



## **Supplementary Information**

### **Written submission from Ontario Power Generation Inc.**

In the Matter of the

**Ontario Power Generation Inc.**

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Application to extend the operation of  
Pickering Nuclear Generating Station  
Units 5 to 8 until December 31, 2026

**Commission Public Hearing**

**June 2024**

## **Renseignements supplémentaires**

### **Mémoire d' Ontario Power Generation Inc.**

À l'égard d'

**Ontario Power Generation Inc.**

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Demande visant à prolonger l'exploitation  
des tranches 5 à 8 de la centrale nucléaire de  
Pickering jusqu'au 31 décembre 2026

**Audience publique de la Commission**

**Juin 2024**



# Supplemental Written Submission

**In support of Pickering's power reactor  
operating licence amendment application**

CMD 24-H5.1A

**Public Hearing**

Scheduled for:  
*June 2024*

**ONTARIO  
POWER  
GENERATION**



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# 1.0 Introduction – Supplemental information

In June 2023, Ontario Power Generation (OPG) requested authorization from the Canadian Nuclear Safety Commission (CNSC) to operate the Pickering Nuclear Generating Station (NGS) units 5 to 8, until the end of December 2026. This authorization was requested with the required information as detailed by the Pickering NGS Power Reactor Operating Licence PROL-48.01/2028 and the associated Licence Conditions Handbook.

The application, “Pickering Nuclear Generating Station Power Reactor Operating Licence Amendment Application” (Reference 1) provided information to demonstrate that Pickering NGS will continue to meet all the legal requirements of the Nuclear Safety and Control Act and the associated Regulations, and that Pickering NGS will continue to operate safely and within the required margins for an operating nuclear plant. As well, OPG requested approval for the licence limit for operation of the pressure tubes up to 305,000 Equivalent Full Power Hours (EFPH) for the lead Pickering NGS unit (unit 6).

This supplemental document provides additional information for the requested

authorization (Sections 1 – 5) and provides updates to the status of metrics and information that were pending at the time of the application, listed by Safety Control Area (Section 6). This supplemental document is meant to be read in conjunction with the application and does not negate any information that was already provided.

Additionally, OPG acknowledges that the CNSC staff have proposed a change to amend the current PROL to remove licence condition 15.3 related to pressure tube assessment and include a new licence condition 6.2 related to an enhanced fitness for service program for fuel channels in extended operation. Additional information on fuel channels is provided in this supplemental document and OPG confirms that Pickering NGS can comply with the proposed licence condition 6.2.

In summary, the original licence amendment application provided in June 2023, together with this supplemental document, contains the information to demonstrate that Pickering NGS meets all the regulatory requirements for the continued safe operation of Pickering NGS units 5 to 8 until the end of 2026. OPG continues to be qualified to carry on the licensed activities and continues to make adequate provisions to protect the health, safety and security of persons, and the environment.



## 1.1 Land acknowledgement

The lands and waters on which the Pickering Nuclear Generating Station is situated are the traditional territory of the Michi Saagig and Chippewa Nations, collectively known as the Williams Treaties First Nations. The lands are covered by the Gunshot Treaty (1877-88) and the Williams Treaties (1923). The Gunshot Treaty Rights, including the rights to hunt, harvest and fish were reaffirmed in 2018 by Canada and the Province of Ontario.

Ontario Power Generation respectfully acknowledges that the Williams Treaties First Nations maintain a cultural and spiritual presence within and relationship to these lands and the waters that touch them and continue to protect and care for them to ensure their health and integrity for generations to come.

As a company, Ontario Power Generation remains committed to working with the Williams Treaties First Nations, to develop positive and mutually beneficial relationships.



## 2.0 Supplemental information to the request to operate Pickering Nuclear Generating Station *units 5 to 8 to 2026*

The current Pickering Power Reactor Operating Licence (PROL) 48.01/2028 includes continued commercial operation of all reactor units until December 2024 as well as post-shutdown activities associated with removal of fuel and water in preparation for the safe storage of all units.

In June 2023, as required by the Power Reactor Operating Licence PROL-48.01/2028, OPG requested authorization from the Canadian Nuclear Safety Commission (CNSC) to operate Pickering Nuclear Generating Station (NGS) units 5 to 8 until December 31, 2026. OPG requests the CNSC to authorize operation of Pickering NGS units 5 to 8 until December 31, 2026 and approve the new licence limit for operation of the pressure tubes up to 305,000 EFPH for the lead Pickering NGS unit (unit 6). (Reference 1)

At the end of the authorized operations period, Pickering units 5-8 will enter the extended shutdown state as described in Sections 2.2 and 2.3 of this document.

### 2.1 2023 Operating performance

Pickering NGS has continued to show strong performance throughout 2023, providing the station's highest generation output since 2019, and the second highest as a six-unit station. In 2023,

the Pickering NGS production was 21.5 Terawatt-hours (TWh) – which is 0.1 TWh higher than 2022 and 0.7 TWh above our 2023 production target. This strong performance is a result of a decrease in the number of planned outage days, along with a better-than-expected forced loss rate.

OPG uses sophisticated monitoring and measurement systems to track each station's performance. These measurements are crucial for assessing the efficiency, reliability, and overall health of our generation infrastructure and allow OPG to ensure continued safe operations of Pickering NGS.

### 2.2 Potential refurbishment of Pickering units 5 to 8

The potential refurbishment of Pickering units 5 to 8 is not considered in this application to amend the Pickering NGS PROL. Information is included here for consideration that Pickering NGS units 5 to 8 will enter the defueled and dewatered safe state during extended shutdown.

In August 2023, OPG completed the assessment stage for the potential refurbishment of Pickering NGS units 5 to 8, as requested by the Province of Ontario on September 29, 2022. The assessment stage included scope development, schedule development,



risk assessments, economic evaluations, and regulatory strategies. It also included preliminary high-level technical assessments, progress updates, initial financial assessments, industry capacity and capability assessments and commercial strategies, community engagement and initial discussions with First Nations communities.

On January 30, 2024, OPG's Shareholder, the Province of Ontario, approved the Pickering NGS refurbishment and OPG is proceeding with the project definition and planning phase which will further define the regulatory and safety requirements.

Upon the required shutdown of Pickering NGS units 5 to 8, the station will be in the extended shutdown state. The units will be transitioned individually from normal operations to a defueled and de-watered state until the next phase has been determined, or when refurbishment begins.

OPG has also taken the opportunity to provide updates and information on the possible refurbishment of Pickering NGS units 5 to 8, to the First Nations and communities, the public and key stakeholders through regular meetings and public information sessions, which are currently on-going.

### **2.3 Safe states for extended shutdown**

Pickering NGS units 5 to 8 will remain in the extended shutdown state, transitioning to a defueled and dewatered

state, until the next phase of the refurbishment has been determined and defined. Nuclear safety is assured during the transition of each unit from an operating unit to a unit in extended shutdown state.

The shutdown of an individual unit is divided up into four states that represent key transition points in the overall lowering of the risk profile of the unit as it transitions to the extended shutdown state. They are defined as follows:

#### **State 1: Transition from normal operations to Guaranteed Shutdown State (GSS)**

In this state, the unit moves from full power operation to the GSS as per normal operating practices and procedures. This is a standard operating state for a unit (i.e., during regularly scheduled maintenance outages), for which applicable nuclear safety requirements are already clearly defined and reflected in the station operating documentation.

#### **State 2: Unit in GSS**

The transition from State 1 to State 2 occurs when a GSS is established and the Heat Transport System (HTS) is depressurized and cooled down to below 90°C. In State 2, the unit is in a GSS and will remain in this state until the unit has been completely defueled. Most unit systems will need to remain available until defueling is complete. Consideration is also given to system requirements that are dependent on the selection of the GSS method.

### State 3: Unit defueled

The transition from State 2 to State 3 occurs once the reactor core has been completely defueled. In State 3, the unit has been defueled, but the HTS and Moderator System (as applicable depending on the GSS) have not been drained. Once a unit is defueled, safety requirements related to accident prevention and mitigation related to fuel cooling and criticality will no longer apply.

### State 4: Unit defueled and dewatered

The transition from State 3 to State 4 occurs once dewatering of the unit HTS and Moderator System is complete. In State 4, the unit is defueled with the HTS and Moderator System drained. Once a unit has been dewatered, it will be possible to eliminate safety requirements imposed by the presence of D2O and tritium in the HTS and Moderator System.

