all it does...” CEO Nancy Shaw, Oshawa Chamber of Commerce

“I’m proud to be the mayor of a community that generates 14% of Ontario’s electricity through our trusted community partner, OPG. Many OPG employees call Pickering home and are committed to making safety their priority, and as such, I would be pleased to see Pickering Nuclear operate to 2024 and continue adding value to our community and to our province.” Mayor Ryan, City of Pickering

ADDENDUM A:

Fitness for Service Program Overview

Several interventions, for example CMD 18-H6.24, 18-H6.56, 18-H6.60, 18-H6.63, and 18-H6.155, claim that the age of the Pickering plant makes it unsafe. This is not the case. OPG is committed to ensuring systems, structures and components at the plant are fit for service to the end of 2024, and that inspection programs will ensure fitness for service during the next licence period.

Ensuring fitness for service is part of the culture at OPG that permeates the organization and its many programs. OPG has a thorough Equipment Reliability Program that requires appropriate maintenance, testing, inspections, monitoring, and component replacement be conducted to ensure structures, systems and components remain fit for service and the plant remains safe to operate at all times.

As part of the Periodic Safety Review, OPG has assessed the Pickering structures, systems and components (over 500,000) and has concluded that effective maintenance plans are in place to support safe and reliable operation to the end of 2024 and transition to safe storage by 2028.

OPG has and continues to make significant investments to modernize and to improve the reliability and safety of the plant.

OPG's Equipment Reliability Program is multi-faceted and comprised of eleven key programmatic elements that synergize to continuously improve the condition of the plant and its performance. These programmatic elements, as illustrated in Figure A.1 are briefly described below.