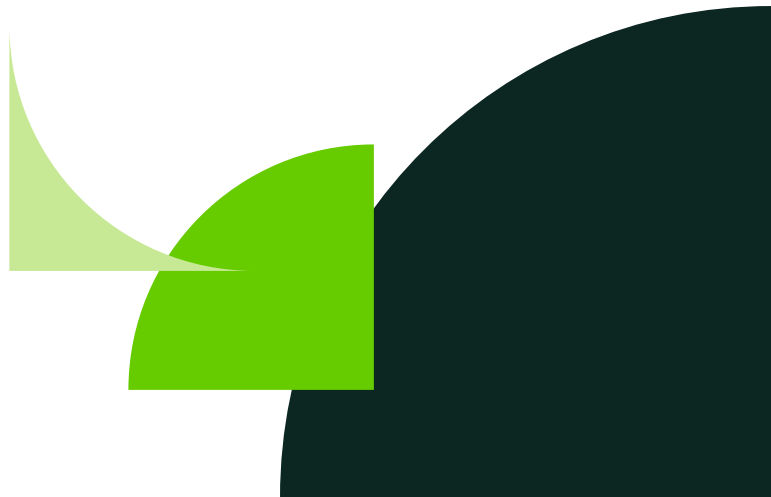
## 3.0 Update to the periodic safety review and status of integrated implementation plan actions

As required by the current Pickering NGS licence, a re-assessment of the continued validity of the Periodic Safety Review 2 (PSR2), called PSR2-B, was carried out to confirm that design, condition and

operation of Pickering NGS supports continuing commercial operation from 2024 to 2026. The PSR2-B concluded that the current plant design, operation, processes and management system will ensure continued safe operation of Pickering NGS units 5 to 8 to the end of December 2026.

The PSR2-B did not identify any new gaps except to update those actions which were time dependent on the end date for operation of the components and actions identified to meet new versions of the standards that are not yet in the licence. These actions, incorporated into the Integrated Implementation Plan (IIP), define the actions required to ensure the continued validity of the periodic safety review, until the evaluated date of December 2026.

The IIP was submitted to the CNSC to support the continued operation of Pickering NGS units 5 to 8 until the end of 2026. In July 2023, the CNSC staff concluded that the IIP meets CNSC regulatory requirements and OPG's re-assessment strategy document supports the continued operation of Pickering NGS units 5 to 8 until 2026.



Safety and Control Area	IIP Assignments	IIP Resolution Actions
Management System	1	1
Safety Analysis	4	1
Physical Design	1	1
Fitness for Service	9	8
Emergency Preparedness and Fire Protection	4	2
Total	19	13
Total IIP Commitments	32	

*Table 1 - Shows the number of IIP Resolution Actions and Assignments related to each Safety and Control Area (SCA)*

Since the acceptance of the IIP by the CNSC staff, OPG has been working towards completing the action items prior to their committed dates as identified in the IIP. OPG has submitted 4 assignments for completion concurrence to the CNSC staff. These 4 assignments include:

1. G01-RS5-06-01.1-B Fitness for Service for Fuel Channels, to update the Periodic Inspection Plan for the Fuel Channels Pressure Tubes to reflect the extended operating period for units 5 to 8 up to the end of 2026. Update of the Pickering NGS units 5 to 8 Periodic Inspection Program (PIP) Plan incorporated the gap analysis between the 2014 and 2019 editions of Canadian Standards Association (CSA) N285.4 Clause 12 for fuel channel inspection requirements.
2. G01-RS7-06-03.1-B Fitness for Service for Fuel Channels, to perform spacer testing and reassessment of Inconel X-750 spacers for Pickering NGS unit 8. The spacer testing was completed to determine the maximum load capacity for Pickering NGS unit 8 and submitted to the CNSC. The removed spacers taken during the Darlington NGS unit 3 refurbishment help support demonstration of Fitness for Service for all Pickering NGS units 5 to 8 Inconel X-750 spacers.
3. G01-RS8-06-04.1-B Fitness for Service for Fuel Channels, to develop and submit implementation plan for developing inputs to satisfy the methodology in the Non-Mandatory Annex G of N285.8-15 Update 1, for performing uncertainty analyses in evaluations where the threshold requirement is met. Implementation plans for uncertainty analysis to satisfy non-mandatory Annex G of CSA N285.8-15 Update #1 for reactor core assessments have been provided to CNSC.
4. G20-RS1-01-08.1-B Governance Implementation / Effectiveness Issues, to implement the loop failure detection modification for the emergency water system on units 5 to 8. This installation of the modification was completed, and the required Available for Service meeting was completed, and the results submitted to the CNSC.

OPG is actively managing the remaining commitments to completion and expects to finish them before December 31, 2024 as required by the IIP.

## 4.0 Update to the Reconciliation Action Plan

OPG is committing to a continued journey of reconciliation with Indigenous Nations and communities through a Reconciliation Action Plan (RAP).

The Reconciliation Action Plan is OPG's road map for how it intends to work in partnership with Indigenous Nations and communities, businesses and organizations to advance reconciliation. It's also about how it intends to grow and continue learning as an organization. More information on the Reconciliation Action Plan is available in Section 4.1.4.2.3 of the 2026 Licence Amendment Application.

OPG is updating the RAP to include additional targets that were developed based on feedback from Indigenous Nations and communities and Indigenous businesses.

New targets have been established and will be in addition to the targets from the original RAP.

OPG has once again met its targets for 2023 under the areas of Leadership, Relationships, People, Economic Empowerment, Environmental

Stewardship, including the notable activities below:

- ▶ OPG placed 32 Indigenous Opportunities Network (ION) candidates in roles for a grand total of 125 placements in the industry since late 2018 when we first started taking candidates into the program. Our goal this past year was to place at least 20 candidates and we achieved 60 percent placements above our initial target. In 2024 our goal is to more than double our placements and reach a new goal of 50 candidates placed within the energy sector.
- ▶ OPG has expanded opportunities for Indigenous businesses to participate in nuclear procurement. As a result, the nuclear qualified vendors list now includes 3 Indigenous businesses, surpassing the initial target of 2.
- ▶ Since 2021, we have met \$237.4 million of the \$1 billion economic impact target for Indigenous communities and businesses over 10 years (by 2031).
- ▶ OPG is actively seeking input from the Williams Treaties First Nations (WTFNs) and the OPG Indigenous Circle throughout the design process for the new OPG Headquarters in Oshawa. This feedback will be used to infuse elements of local Indigenous culture into the architecture and landscape of the new headquarters.

## 5.0 Update for fuel channels and proposed new licence *condition*

### 5.1 Update for fuel channels fitness for service

In the Pickering NGS application, OPG requested approval of a licence limit for operation of the pressure tubes up to 305,000 EFPH for the lead Pickering NGS unit (unit 6). (Reference 1)

In Reference 2, OPG provides CNSC staff with OPG's assessment demonstrating the Pickering NGS units 5 to 8 that fitness for service of fuel channels, is assured to the conservative projected Equivalent Full Power Hours (EFPH) for each unit.

In September 2023, OPG provided a second semi-annual update on activities related to status of fuel channel inspections. Work completed to date continues to support that pressure tubes installed in all OPG reactors remains safe for operation with postulated elevated [Heq] in both the inlet and outlet regions.

In response to CNSC staff review of the assurance of FFS:

- ▶ Establishment of the basis for continued demonstration of FFS of fuel channels has been completed through update of the Fuel Channel Life Cycle Management Plan for operation to the end of December 2026.

- ▶ OPG continues to complete commitments and is progressing work on the remaining items, further details of this work are contained in Appendix A.

### 5.2 Proposed new licence condition for fuel channels

In the 2018 decision on the licence renewal for Pickering NGS, CNSC staff recommended that the Commission include in the renewed PROL PNGS specific licence condition 15.3 which would require OPG to demonstrate, before pressure tube Hydrogen Equivalent [Heq] exceeded 120 ppm, that pressure tube fracture toughness would be sufficient for safe operation beyond 120 ppm.

Licence Condition L.C. 15.3, was added to the 2018 Pickering NGS licence, PROL 48.00/2028.

In December 2023, OPG provided prior written notification and concurrence for operation of Pickering NGS units 5 to 8 pressure tubes with [Heq] above 120 ppm. Safe operation above 120 ppm has been demonstrated based on ongoing confirmation that the probability of flaws in the region remains very low, in addition to burst tests that demonstrate acceptable material properties.

Currently, due to the evolving inspection results and analysis in the industry, licence condition 15.3 has become obsolete. CNSC staff have indicated that they will recommend the removal of L.C. 15.3 and the addition of a new L.C. 6.2 which would require Pickering NGS to implement and maintain an enhanced fitness for service program for fuel

channels in extended operation. Currently, the life cycle management plans for fuel channels have been updated for operation to December 2026, as a result of actions taken for PSR2-B.

With respect to a new licence condition on fuel channel fitness for service, OPG can and will satisfy the requirements of L.C. 6.2 when implemented into Pickering NGS's PROL.

## 6.0 Safety and control areas

The following information is provided as updates to specific Safety and Control Areas, supplementary to the information provided in Pickering NGS's June 2023 "Pickering Power Reactor Operating Licence Amendment Application" (Reference 1). The relevant section which is being updated is referenced to this document, referred to as the "2026 Licence Amendment Application".