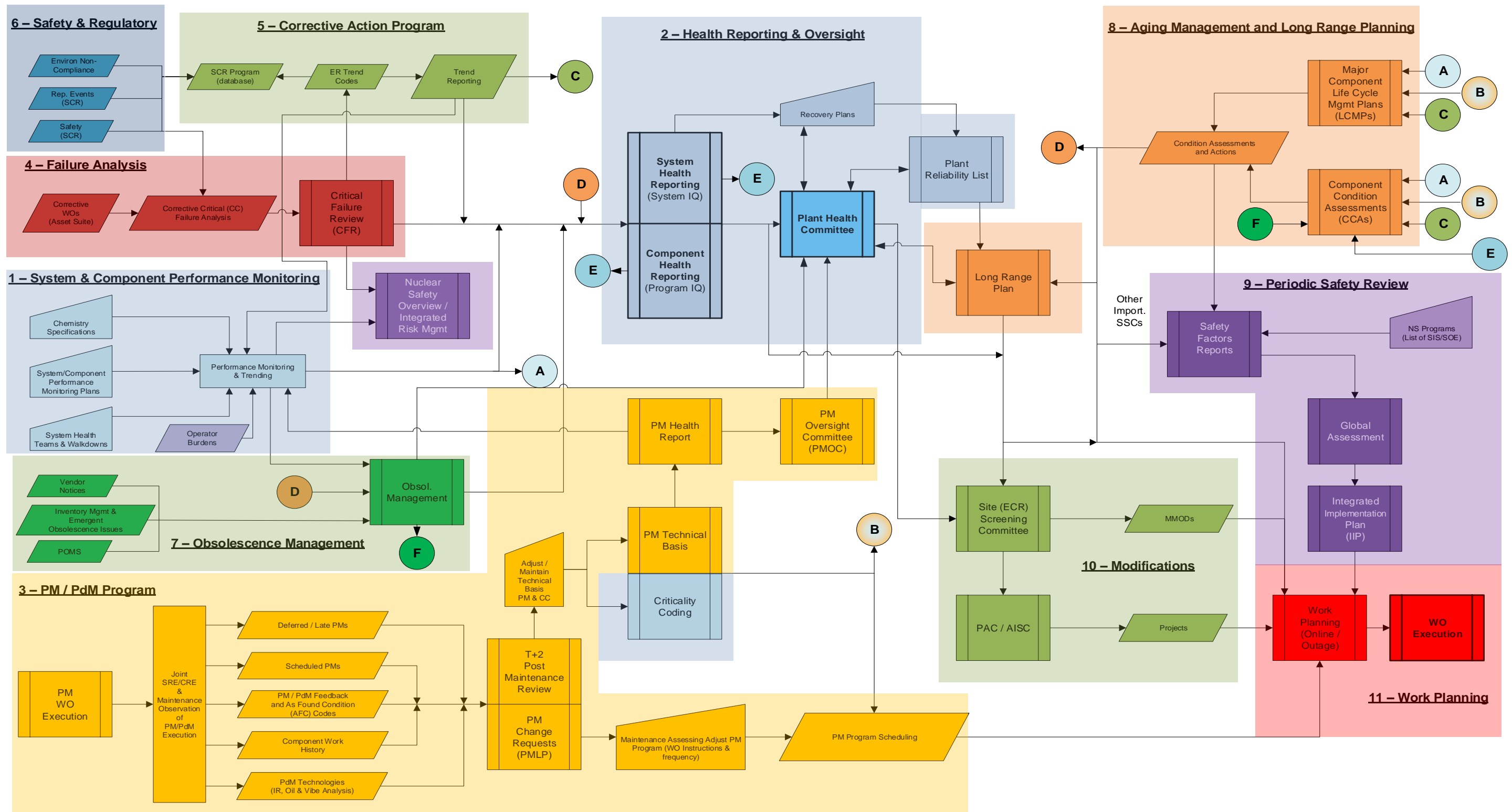


Figure A.1: OPG's Equipment Reliability Process Flow

1) System and Component Performance Monitoring

Performance monitoring ensures regular inspections of the plants Structures, System and Components (SSC) are conducted and that their maintenance is completed so that their intended design function and performance objectives are met at all times.

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
Chemistry Specifications	System Performance Monitoring Chemistry Program Equipment Reliability Program
System/ Component Performance Monitoring Plans	System Performance Monitoring Component and Equipment Surveillance Pump Strategy Motor Strategy AOV Strategy MOV Strategy NV Strategy HX Strategy Buried Piping
System Health Teams & Walkdowns	System Performance Monitoring
Operator Burdens	System Performance Monitoring Rounds And Routines Control of Operator Challenges Temporary Change Records
Performance Monitoring & Trending	System Performance Monitoring Component and Equipment Surveillance Critical Equipment Identification And Categorization
Nuclear Safety Overview/ Integrated Risk Management	Risk and Reliability Program

2) Health Reporting and Oversight

Health reporting ensures that the current health of the plants SSCs are documented and that actions plans, when required, to improve their health are in place.

The Plant Health Committee provides weekly oversight to ensure action plans are appropriate and resourced.

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
Component Health Reporting	Component And Equipment Surveillance
System Health Reporting	System Performance Monitoring Equipment Reliability Program System Health Reporting
Recovery Plans	Equipment Reliability Implementation
Plant Health Committee	Equipment Reliability Program
Plant Reliability List	
Long Range Plan	Equipment Reliability Implementation Nuclear Outage Generation Planning Nuclear Business Planning Program Nuclear Business Planning

3) Preventative (PM) and Predictive (PdM) Maintenance

Maintenance is performed on both a timed and condition based schedule. Results of maintenance and as found conditions are documented and regularly reviewed so that maintenance programs are adjusted on an ongoing basis to reflect real time learning.

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
PM WO Execution	Preventive Maintenance Technical Specifications Predictive Maintenance Program Requirements
Joint SRE/CRE & Maintenance Observation of PM/PdM Execution	Preventive Maintenance Technical Specifications Predictive Maintenance Program Requirements Equipment Reliability Program
Deferred/Late PMs	
Scheduled PMs	
PM/PdM Feedback and As Found Condition (AFC) Codes	
Component Work History	
PdM Technologies (IR, Oil & Vibe Analysis)	

Program	Sub-Elements of the Program
T+2 Post Maintenance Review	
PM Change Requests (PMLP)	
Adjust/Maintain Technical Basis PM & CC	
Maintenance Assessing Adjust PM Program (WO Instructions & frequency)	Preventive Maintenance Technical Specifications Predictive Maintenance Program Requirements
PM Program Scheduling	
PM Technical Basis	
Criticality Coding	Critical Equipment Identification And Categorization
PM Health Report	Preventive Maintenance Technical Specifications Predictive Maintenance Program Requirements Fleetview Program Health And Performance Reporting
PM Oversight Committee (PMOC)	Preventive Maintenance Technical Specifications Predictive Maintenance Program Requirements

4) Failure Analysis

This element ensures that failures of SSCs are analyzed, causes are fully understood, trends are assessed and that effective corrective action plans are put in place to prevent recurrence.

Figure A.1 provides a box number and title for each element of the program. The associated components of these sub-elements are listed in the table below.

Program	Sub-Elements of the Program
Corrective WOs (Asset Suite)	Corrective Action
Corrective Critical (CC) Failure Analysis	Equipment Reliability Implementation Equipment Reliability Program
Critical Failure Review (CFR)	

5) Corrective Action Program

The results of failure analysis and its associated corrective action plans are documented and tracked in the Corrective Actions Program database. This ensures learnings are documented and shared within OPG and, as appropriate, externally with industry. This also ensures that oversight is provided for effective implementation of corrective action plans.

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
SCR Program (database)	Corrective Action Processing Station Condition Records
ER Trend Codes	Corrective Action Trend Codes Applied To Station Condition Records
Trend Reporting	Corrective Action Trending And Analysis Instruction And Performance Improvement Reporting

6) Safety and Regulatory

This element ensures that safety related failures receive additional scrutiny and are reported as appropriate to meet regulatory requirements.

Figure A.1 provides a box number and title for each element of the program. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
Environmental Non-Compliance	Conduct Of Regulatory Affairs Environmental Management Environmental Management System Environmental Nonconformity, Corrective and Preventive Action
Reportable Events (SCR)	Conduct Of Regulatory Affairs Processing Station Condition Records Preliminary Event Notification

Program	Sub-Elements of the Program
Safety (SCR)	Conduct Of Regulatory Affairs Processing Station Condition Records Safety Hazard and Worker Safety Concern Resolution

7) Obsolescence Management

This element ensures obsolete components are proactively identified and replaced in a timely manner.

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
Vendor Notices	Obsolescence Management
Inventory Management	Obsolescence Management Items and Services Management
POMS	Obsolescence Management
Obsolescence Management	

8) Aging Management and Long Term Planning

OPG's Integrated Aging Management Program (IAMP), which is compliant with both IAEA Safety Guide NS-G-2.12 and CNSC REGDOC-2.6.3, ensures OPG understands the condition of the Pickering structures, systems and components which include critical station equipment, and that the necessary activities are in place to assure the health of these structures, systems and components through the licence period.

Integrated aging management is implemented using the "Plan-Do-Check-Act" framework (Figure A.2) and through the coordination of several programs, which include the Equipment Reliability Program, the Major Components Program, and the Component and Equipment Surveillance Program that assess all of the plant SSCs including critical station equipment (e.g., fuel channels). The aging management program ensures long term plans are developed so that necessary activities are in place to assure the long term health of these SCCs through the licence period.