### 6.1 Management systems

OPG's mature and effective nuclear management system provides the framework for programs, standards and processes which collectively ensure that OPG's Pickering NGS operates safely, and that safety is the foremost consideration in management decisions and actions. The following sections provide a description of improvements and initiatives since the application submission in this area. More information on the Management Systems SCA is available in Section 6.1 of the 2026 Licence Amendment Application (Reference 1).



*2026 Licence Amendment Application  
section 6.1.1.1 – Management system*

In 2023, through benchmarking, self-assessments and stakeholder input, OPG made improvements to the Fleetview Program Health and Performance Reporting process, which assess the effectiveness of the Nuclear Management System. These improvements include:

- ▶ Standardized Area Performance Summary (internal) and Integrated Performance Summary Report (external),
- ▶ Capturing performance indicators in the Plant Information Center, providing a comparison of OPG performance to industry, and better understand gaps to achieving Industry Top Quartile performance.

As per the change management plan, a self-assessment is planned for Q2 2024 to assess the effectiveness of the changes made and determine if further improvements are needed.

*2026 Licence Amendment Application  
section 6.1.1.2 – Staffing management*

Staffing

OPG has integrated and robust workforce planning processes that maximize and deploy our resources where they are required to support our work programs. We take a fleet perspective with our staffing programs and work with our bargaining agents to maximize our resource flexibility. Our highly skilled workforce is needed to support a wide

range of operational, project, and outage work across OPG.

**6.2 Human performance management**

The Pickering Human Performance department aims to improve human performance at every level of the organization. In this cross-functional approach, each line organization maintains accountability for their human performance (Hu), while the Pickering Human Performance Department provides performance analyses, recommendations, and develops initiatives to support continuous Hu improvement. The following sections provide a description of some current improvements and initiatives in this area. More information on the Human Performance Management SCA is available in Section 6.2 of the 2026 Licence Amendment Application.

*2026 Licence Amendment Application  
section 6.2.1.1 – Human performance management*

Current improvement plans include implementing an enhanced human performance training to “Stop When Unsure”. This training supports a culture of having a questioning attitude which reinforces the response to stop for cues of uncertainty, before an error becomes a consequential event.

Another initiative is to improve the Observation and Coaching (O&C) program. Pickering NGS is implementing the “Coaching to Enhance Performance” initiative. This training supports and

teaches supervisors the importance of quality observation and coaching and how to perform effective O&Cs. The process provides consistency in methodology, quality data collection and feedback, leading to more effective observations from a workforce that embraces the process as it delivers uplifting, informative, and fair results for overall individual and organizational performance improvement.

***2026 Licence Amendment Application section 6.2.1.2 – Personnel Training***

The health of training is carefully monitored with a defined program to ensure that there is Systematic Approach to Training (SAT) foundation for our nuclear training programs, to ensure staff have the appropriate knowledge, skill and attitudes for safe and efficient plant operations.

***2026 Licence Amendment Application section 6.2.1.3 – Certification***

OPG, in consultation with the industry, is developing an implementation plan to transition to the latest revision of REGDOC 2.2.3 Personnel Certification,

Vol III: Certifications of Persons Working at Nuclear Power Plants.

There continues to be a high number of qualified individuals for each position that requires CNSC certification. Table 2 below contains the number of Pickering certified staff, as of December 31, 2023.

***2026 Licence Amendment Application section 6.2.1.5 – Fitness for Duty***

OPG has implemented programmatic elements to comply with certain requirements as mandated by CNSC REGDOC 2.2.4 – Fitness for Duty, Vol. II: Managing Alcohol and Drug Use (version 3) (REGDOC 2.2.4) which was issued in November 2020 and has been in effect since January 2021. On June 6, 2023, the Federal Court of Canada endorsed the CNSC’s move to require pre-placement and random alcohol and drug testing for workers in Safety-Critical positions at high-security nuclear facilities; however, the implementation of these requirements is currently stayed, pending the outcome of an appeal filed by the Unions on the Federal Court’s

<b>Pickering NGS Units 5 to 8</b>			
<b>Certified Position</b>	<b># Certified Staff</b>	<b># of Trainees</b>	<b>Minimum Required</b>
Shift Manager and Control Room Shift Supervisor	22	8	10
Authorized Nuclear Operator	53	9	30
Responsible Health Physicist	2	1	1

*Table 2 - Number of Pickering Certified Staff (December 31, 2023)*



decision. All licensees, including OPG, are currently restricted from implementing pre-placement and random alcohol and drug testing pending the final disposition of the appeal.

### **6.3 Operating performance**

The Operating Performance program continues to ensure that plant operation is safe and secure, with adequate regard for safety of the public, environment, plant personnel and equipment and international obligations. The following sections provide an update on some current improvements and initiatives in this area. More information on the Operating Performance SCA is available in Section 6.3 of the 2026 Licence Amendment Application.

#### *2026 Licence Amendment Application section 6.3.1.2 – Plant status control*

OPG had a significant reduction in misposition events over the past few years.

Misposition events categorized as Level 3 and Level 4 are not significant themselves but are tracked for trending purposes, and as a leading indicator to help inform activities to improve plant status control.

#### *2026 Licence Amendment Application Section 6.3.1.5 – Outage Management Performance*

A recent outage improvement initiative at Pickering NGS is the use of an outage shift schedule to efficiently deploy resources during critical outage execution windows. This initiative ensures that there are dedicated resources attached

to the outage schedule, improving the predictability of the outage commitment and timelines by improving ownership of issues and enabling effective oversight, resourcing, and readiness.

### **6.4 Safety analysis**

OPG continues to maintain and routinely update the Safety Analysis to demonstrate the fundamental safety functions to control power, cool the fuel, and contain or limit any accidental releases from the plant.

With the completion of the Probabilistic Safety Assessment (PSA) update, OPG has gathered insights from the High Wind PSAs for Pickering A and B to identify areas to reduce the risk resulting from hazards due to high winds at PNGS. The risk improvement strategy identifies High Wind PSA elements that are expected to provide the most safety protection when undergoing refinements. The strategy identifies analytical improvements and potential safety improvement opportunities and has been submitted to the CNSC in January 2024 for further review.

### **6.5 Physical design**

Information on the Physical Design SCA is available in Section 6.5 of the 2026 Licence Amendment Application.

### **6.6 Fitness for service (FFS)**

OPG's fitness for service programs ensure all equipment is available to perform its intended design function when called upon to do so. The physical condition of

structures, systems and components at Pickering NGS remain available, reliable, effective and consistent with design, analysis and quality control measures. The following sections provide a description of some current improvements and initiatives in this area. More information on the Fitness for Service SCA is available in Sections 4.1.3 and 6.6 of the 2026 Licence Amendment Application.

**2026 Licence Amendment Application section 6.6.1.1 – Equipment reliability**

The improvement in ERI performance between 2023 Q3 and 2023 Q4, as shown in Figure 1, is the result of improved availability of systems important to safety, improved chemistry performance, and long-term sustained reduction in equipment related forced loss rate.

**2026 Licence Amendment Application sections 4.1.3.2 – Fuel channel fitness for service and 6.6.1.2 – Major components**

As part of the continued condition assessment of fuel channels, OPG has completed several monitoring activities for key aging mechanisms including deuterium ingress through hydrogen isotope concentration measurements and material property changes through spacer material surveillance.

As previously discussed in Section 4.1.3.2.8 of the Licence Amendment application, following the high inlet and outlet rolled joint [Heq] findings at Bruce Power, OPG has increased sampling to monitor deuterium ingress to ensure confidence in [Heq] predictions. Two Rolled Joint (RJ) scrape channels (which

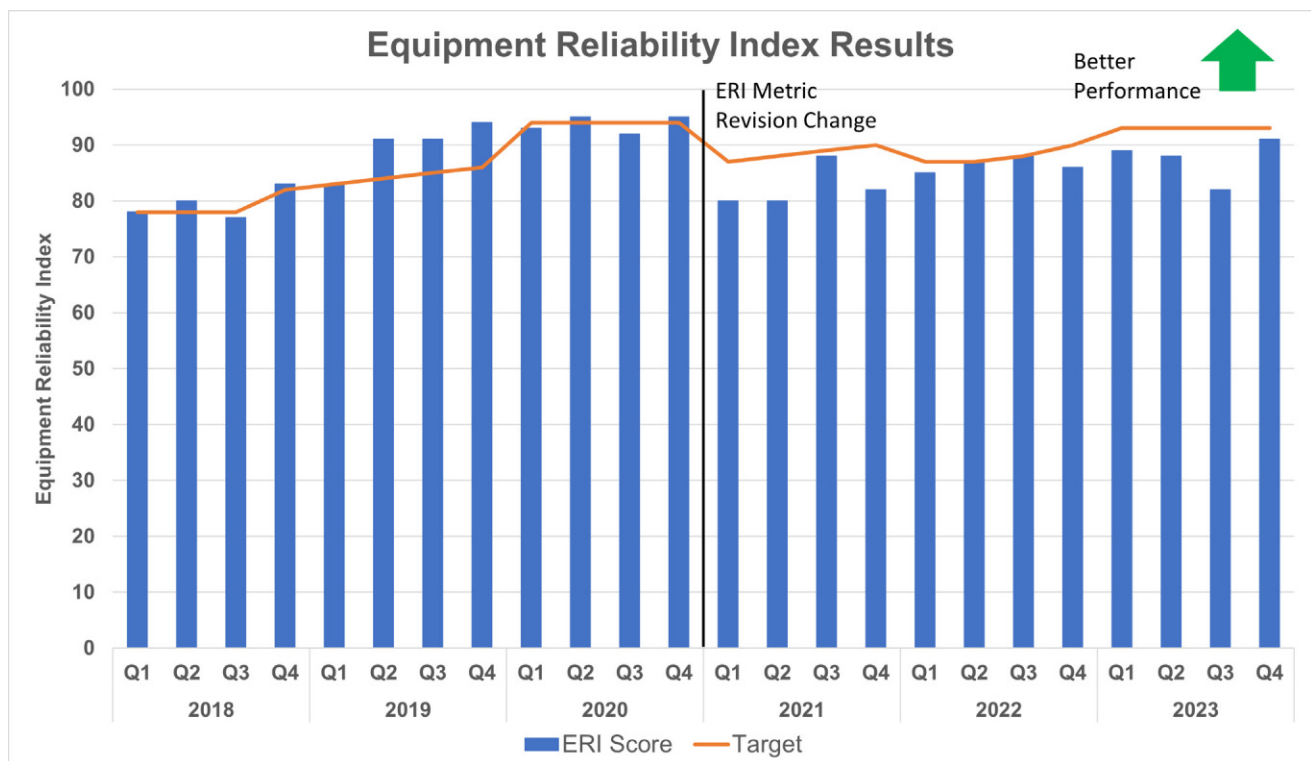


Figure 1 - Equipment Reliability Index (ERI) Results (a higher ERI value shows better performance)

were targeted based on the high [Heq] OPEX) from Pickering NGS unit 6 were dispositioned to be acceptable for continued operation. Flaw inspection findings also continue to support that there is a low probability of flaw formation and thus crack initiation in the region.

Work is also progressing on the Research and Development activities from the [Heq] roadmap to enhance existing [Heq] model predictions. In September 2023, OPG provided its second semi-annual update on activities related to the discovery of elevated [Heq]. Work completed to date continues to support that pressure tubes installed in all OPG reactors remains safe for operation with postulated elevated [Heq] in both the inlet and outlet regions.

OPG has also completed spacer surveillance testing to support demonstration of no PT to CT contact as previously discussed in the 2026 Licence Amendment Application Sections 4.1.3.2.10 and 4.1.3.2.11. Results from the 2022 unit 5 Zr-Nb-Cu spacers indicate sufficient load carrying capacity and spacer integrity to at least 305,000 EFPH, which demonstrates FFS of all Pickering NGS units 5 to 8 Zr-Nb-Cu spacers to the projected EFPHs. Additionally, removed Inconel X-750 spacers taken during the Darlington NGS unit 3 refurbishment help support demonstration of fitness-for-service for all Pickering NGS units 5 to 8 Inconel X-750 spacers.

As part of OPG's assessment to demonstrate that operation remains within the station's safety analyses, updated

FFS assessments have been completed on Pickering NGS unit 6 (lead unit) which confirm the operational risk remains low.

### *2026 Licence Amendment Application section 6.6.1.6 – Maintenance*

In 2023, Pickering NGS aligned to the Institute of Nuclear Power Operations (INPO) performance indicator reporting structure. The Maintenance Rework indicator is a significant contribution to the overall maintenance index and at the end of 2023, Pickering NGS Maintenance Index achieved industry top quartile performance.

### *2026 Licence Amendment Application section 6.6.1.7 – Fuel handling reliability*

Fuel Handling (FH) Equipment Reliability Index (ERI) has improved continuously since 2021 and achieved Pickering NGS best and industry leading performance throughout 2023. A key performance indicator, Forced Loss Rate (FLR),



has seen substantial year over year performance improvement since 2021 and achieved station best performance in 2023. Three of the Pickering NGS’s best years in terms of FH FLR have occurred in the past 5 years, demonstrating the continuous improvement of FH Equipment Reliability.

The Fuel Handling team is continuing to implement a large portfolio of equipment reliability projects to improve performance and prepare for Safe Storage and defueling activities. As of the end of 2023, Pickering NGS FH has replaced all eight irradiated fuel bay (IFB) heat exchangers as part of

our lifecycle management strategy. This increased the bay cooling margin to prepare for defueling as well as long term storage of irradiated fuel.

Based on completed and planned projects and initiatives, the station has set continuously increasing targets for FH ERI through the remaining operating life for all units as well as through the defueling campaign. Throughout 2023, the Pickering NGS FH ERI has sustained station best and industry leading performance, which reflects the station’s ongoing commitment to excellence in FH equipment reliability, as shown in Figure 2.

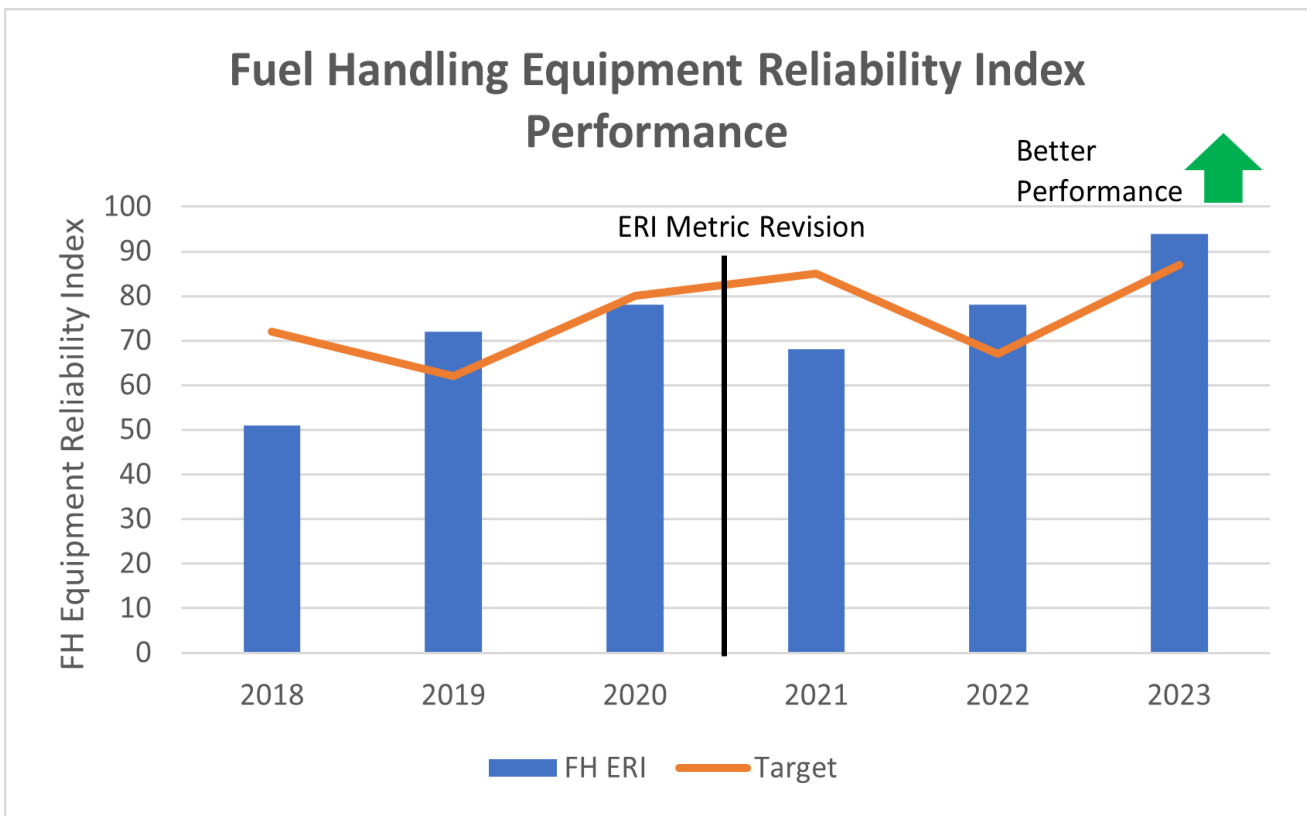


Figure 2 - Fuel Handling Equipment Reliability Performance (a higher Fuel Handling ERI value shows better performance)

### *2026 Licence Amendment Application Section 6.6.1.8 – Maintenance backlog*

It is a priority to ensure that Corrective Critical (CC), Corrective Non-Critical (CN), Deficient Critical (DC) and Deficient Non-Critical (DN) work order backlog is maintained at a minimum, which in turn allows important preventative maintenance programs to be executed to improve overall system reliability.