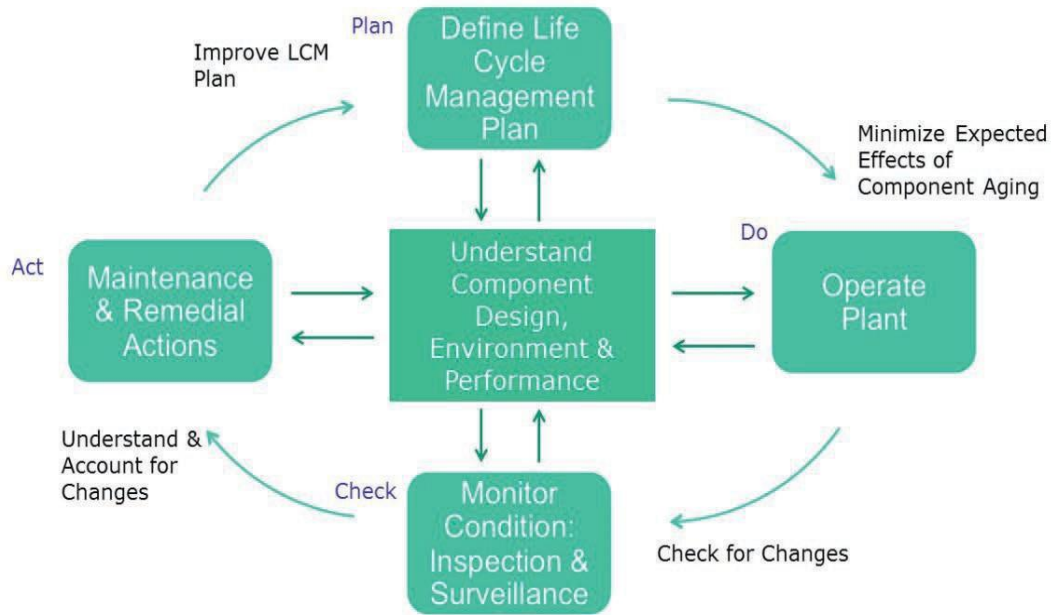


Figure A.2: Plan-Do-Check-Act Model

The Aging Management Program and the activities it drives through long term planning are key to ensuring critical equipment aging is proactively managed such that operation of the nuclear power plant remains within the licensing basis of the facility and allows for station safety and operational goals are met in the long term. OPG produces and regularly updates major components Life Cycle Management Plans (LCMP) which ensure that the activities to assure fitness for service are well defined and that these activities are planned and coordinated. With revision on an annual basis, each LCMP is sent to the CNSC for review prior to being formally implemented. The plan is optimized by ongoing assessment of component condition. Execution of the plan requires projections to be made regarding fitness for service for the planned life of the components. This process ensures the effects of component aging are managed, allowing for operation of the reactor to target end of life with mitigating actions implemented as required. The LCMPs are submitted to the CNSC pursuant to the Pickering operating licence.

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
Major Component Life Cycle Management Plans (LCMPs)	Major Components Program Feeders Technical Basis Document Pickering Units 1 and 4 Steam Generator Life Cycle Management Plan Pickering Units 5-8 Steam Generator Life Cycle Management Technical Basis Report on Technical Basis for Fuel Channels Life Cycle Management Plan

Program	Sub-Elements of the Program
Component Condition Assessment (CCAs)	Integrated Aging Management Aging Management Process
Condition Assessment and Actions	Aging Management Process

9) Periodic Safety Review (PSR)

The PSR ensures that fitness for service issues that affect nuclear safety related SSCs are identified, factored into the Global Assessment results and actions, as appropriate, are included in the Integrated Implementation Plan (IIP).

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
NS Programs (List of SIS/SOE)	Pickering A And B List Of Safety Related Systems Pickering A Systems Important To Safety Pickering B Systems Important To Safety Preparation of Safe Operating Envelope Compliance Tables
Safety Factors Reports	Periodic Safety Reviews
Global Assessment	
Integrated Implementation Plan (IIP)	

10) Modifications

This element ensures that replacement of SSCs that require a plant modification are appropriately prioritized, funded, planned and executed. Larger scale and more complex modifications would be part of the Long Term Plan and implemented as a Project.