The Pickering NGS work order backlog performance has significantly improved over the past few years. As shown in Figure 3 below, the updated data shows continued improvement to the end of 2023 through the sustained decrease of the CC/CN and DC/DN maintenance work order backlog. This is largely due to a number of station initiatives and dedicated resources to ensure that

Pickering NGS achieves industry best performance in this area.

## **6.7 Radiation protection**

The Radiation Protection (RP) program controls occupational and public exposure As Low As Reasonably Achievable (ALARA) and prevents and monitors for the uncontrolled release of contamination or radioactive materials from the site through the movement of people and materials. The RP program includes a set of action levels to provide an alert before a regulatory dose limit is reached. The following sections provide a description of some current improvements and initiatives in this area. More information on the Radiation Protection SCA is available in Section 6.7 of the 2026 Licence Amendment Application.



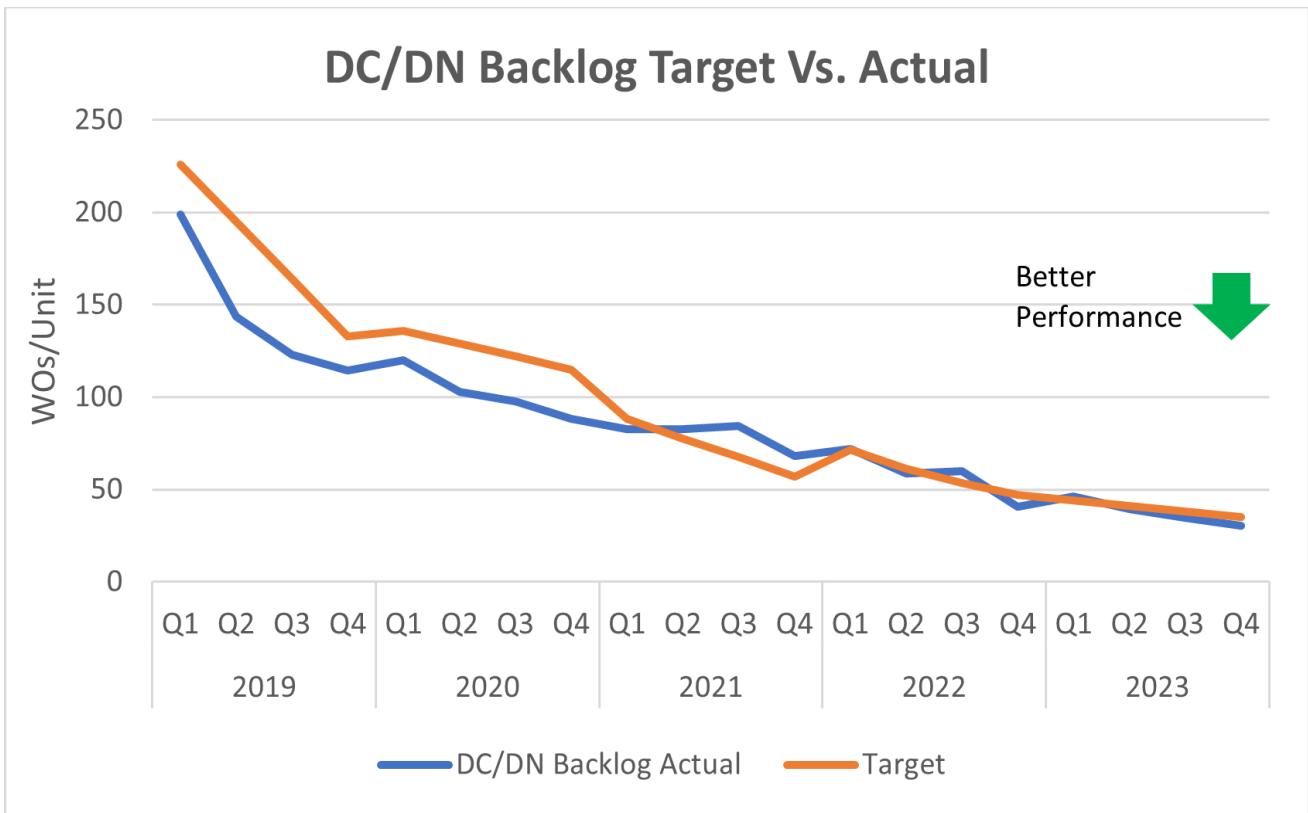
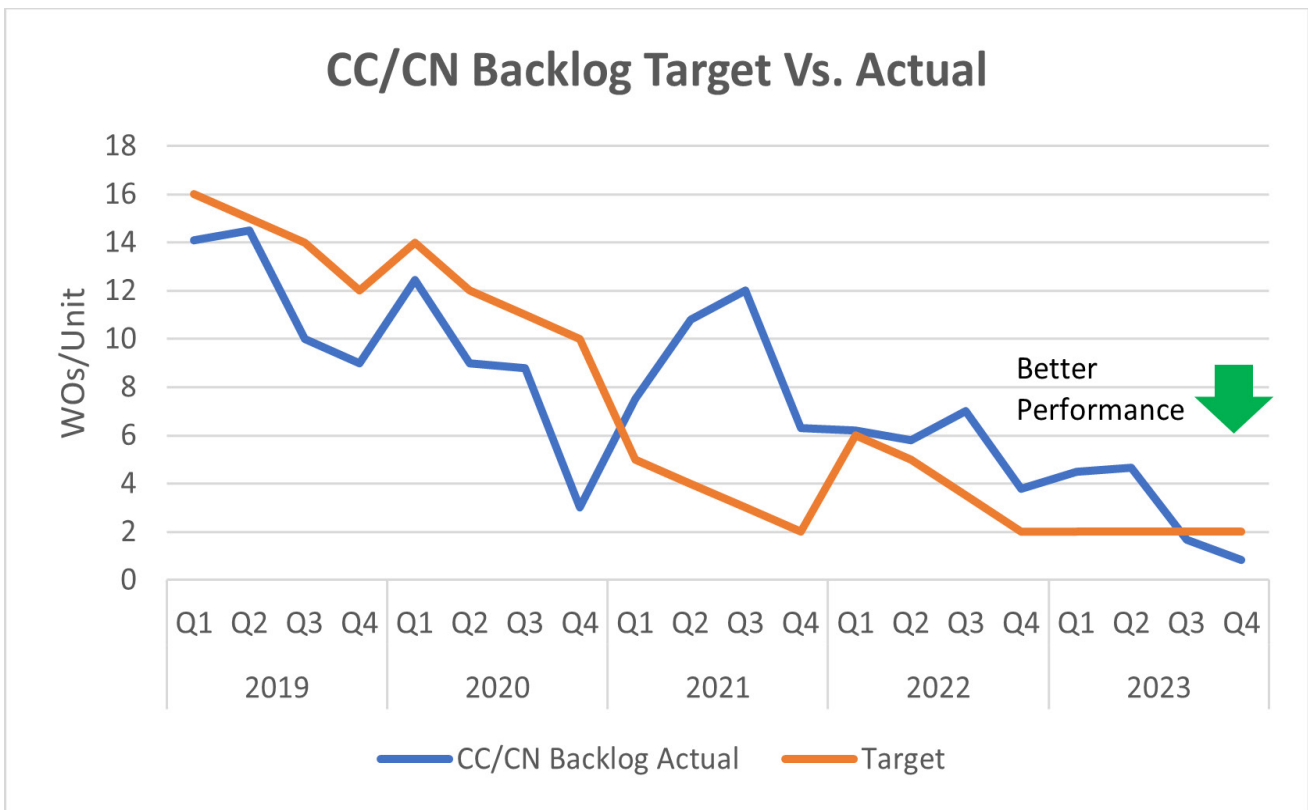


Figure 3 - Corrective Critical and Non-Critical (CC/CN) Maintenance Backlog (Top) and Deficient Critical and Non-Critical (DC/DN) Maintenance Backlog (Bottom) (a lower number of backlogged work orders show better performance)

*2026 Licence Amendment Application  
section 6.7.1.1 – Application of As Low  
as Reasonable Achievable*

As shown in Figure 4, the Pickering NGS collective radiation exposure continues to show better than the target dose. The exposure dose performance in 2023 is due to lower than planned dose rates for planned maintenance outages. Also, site wide initiatives to reduce radiation exposure including dose goal setting, source term reduction and mitigation, work methods improvement and improving RP worker practices by driving individual accountability.

*2026 Licence Amendment Application  
Section 6.7.1.2 – Worker dose control*

Pickering NGS monitors performance of precursor indicators related to worker dose control such as the number of EPD

dose alarms. These precursor indicators are tracking of low-level events in order to identify and correct behaviors or improve related work plans. There continues to be no worker doses at Pickering NGS which exceed regulatory or OPG administrative dose limits.

**6.8 Conventional health and safety**

Conventional health and safety work practices and conditions at the station result in a high degree of personnel safety. The following section provides a description of some current improvements and initiatives in this area. More information on the Conventional Health and Safety SCA is available in Section 6.8 of the 2026 Licence Amendment Application.

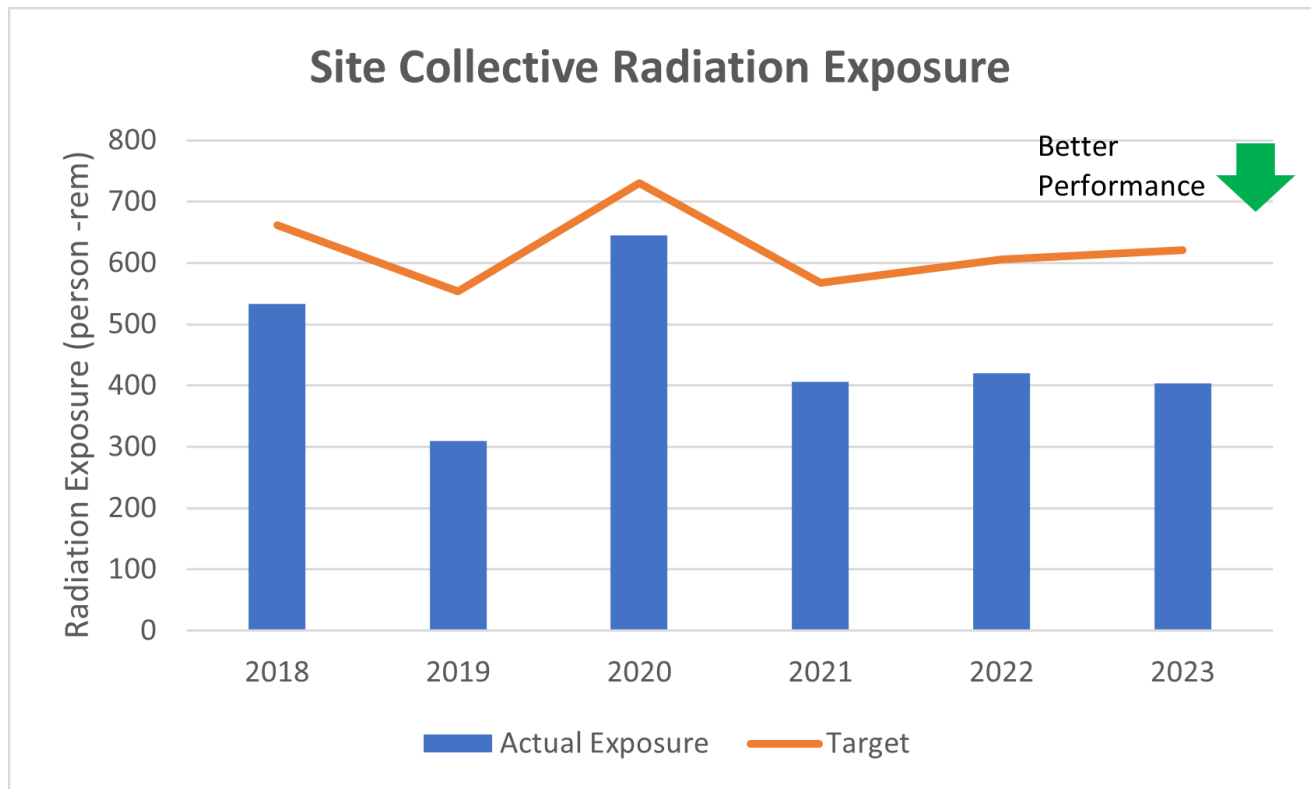


Figure 4 - Site Collective Radiation Exposure (a lower radiation exposure shows better performance)

**2026 Licence Amendment Application  
section 6.8.1.1 – Conventional health  
and safety program**

Annual accident injury rate

Previously, OPG measured safety performance using Accident Injury Rate (AIR) as a metric. In 2018 this was changed to measuring Total Recordable Injury Frequency (TRIF) to align with Canadian industry benchmarks.

As of the end of 2023, the Pickering NGS AIR/TRIF rate was below target as shown in Figure 5 below. The AIR/TRIF rate is expected to continue to trend downwards as OPG continues to drive health and safety program enhancements.

Accident severity rate

Pickering’s Accident Severity Rate performance over the current licensing period was strong. From 2019 to 2023, Pickering achieved five consecutive years with no lost time injuries resulting in top quartile performance in the Canadian utility generation sector.

Safety enhancements

A number of health and safety enhancements have been made to the program, equipment and systems at Pickering NGS during the current licensing period. The next steps in driving continuous improvement in OPG’s performance in

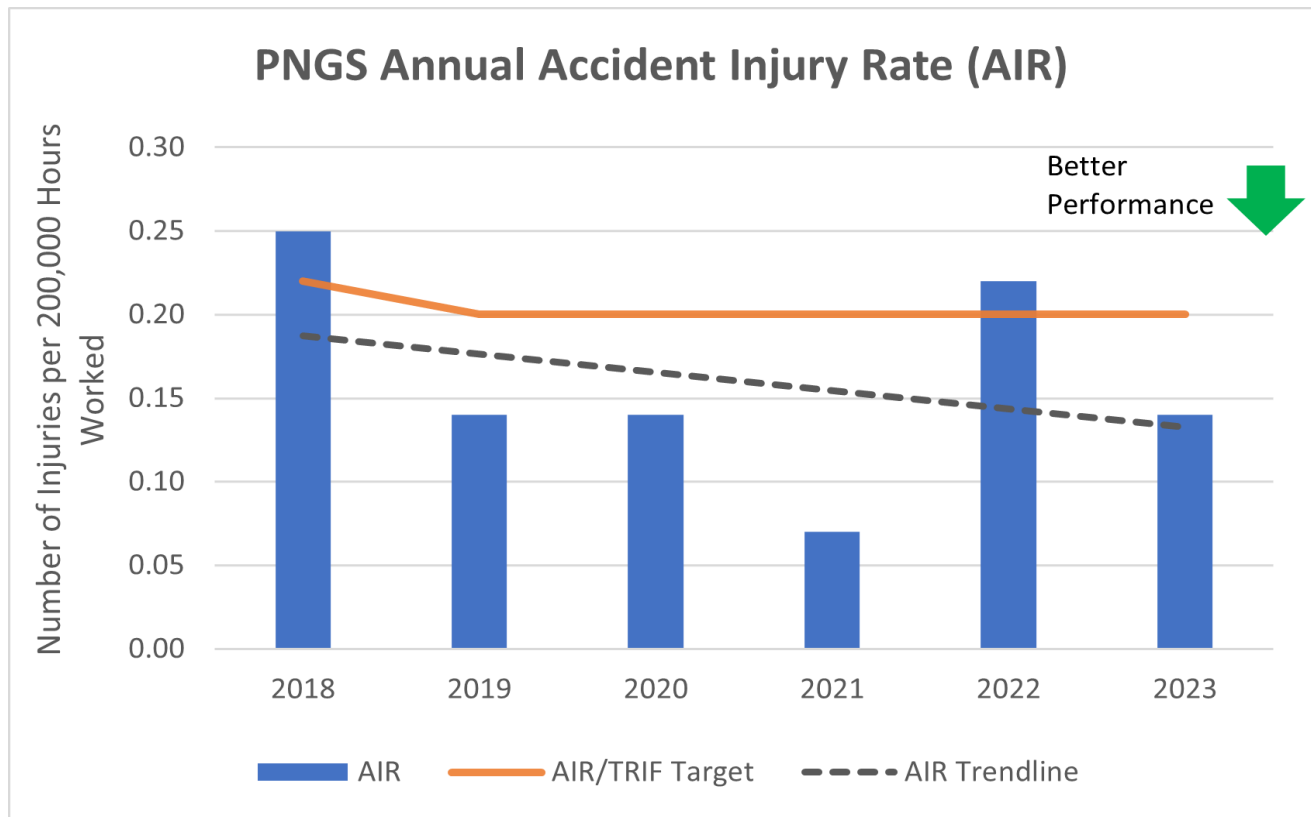


Figure 5 - Pickering NGS Annual Accident Injury Rate (a lower injury rate shows better performance)



Health and Safety Management system and Human Performance programs is the Fail Safe program.

The Fail Safe program recognizes that human error is inevitable. By planning and reflecting on work with a Fail Safe lens, we can anticipate where errors may occur and build capacity with strong defenses. As a learning organization, this perspective is essential to proactively identify improvement opportunities. This will provide the platform to take our health and safety program and performance to the next level as we proactively measure the effectiveness of our defenses, instead of the presence or absence of events. This provides the platform to further improve OPG's safety program. Currently, Fail Safe initiatives which have been completed at Pickering NGS include:

- ▶ Implement timely training sessions of the new electronic safe work planning platforming order to direct focus to identifying hazards present during work planning process.
- ▶ The Timely Completion of Safety Corrective Actions metric was introduced in 2018 and is the percentage of corrective actions, arising from safety events, that are completed on or before the initial due date (zero extensions). This metric encourages positive behaviors and outcomes desired in OPG employees and work programs and supports building the safety culture. Since the introduction of this metric, Pickering NGS has maintained performance at 100 percent.