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
Site (ECR) Screening Committee	Engineering Change Control Modification Process
PAC/AISC	Guide To Modification Process
MMODs	
Projects	Engineering Change Control Modification Process Guide To Modification Process Project Management

11) Work Planning

All work that directly impacts the plants SSCs (maintenance, repair, replacement projects, etc.) is executed via OPG's work management processes. Routine on-power maintenance activities are performed on a daily basis, while other more complex tasks or inaccessible equipment (e.g. fuel channels) require a unit shutdown, or 'outage' to perform the required maintenance.

Figure A.1 provides a title for each sub-element of this program element. The associated components of these sub-elements of the program are listed in the table below.

Program	Sub-Elements of the Program
Work Planning (Online/Outage)	Production Work Management Forced Outage Management Planned Outage Management Integrated On-Line Work Scheduling Work Initiation Approval and Prioritization Conduct Of Maintenance
WO Execution	Production Work Management Work Performance Conduct Of Maintenance

OPG has assessed the Pickering SSCs and have concluded that effective maintenance plans are in place to support safe and reliable operation to the end of 2024 and transition to safe storage by 2028.

ADDENDUM B: Pickering Used Fuel Storage - Overview

Used fuel discharged from the reactor is stored initially in the Pickering irradiated fuel bays (IFB) for wet storage. The bays together with the cooling and purification systems, provide fuel cooling and shielding, and the water allows access to the fuel, via remotely operated and automated systems, for handling and examination. The bay structure and structural elements (such as fuel containers and stacking frames) provide mechanical protection. See Figure B.1.



Figure B.1: Pickering Auxiliary Irradiated Fuel Bay

Pickering 5-8 has one irradiated fuel bay to store and cool used fuel bundles. Used fuel that has been stored in the IFB for at least 10 years is transferred to dry storage containers and transported to the Pickering Waste Management Facility (PWMF) for interim storage. Used fuel bundles from Pickering 1-4 are held in the Pickering 1-4 irradiated fuel bay for 4 years and then transferred to the Auxiliary Irradiated Fuel Bay (AIFB). The Auxiliary Irradiated Fuel Bay is used to store and cool used fuel bundles from Units 1 and 4 and for Units 5-8 cobalt-60 storage and processing. Once cooled, typically an additional 6 years, the used fuel bundles from the AIFB are transferred to dry storage containers and transported to the PWMF for interim storage. Please refer to Figure B.2 and B.3 which provides details of the dry storage container and Figure B.4 which pictorially depicts the process.

The dry storage containers are large, transportable containers with an inner cavity for fuel containment (See figure B.2). Each one is designed to hold 384 fuel bundles and weighs approximately 60 tonnes when empty and 70 tonnes when loaded.