- ▶ Trending Prevention and Intervention program supports departments in identifying and addressing early conditions by focusing on safety-related actions and increased management oversight.
- ▶ Integration of the Quality Safety Practice metric into Pickering NGS forums to promote awareness on site level observations and potential trends which may arise. This is a proactive indicator which uses field level observations and insights to determine Pickering NGS areas of strength and outlines potential opportunities for improvement before breakthrough events. This proactive indicator builds onto existing performance monitoring and allows early identification of hazards and real-time comparison of target areas for effectiveness measurement.

## 6.9 Environmental protection

OPG's comprehensive environmental protection program aims to continually minimize impacts from the station operation to the environment and human health. This is achieved by ensuring there are multiple barriers in place to control and minimize emissions to the environment and to ensure all emissions are monitored. The following section provides a description of some current improvements and initiatives in this area. More information on the Environmental Protection SCA is available in Sections 4.1.2.5 and 6.9 of the 2026 Licence Amendment Application. The metrics provided in the 2026 Licence Amendment

Application related to the Environmental Protection SCA for 2023 year-end are not yet available and are not shown in this document. However, interim Environmental Emissions Data for Pickering NGS in 2023 Q2 can be found on OPG.com.

#### *2026 Licence Amendment Application section 6.9.1.4 – Fish impingement and entrainment*

In April 2023, OPG submitted an application for an administrative amendment to the Fisheries Act Authorization (FAA) to the Fisheries and Oceans Canada (DFO), to reflect operation beyond December 31, 2024 subject to Commission approval. In September 2023, the DFO notified OPG that an amendment would not be required should operations of units 5 to 8 continue from December 31, 2024 to December 31, 2026 as these dates still fall within the valid Authorization period.

OPG has also notified the DFO of its intent to file an application for technical amendments to the Authorization to update the impingement and entrainment losses and offset gains using revised metrics. A twelve month entrainment study is being undertaken in 2024 and 2025. After the study is complete, the entrainment losses for 2018-2023 will be updated based on the study findings.

## **6.10 Emergency management and fire protection**

Pickering NGS has effective emergency preparedness measures and fire protection response capabilities in place to prevent and mitigate the

effects of nuclear and hazardous substances releases, as well as, fire hazards, both onsite and offsite, in order to protect the workers, the public and the environment. The following sections provide a description of some current improvements and initiatives in this area. More information on the Emergency Management and Fire Protection SCA is available in Sections 4.1.2.4 and 6.10 of the 2026 Licence Amendment Application.

#### *2026 Licence Amendment Application section 4.1.2.4 – Emergency preparedness*

##### Drills and Exercises

In September of 2023, a scheduled multi-day exercise was conducted successfully at the Pickering NGS with all objectives met. The exercise, known as Exercise Unified Command 2023, involved collaborative efforts from the emergency response organization, station crews, personnel from various departments within the organization, and external stakeholders at the Federal, Provincial, and Municipal levels of government. The primary goal of the exercise was to test the ability of responding agencies to collectively respond to a simulated severe accident at the Pickering NGS resulting in an offsite release as per requirements of CNSC REGDOC-2.10.1 Nuclear Emergency Preparedness and Response. This type of event encompassed dynamic situations, such as managing competing priorities, coordinating the flow of information, and collaborating with external agencies. The exercise, which was a complex and cross-functional endeavor, challenged

participants with unknown scenarios. The next full-scale nuclear emergency response exercise at Pickering NGS is planned for 2026 and will continue every 3 years.

## 6.11 Waste management

Information on the Waste Management SCA is available in Section 6.11 of the 2026 Licence Amendment Application.

## 6.12 Security

The Nuclear Security Program ensures the safe and secure operation of the station, maximizing protection against threats to security through the use of equipment, personnel and procedures. The following sections provide a description of some current improvements and initiatives in this area. More information on the Security SCA is available in Section 6.12 of the 2026 Licence Amendment Application.

### *2026 Licence Amendment Application Section 6.12.1.1 – Nuclear Security Program*

The Security program has undergone a detailed assessment which has resulted in a number of programmatic changes in 2023. The Security program has been elevated to a higher corporate authority for both oversight and decision making. The Security Excellence Plan was developed with specific focus areas and target initiatives to drive improvement. As well, the Security Excellence Plan Meeting was created using a robust process which has been successfully used by other fleet programs. This resulted in the 2023

security excellence plan initiatives being executed with high priority. The development of the 2024 excellence plan is currently in progress.

- ▶ OPG's security governance were assessed against requirements of the Nuclear Security Regulation and regulatory documents, which resulted in the identification of procedural gaps. These gaps are actively being closed with procedural revisions.
- ▶ Pickering NGS is in the process of upgrading its security systems. The Entry Control System upgrade has been completed and the Security Monitoring System project upgrades are set to start the transition early in 2024.
- ▶ The Security training process is lengthy, is consistent with nuclear industry peers, and is aligned with municipal policing hiring practices. As a result, fifty-eight new highly trained and qualified security employees were onboarded in 2023.

## 6.13 Safeguards and non-proliferation

Information on the Safeguards and Non-Proliferation SCA is available in Section 6.13 of the 2026 Licence Amendment Application.

## 6.14 Packaging and transport

Information on the Packaging and Transport SCA is available in Section 6.14 of the 2026 Licence Amendment Application.

## 7.0 Update on CSA standards and REGDOCS

Table 3 provides a list of the CSA standard and REGDOCS which Pickering NGS will implement before the end of 2025 and as documented in the Pickering Licence Conditions Handbook (LCH-PR-48.00/2028-R006).

Item	Standard	Implementation Date
1	REGDOC-2.9.1 Environmental Protection: Environmental Principles, Assessments and Protection Measures, Version 1.2	December 31, 2023
2	REGDOC-2.11.1 Waste Management, Volume I: Management of Radioactive Waste	October 11, 2023
3	REGDOC-2.12.1 High Security Facilities, Volume II: Criteria for Nuclear Security Systems and Devices	September 27, 2023
4	REGDOC-2.12.3 Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1	September 27, 2023
5	CSA N285.5-22 Periodic inspection of CANDU nuclear power plant containment components (implementation plan for Units 5-8 only)	OPG has committed to provide the CNSC with OPG's Transition Plan identifying the compliance date and describing the plan and key transition dates for implementation of the 2022 edition of CSA Standard N285.5 by March 28, 2024.
6	CSA N288.1-20 Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	December 31, 2024
7	CSA N288.4-19 Environmental monitoring programs at nuclear facilities and uranium mines and mills	October 3, 2023
8	CSA N292.0-19 General principles for the management of radioactive waste and irradiated fuel	October 23, 2023
9	CSA N292.1-16 and Update 1 (R2021) Wet storage of irradiated fuel and other radioactive materials	Next update June 15, 2024
10	CSA N292.3-14 Management of low and intermediate-level radioactive waste	October 10, 2023
11	CSA N292.8-21 Characterization of radioactive waste and irradiated fuel	Next update May 31, 2024
12	CSA N292.2-13 and Update 1 (R2018) Interim dry storage of irradiated fuel	October 25, 2023

Table 3 - CSA Standards and REGDOCS Pickering NGS added to Pickering LCH

## 8.0 References

1. OPG Letter, J. Franke to D. Saumure, “Pickering Nuclear Generating Station – Power Operating Licence Amendment Application”, June 16, 2023, CD# P-CORR-00531-23266P,
2. OPG Letter, J. Franke to R. Richardson, “Pickering NGS – Assurance of Major Components Fitness -for -Service for the Conservative Projected Operating Hours of Pickering units 5-8”, April 19, 2023, CD# NK30-CORR-00531-08660P.

## 9.0 Acronyms

<b>AIR</b>	Accident Injury Rate	<b>FH</b>	Fuel Handling
<b>CANDU</b>	CANada Deuterium Uranium	<b>FLR</b>	Forced Loss Rate
<b>CC</b>	Corrective Critical	<b>GSS</b>	Guaranteed Shutdown State
<b>CN</b>	Corrective Non-Critical	<b>HTS</b>	Heat Transport System
<b>CNSC</b>	Canadian Nuclear Safety Commission	<b>IIP</b>	Integrated Implementation Plan
<b>CSA</b>	Canadian Standards Association	<b>INPO</b>	Institute of Nuclear Power Operations
<b>DC</b>	Deficient Critical	<b>ION</b>	Indigenous Opportunities Network
<b>DFO</b>	Fisheries and Oceans Canada	<b>LC</b>	Licence Condition
<b>DN</b>	Deficient Non-Critical	<b>LCH</b>	Licence Conditions Handbook
<b>EFPH</b>	Equivalent Full Power Hours	<b>LCMP</b>	Life Cycle Management Plan
<b>EPD</b>	Electronic Personal Dosimeter	<b>NGS</b>	Nuclear Generating Station
<b>ERI</b>	Equipment Reliability Index	<b>O&amp;C</b>	Observation and Coaching
<b>FAA</b>	Fisheries Act Authorization	<b>OPEX</b>	Operating Experience
<b>FC</b>	Fuel Channel	<b>OPG</b>	Ontario Power Generation
<b>FFS</b>	Fitness for Service	<b>PIP</b>	Periodic Inspection Program
		<b>PROL</b>	Power Reactor Operating Licence
		<b>PSA</b>	Probabilistic Safety Assessment
		<b>PSR</b>	Periodic Safety Review
		<b>PT</b>	Pressure Tube
		<b>RAP</b>	Reconciliation Action Plan
		<b>RJ</b>	Rolled Joint
		<b>RP</b>	Radiation Protection
		<b>RS</b>	Resolution Statement
		<b>SAT</b>	Systematic Approach to Training
		<b>SCA</b>	Safety and Control Area
		<b>TRIF</b>	Total Recordable Injury Frequency
		<b>TWh</b>	Terawatt-hour
		<b>WTFN</b>	Williams Treaties First Nations

# Appendix A

Item	Action Item	Action Description	Update
1	2022-OPG-25104	Hydrided Region Overload (HROL)	In December 2023, OPG provided an update on the progress and testing to-date for HROL under rapid cooldown conditions. OPG remains on track for completion of an amendment to the Mark 3 HROL model to incorporate the test results by July 2024, which will be submitted to the CNSC.
2	N/A	Extension to Pickering 5 to 8 Material Surveillance PIP Window	The P5N09 pressure tube material surveillance report was submitted to CNSC staff. The results met the acceptance criteria for all testing performed.
3	2023-OPG-27200	Hydrogen Concentration ([Heq]) Discovery Issues	Semi-annual update #2 with updates regarding the activities related to elevated [Heq] and crack initiation testing was submitted in September 2023. Work completed continues to support that Pressure Tubes (PTs) in OPG reactors remain safe for operation. OPG will provide the next update by March 29, 2024.
4	2017-OPG-11706	Fracture Toughness Model Limitation to PT FFS Assessments	OPG has worked with industry partners to extend the [Heq] validity of the Revision 2 engineering fracture toughness model, up to 110 ppm within 1.5 m from the front end, and up to 200 ppm in the remainder of the PT. The next update of the burst test plans which support the fracture toughness model is planned by July 31, 2024.
5	N/A	Structural Integrity of Tight-Fitting Spacers	A revised spacer fitness-for-service (FFS) assessment based on supporting test results from the Darlington unit 3 refurbishment spacers have demonstrated the FFS validity limit is extended to 285 kEFPH. The 285 kEFPH bounds the projected operation for Pickering units 5 to 8 for channels with tight-fitting spacers.
6	2023-48-26686	Compliance to N285.4-2019	A PIP plan update for CSA N285.4-19 Clause 12 incorporating the gap analysis between the N285.4 2014 and 2019 editions was submitted and accepted by CNSC staff.  The transition plan to CSA N285.4-19, Update #1 was submitted to the CNSC and requests CNSC acceptance of the plan by February 5, 2024 and closure of AI 2023-48-26686.

Table A – Shows the Summary of Action Items and Commitments to CNSC regarding Major Components and CSA N285.5-18 at Pickering NGS 5 to 8

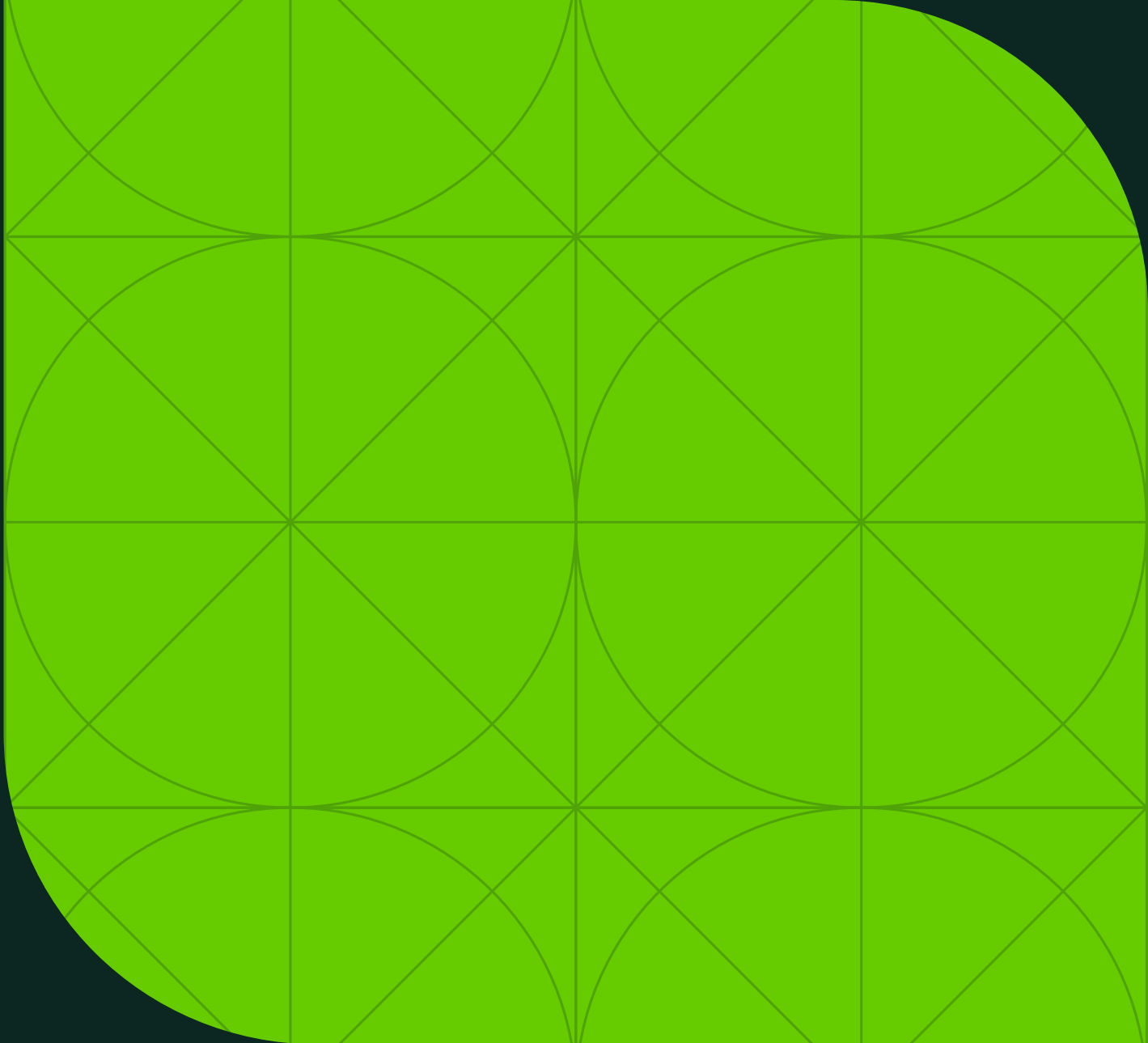
# Appendix A *(continued)*

Item	Action Item	Action Description	Update
7	2022-48-24858	Submission of Parametric Study for Channel Specific Probabilistic Blister Susceptibility Methodology	OPG informed CNSC staff that the parametric study of the channel specific probabilistic blister susceptibility assessment methodology will be submitted by April 17, 2024.
8	2022-48-28576	Validation of Channel-Specific Assessment Methodology in Pickering unit 8	OPG stated that P2381 would include repeat gap inspection in four channels for validation of the channel specific assessment methodology, resulting in a total of six validation channels including two previously assessed P8 channels. Three channels from the P2381 outage were completed, resulting in a total of five validation channels. This satisfies the requirement that validation be performed on a minimum of five repeat channels per unit. Results will be reported in the updated CS-PBSA following the outage.
9	N/A	Validation of Channel-Specific Assessment Methodology in Pickering unit 6	OPG submitted a validation report, incorporating repeat PT-CT gap measurements on five channels from P2361, for a total of seven Pickering unit 6 channels. The report demonstrates that results from the first gap measurement can be used to successfully predict the gap at the time of the second measurement.
10	2022-OPG-20662	Probabilistic Fracture Protection Acceptance Criteria	In August 2023, OPG submitted the requested items raised under AI 2022-OPG-20662 and requested closure. Once closed, an update to the Pickering LCH with the Probabilistic Fracture Protection acceptance criterion will be made.
11	2023-48-27368	Compliance to N285.5-18	OPG has reviewed the CNSC staff request to transition to CSA N285.5-18 and has proposed to transition to the 2022 edition. OPG expects to be in full compliance with the 2022 edition by June 2, 2027. A transition plan identifying the compliance date, describing the plan with key dates will be provided by March 28, 2024.

Table A – Shows the Summary of Action Items and Commitments to CNSC regarding Major Components and CSA N285.5-18 at Pickering NGS 5 to 8







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