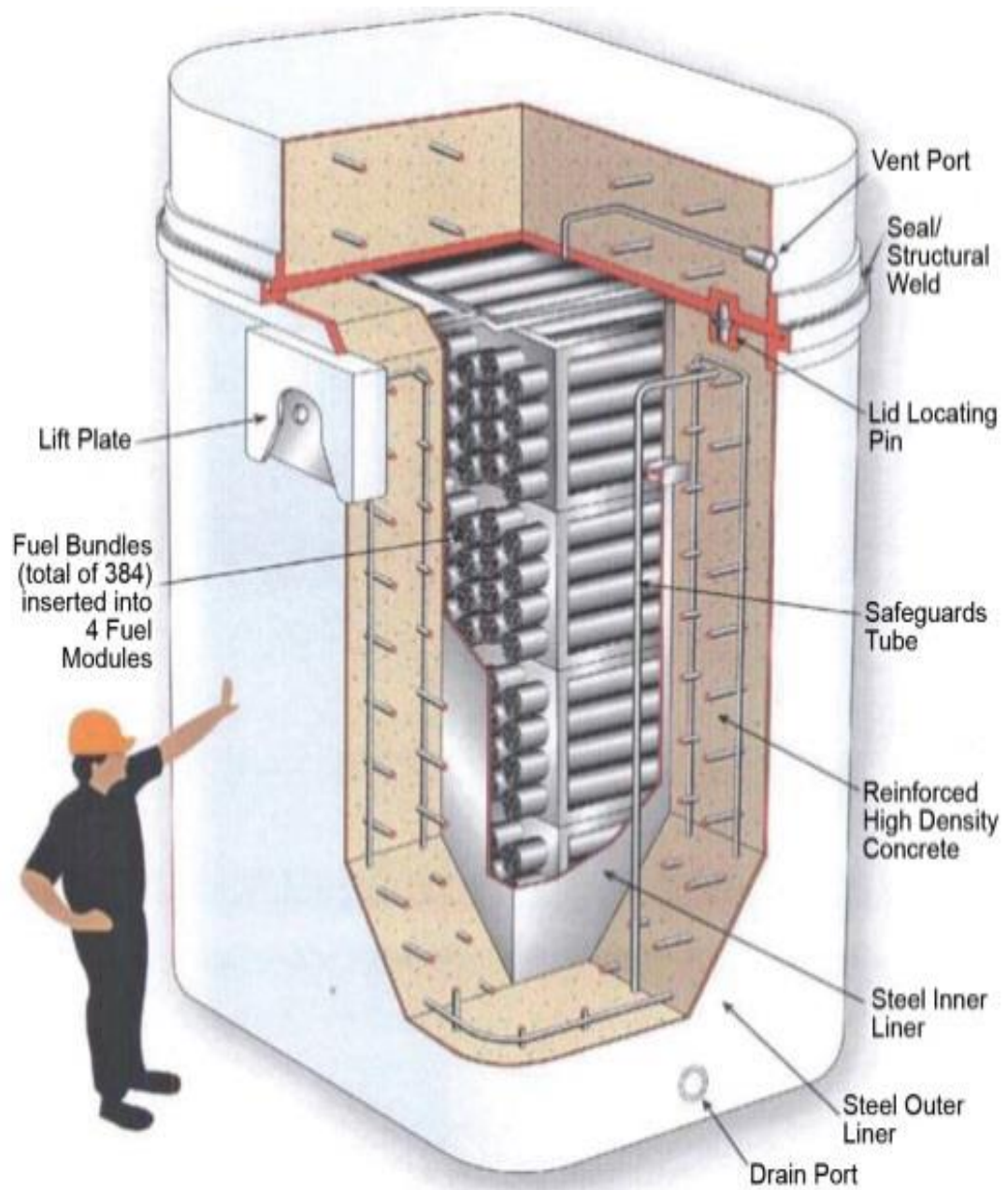


Figure B.2: Dry Storage Containers – Detailed View

The containers are rectangular, with walls of reinforced, high-density concrete sandwiched between interior and exterior shells made of carbon steel. Helium is used as the inert cover gas in the dry storage container cavity to protect the fuel bundles from potential oxidation reactions and to facilitate leak testing of the containment boundary. There are no radiological releases under normal operating conditions and the dry storage modules do not pose a radiological risk to staff (see figure B.3).



Figure B.3: Dry Storage Containers at Pickering Waste Management Facility

The movement of used fuel from the bays to dry storage is performed to ensure that sufficient fuel bay storage area is available to receive used fuel from the refueling of the reactor during normal operation or defueling of the units as part of the activities to place the unit in a safe storage state. The dry storage facility provides safe, secure, passive dry storage of used fuel onsite until a permanent storage facility is in operation.

Pickering NGS has been removing used fuel from the irradiated fuel bays and transferring it as dry fuel to the Pickering Waste Management Facility since 1996. PWSMF staff have not had a lost-time accident in over 23 years.

The PWSMF is licensed separately by the CNSC.

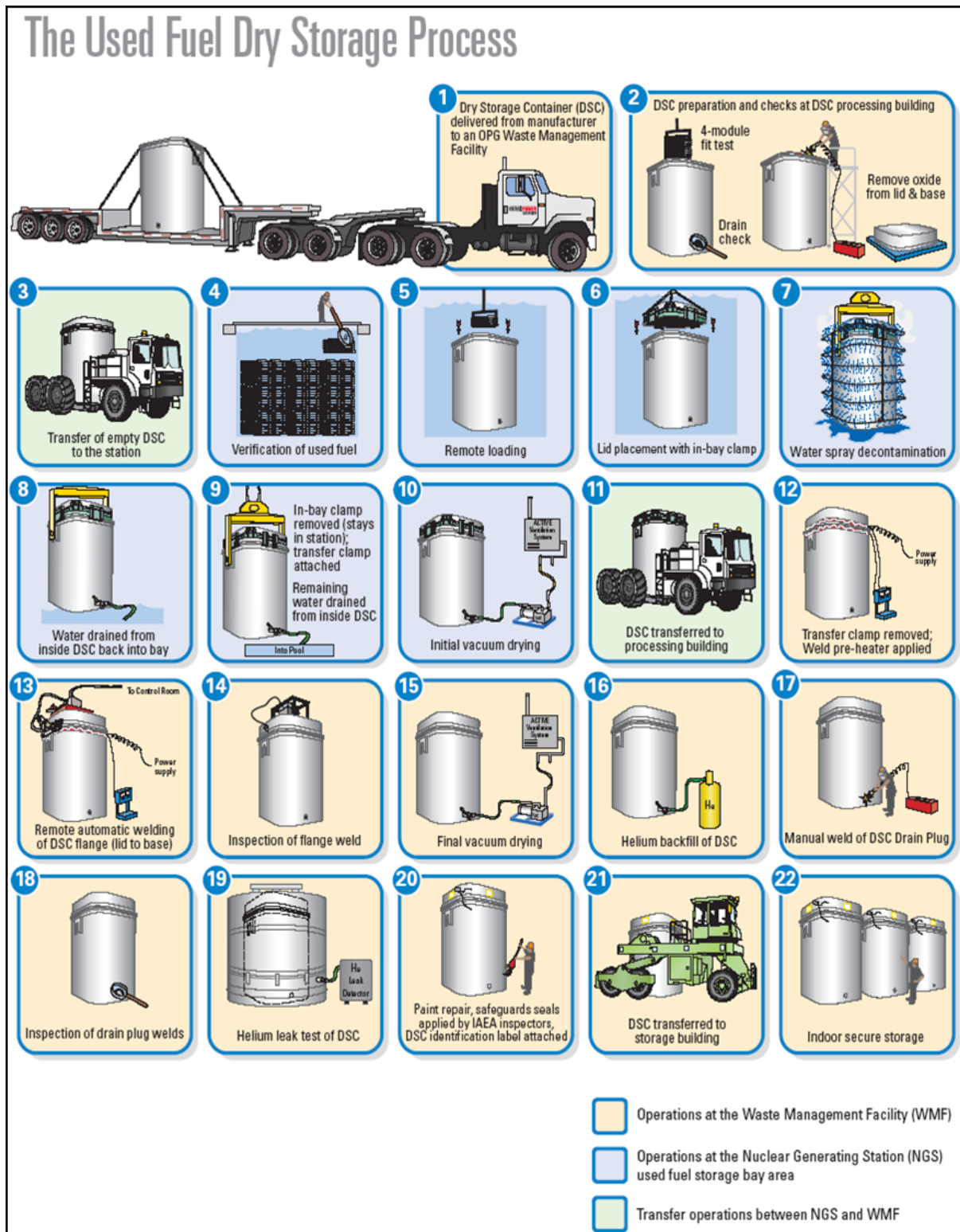


Figure B.4: Used Fuel Dry Storage Process